

**The End of the Line:  
Sustainable energy for rural  
peripheral regions**

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**Winston Churchill Memorial  
Trust**

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# 1. Introduction

## 1.1 A new Energy Economy

We are currently witnessing a paradigm shift of our energy economy. Our energy infrastructure is moving from what is currently a highly centralised system to one at the edge. The implications this has on how we produce, store, distribute and consume energy are significant. This shift in infrastructure will also move the market to the end of the line, turning the current system on its head. Such a change will allow for individual communities to take back the control of their own energy futures and ultimately to retain the value of their energy, locally. This is without doubt the next 'industrial revolution' and it can once again be driven from peripheral regions such as Cornwall.

The scale of this opportunity has been outlined by a recent House of Lords report which concluded that £846bn is required before the end of this decade if the European Union is to stave off an energy crisis. The only sustainable solution is to invest this money at the end of the line. Cornwall's geographical location combined with its diversity, creativity and innovative culture puts it in a unique position to capitalise on this.

## 1.2 The Smart Grid

Smart grids are a response to the above changes, providing a new type of electricity network which can respond to peaks and troughs in energy generation and demand. This will allow for the more efficient exploitation of renewable energy resources and increase in demand predicted through the move to electric heating and transportation.

Currently energy flows much like an upside down tree from large, mostly fossil fuel based suppliers, out through the branches to consumers. With the deployment of distributed renewable energy resources this energy tree is turned up the right way with energy being produced at the edge of the network alongside the consumers.

A smart grid network will allow for the more effective use of distributed, variable energy, through matching demand with the available energy. It will do this through reducing demand at peak times in homes and businesses, and through storing energy at times of excess, releasing it at times of need. The Smart bit is the two-way flow of energy and information which allows the grid to automatically balance itself.

## SMART GRID

A vision for the future — a network of integrated microgrids that can monitor and heal itself.

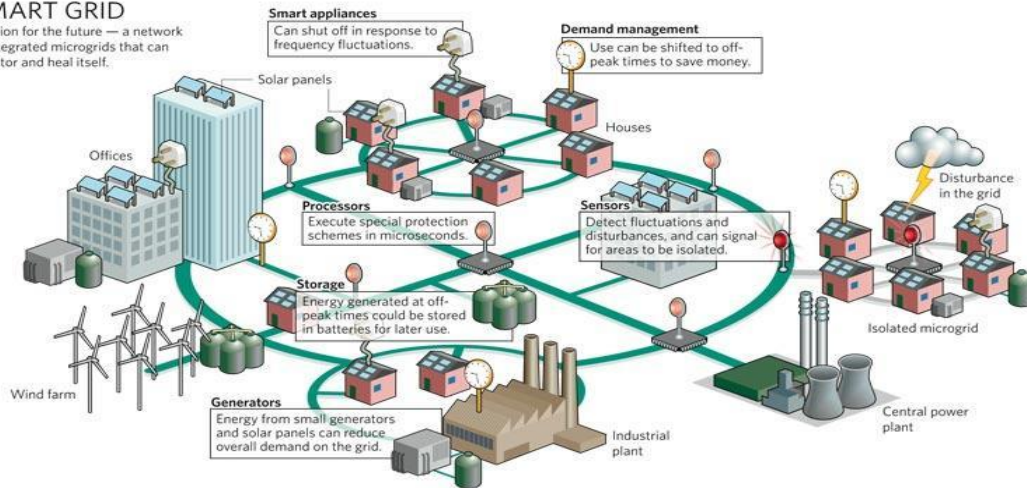


Figure 1. The Smart Grid

This will expose and eliminate waste and inefficiency from the system, empower consumers to interact directly with the grid, and increase capacity through more efficient power production and delivery. Smart grids will therefore play an integral role in supporting the move towards a more sustainable and resource efficient economy. Figure 1 above shows the major components of a Smart electricity Grid.

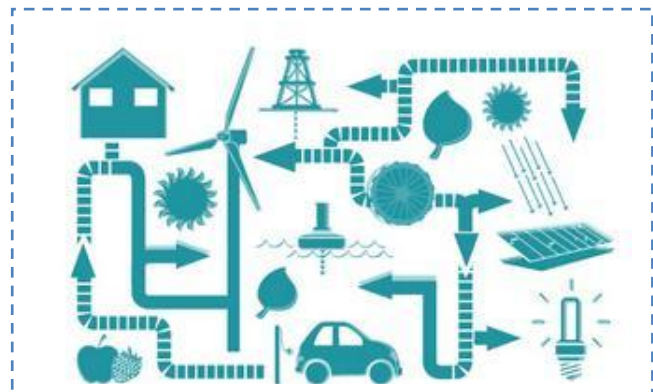
The rapid technological developments in both the communications and IT sectors have now made this possible. This is a truly disruptive change and its scope and scale is akin to the move from an analogue to a digital communications infrastructure, and the changes this brought about, not least the internet. To quote Carvalho and Cooper: -

*'the transformation coming to the electric industry as technological innovation crashes over the utility landscape like a giant wave will leave dramatic change in its wake'*

## 2. Smart Cornwall

### 2.1 What is Smart Cornwall?

Smart Cornwall is a programme of work which I have set up to ensure Cornwall turns what could be a significant economic and social challenge into an opportunity through being early adopters and pioneers of Smart Grid and Smart Energy technologies. To this end the Smart Cornwall programme aims to:-



*"To develop the U.K's first fully integrated smart energy network, providing new high value jobs, creating wealth and opportunities for future generations and leading the way into a prosperous, resource efficient future."*

To deliver this vision a steering group has been formed which is chaired by the Cornwall and Isles of Scilly Local Enterprise Partnership with representation from other key local and national stakeholders. Funding has also been provided for a small delivery team.

This local commitment allows for a clear strategic direction for harnessing this opportunity, ensuring all projects align to a overall goal. This work is currently underway and progressing rapidly to the point where the Smart Cornwall Programme is now (in no small part thanks to the fellowship) a major programme in Cornwall and the Isles of Scilly.

### 2.2 Why Cornwall?

Cornwall and the Isles of Scilly are uniquely placed in the UK; and to a large extent, globally, to lead the way. This is a result of a combination of four unique factors: -

- Some of the most favourable renewable energy resources in the UK;
- Favourable commercial and policy environment for supporting innovation;
- Funding that permits substantial investment in smart energy technologies; and
- Engaged communities.

These four factors provide Cornwall and the Isles of Scilly with the unique opportunity to take a strategic approach to develop a functioning Smart energy marketplace, building in the social and economic opportunities from the outset. It is this strategic approach to not only unlocking the technological challenges (which is the focus of most global projects), but also the social and regulatory challenges that makes this opportunity in Cornwall and the Isles of Scilly.

The Smart energy industry has picked up on this opportunity and we are now seeing, in Cornwall and the Isles of Scilly, and unprecedented interest from some of the world's largest corporations as well as some of the UK and Europe's most innovative SME's.

This unprecedented interest is a reflection of the industries recognition that the Smart Cornwall programme could be a vehicle to unblock the many barriers which are currently hindering the growth of this market. To this end, Smart Cornwall has the opportunity to become a platform for collaboration between local, national and global industry partners to unlock the potential of this shift in our energy economy.

### **2.3 The role of the Winston Churchill Fellowship in delivering Smart Cornwall**

When I was awarded my fellowship late in 2011, Smart Grids and Smart Energy were being discussed in Cornwall, and some isolated small scale work was being undertaken. There was, however, no strategic plan or senior level buy-in to this opportunity. What was clear though was the need to undertake this journey in partnership with other regions in the UK and overseas. The reason for this is that the size of the market and our potential to be at the forefront of its development means we have little need for protectionism. In fact the opposite is the case. Our success will be intrinsically linked with that of other likeminded innovative regions.

I soon identified that a number of counties in Asia, who, like Cornwall, see Smart energy as an engine for growth. This creates a specific opportunity for Smart Cornwall, with the potential to create the right conditions for companies in these counties to develop and test their products and services, prior to the large scale launch in to this marketplace.

It was for this reason, combined with the fact that they are global leaders in this field, that I selected Japan, Korea and Taiwan as the places I would visit to build partnerships in this area. The remainder of the report outlines the work I did during my fellowship and what the outcomes for Cornwall and the Isles of Scilly have been.

### 3. Japan

With some of the largest and oldest technology companies in the world, such as Toshiba, Sony and Hitachi, make Japan a natural location to lead on the development of Smart Grid technologies.

In addition to this the recent Fukushima nuclear disaster and subsequent commitment to close all nuclear power stations has resulted in a significant gap in Japans energy requirements. Part of the solution is to increase the amount of renewable energy production and to improve the efficiency of their electricity grid.

Some of the technical terms used to describe the projects I visited are outlined below: -

CEMS – Central Energy Management System (where all the data is collected and the energy is managed)

HEMS – Home Energy Management System (allows the management of energy in the home)

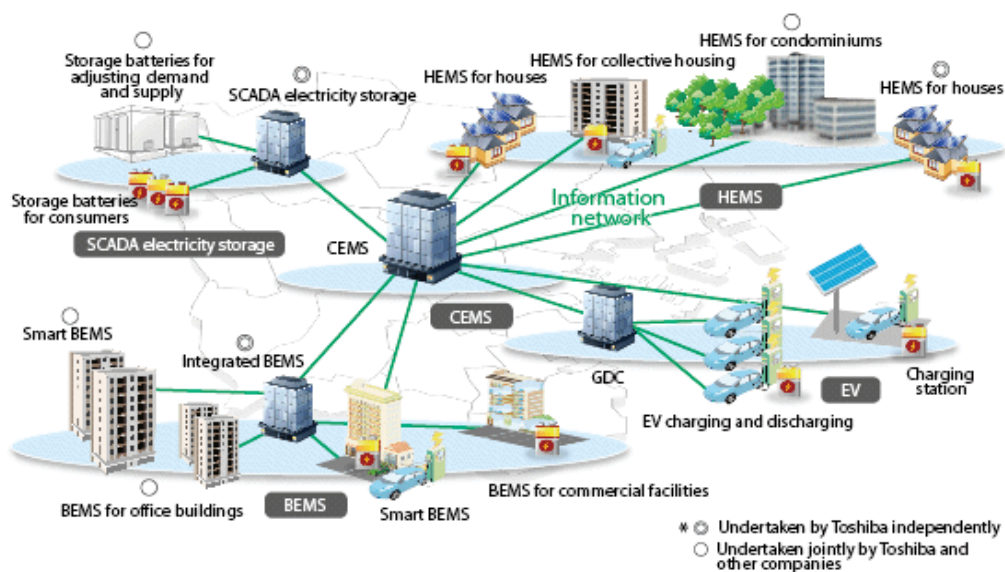
BEMS – Building Energy Management System (allows the management of energy in and office or other public space)

FEMS – Factory Energy Management System (allows the management of energy in factories)

EV – Electric vehicle

PV – Photovoltaic (Solar power)

This is how they all fit together within the Yokohama Smart City Project (below).



### 3.1 Site Visits

During my stay in Japan I visited 4 main Smart Grid demonstration sites: -

- Yokohama City;
- Kashiwa-no-ha Smart City Project;
- Shimizu Corporation smart building; and
- Hitachi's Fukushu Smart Factory.

Each Smart Grid demonstration site used similar principles in terms of a Central Energy Management System (CEMS) which was able to monitor and control energy consumption in different areas of the system (be that a building or a town). Each demonstration was at a different stage of development and had different goals.

#### *Yokohama City*

This is a project being lead by NEDO (Japanese government research funding organisation) alongside a consortium of Japanese businesses. The project is to test the 'Smart City' technologies on 4,000 houses in the city (1% of population).



Solar PV on homes in Yokohama City

The core of the project is to test consumer behaviour in changing their energy use patterns away from peak

times, using home energy management technologies (HEMS). The project will also integrate 2,000 electric vehicles within the Smart energy system as well as 27MW of solar PV.

There are also plans to implement building energy management systems (BEMS) into 1,600,000 m<sup>2</sup> of office space by 2015.

The energy production and consumption from this Smart energy system will be controlled from a smart city management centre (Central energy management system - CEMS).

For more information please follow the link below

[http://www.smsolar.net/Clean%20Energy%20Asia%202010/2\\_21\\_NobukoAsaka\\_i.pdf](http://www.smsolar.net/Clean%20Energy%20Asia%202010/2_21_NobukoAsaka_i.pdf)

There are clearly parallels with the ambitions of Cornwall and the Isles of Scilly, areas of particular interest are:-

- Consumer engagement and mechanisms for encouraging use;
- Technology implementation and use; and
- Project delivery and development.



As a part of my visit I met with the director of policy for Yokohama City (city council). We agreed to form an on-going collaboration to share knowledge as our projects develop.

#### *Kashiwa-no-ha Smart City Project*

Kashiwa-no-ha City is located 25km from Tokyo and is a new town development as a part of the wider city. This town is integrating smart energy systems as well as healthcare systems. The Smart energy system incorporates PV and wind generation, battery storage and BEMS, HEMS as well as EV charging. All this is controlled at the CEMS.

This project is still under development but is novel in Japan in that the CEMS is able to more effectively manage consumption and demand as a result of having greater control on the energy distribution than other areas which is controlled by a single company (they have an exemption from government). This has an interesting linkage with the UK where we have de-regulated energy markets and therefore greater market incentives for reducing energy during peak times (when energy cost are highest).

For more information please follow the link below:

<http://www.mitsuifudosan.co.jp/kashiwanoha/e/future/index.html>

The Kashiwa-no-ha Smart City Project makes an interesting comparison with Yokohama as Smart energy systems (and healthcare) have been integrated from the initial design phase, whereas Yokohama City is retrofitting their systems.

This has a number of synergies with opportunities in Cornwall e.g. retrofit in communities but crucially designing in the Smart energy (and healthcare) solutions to new towns such as the proposed eco-town in the Clay Country.

Hitachi are a key delivery partner in this project and have offered their ongoing support to share learning from this to ensure it is integrated to any developments in Cornwall.

#### *Shimizu Corporation smart building & Hitachi's Fukushu Smart Factory*

These were both examples of individual sites that had embedded Smart Energy technologies BEMS and FEMS (not whole town / city projects). Both provide insights into how the integration of a number of technologies within a microgrid system was able to reduce energy use by up to 60% compared to other buildings of their scale. Further details can be found by following the link below:-

[http://www.shimz.co.jp/english/news\\_release/2012/2012006.html](http://www.shimz.co.jp/english/news_release/2012/2012006.html)

### **3.2 Company meetings**

In addition to the site visits a number of meetings were arranged for me to visit Japanese companies who deliver Smart technologies and were members of the Japan Smart Community Alliance (JSCA) UK sub working group (Toshiba, Hitachi, Shimizu Corporation, and NTD data) as well as NEDO the government funding body for this industry.

These meetings provided me with a detailed understanding of some of the demonstration projects which were being delivered in Japan and across the globe. I was also able to gain an excellent insight into the latest technologies and services each of these companies were delivering.



A traditional Japanese meal with Hitachi colleagues

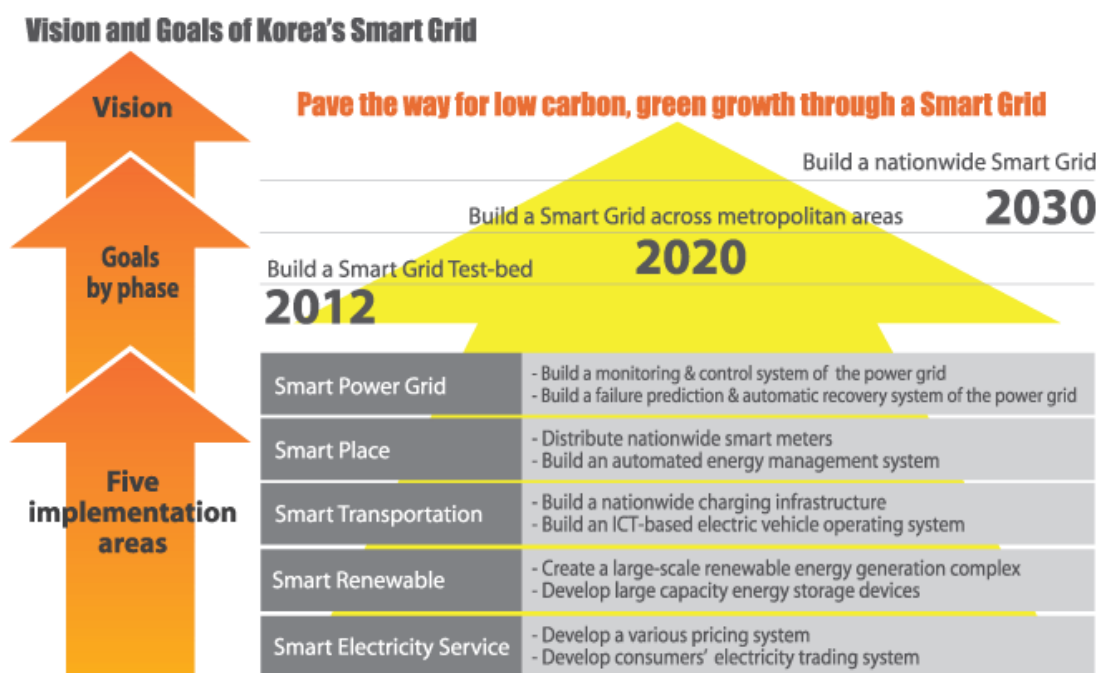
## 4. Korea

Korea has a fascinating history and a remarkable economic story, where it moved from being one of the poorest counties in the region following the Korean war of 1950 – 1953, to the present day where Korea is one of the world’s strongest and innovative economies.

Today Korea sees green growth as the engine of their future prosperity. This was set out by President Lee Myung-bak, marking the 60th anniversary of the founding of the Republic of Korea in 2008, who declared ‘Low Carbon Green Growth’ as the country’s new vision to lead the country’s development for the next 60 years.

In typical Korean style, over the last four years they have not hung around, with Korea seeing significant growth in many environmental good and services industries.

This includes the Smart Grid where they have the most ambitious Smart Grid vision of any country. A vision, which I observed them to be well on the way to delivering (below).



### 4.1 Site Visits

#### *Jeju Island*

The Jeju Island project is widely regarded as the most advanced and integrated Smart grid projects in the world. During this visit we visited a number of demonstration sites, as well as the home of someone who was using the technologies. This visit provided a very valuable insight into how these technologies were integrated at scale and the technological, social and market challenges the trial posed.

A key area of learning was that the technology worked very well and would easily be replicable within the UK. The biggest challenges each consortium of companies faced was encouraging people to use the systems effectively and creating a sufficiently robust energy market to make the technologies commercially viable.



Discussing Korea Telecoms demonstration projects on Jeju Island

There were very clear similarities with Jeju island and Cornwall in terms of it key industry sectors (tourism and agriculture) and their commitment to use Smart Grid as both a way to secure their future energy and to diversify their economy.

More information on the Jeju project can be found by following the link below.

<http://www.smartgrid.or.kr/10eng3-1.php>

### *Marine Energy*

I visited a tidal marine energy demonstration project in Jeollanam-do Province being delivered by Jungmac ind R&D. We discussed the opportunities in Cornwall both in terms of the infrastructure in place through the South West marine energy park and the strong UK market for developing marine energy technologies here. This was of great interest to the company and we agreed to take this discussion further on my return.



A tidal energy device

### *Green Tomorrow - 500 square meter zero energy house*

This is a demonstration project by Samsung of a house which suggests a future lifestyle that is both environmentally friendly and convenient. The house delivered three main themes:

- Zero Energy: Reducing the consumption of energy by optimizing energy performance, and generating on-site renewable energy which equals or exceeds the consumption;

- Zero Emission: Eliminates CO2 emissions from all stages – from construction to operation, and to demolition – through such means as using sustainable materials and recycling wastes; and
- Green IT: Implements technologies that increase the efficiency of sustainable energy and create a comfortable living space tailored to the needs of occupants.



The technologies were remarkable and the visit provided a unique insight into the type of house we will all be living in, in the future. As a demonstration many of the technologies will not be commercialised for a number of years, however, it was very interesting and gave a fascinating insight into what is around the corner.

For more information please follow the link below

<http://www.samsungvillage.com/blog/2011/11/samsungblog-living-a-life-the-sustainable-and-smart-way.html>

#### *KT operation centres*

We visited KT's national centre in Seoul and local operation centre in Jeju (CEMS). This visit provided an excellent insight into how such a CEMS works and pulls together the large amounts of real time data from across the Smart Grid.

The operation centre in Seoul was particularly interesting as this was a very large operation which acted not only as a CEMS for projects in Korea but also for a number of projects overseas. This presented a very interesting business model whereby individual micro grids or much larger smart grids could be managed from anywhere in the world.

## 4.2 Jeollanam-do provincial government meeting

I travelled to Jeollanam-do province to meet with the government to explore potential partnership opportunities between this province of Korea and Cornwall. I had identified this province and Cornwall as having many similarities. They have the largest marine renewable energy resources in Korea and will be rolling out a very large Smart grid project and have a number of other related industries such as marine engineering, aerospace and space.



Meeting with officials from Jeollanam-do provincial government

We had a very useful discussion with a number of government and energy industry representatives. All parties were very interested and since these discussions, our partnership has developed significantly (see section 6 below).

## 4.3 Company meetings & Korea Smart Grid Week

I met with a number of companies and organisations both during Korea Smart Grid Week and in the following days. These meeting included: LS, KEPCO, Samsung, Korea Telecom and the Korea Smart Grid institute (KSGI). During a conference, which formed a part of Korea Smart Grid week, I also had an opportunity to present Cornwall's Smart Grid plans.



Me presenting at Korea Smart Grid week

Similar to Japan, they provided a detailed understanding of some of the demonstration projects which were being delivered, as well the latest technologies and services each of these companies were delivering. All of this learning has been integrated into the design of the Smart Cornwall programme back in the UK.

## 5. Taiwan

Like many of the other countries in this region, Taiwan has had a turbulent history but has in recent years transformed its fortunes to become a global manufacturing base, particularly in high technology products. It is therefore no surprise that like Japan and Korea, Taiwanese companies and academic institutions are taking a lead role in the development of Smart Grid technologies.

### 5.1 UK / Taiwan Smart Grid Conference

I presented the Smart Cornwall programme at a conference between UK and Taiwanese Smart grid experts. This provided an excellent insight into the work of some of the leading companies in this field, as well as some of the research projects being undertaken by universities in Taiwan.



Me presenting at a Taiwan Smart Grid conference

On other days follow up meetings were arranged for Delta Electronics and Everlight Electronics where we discussed potential collaborations with Cornwall.

### 5.2 Penghu & Cornwall Protocol of collaboration

One key ambition of my trip was to develop long lasting links between the regions I visited. Before I left for Taiwan I had already put in place arrangements to set sign a protocol of collaboration between Cornwall Council and Penghu government.

Penghu consists of 90 islands off the west coast of Taiwan, with a population of 93,000. Penghu islands have a number of similarities to Cornwall, not least their significant renewable energy resources (principally wind and solar) and the fact that currently they import the vast majority of their energy. With these resources they have an ambitious plan to decarbonise their energy supply. Details of these plans can be found through the link below.

[http://www.re.org.tw/penghu/en/plan\\_detail.aspx](http://www.re.org.tw/penghu/en/plan_detail.aspx)

Of particular significance to the Smart Grid work in Cornwall is that Penghu has been selected as the first major Smart Grid demonstration site in Taiwan. The plans are to roll out the project around the time we are likely to in Cornwall.

The signing ceremony took place at the British Trade and Cultural office in Taipei. The details of this can be found by following the link below.

<http://www.taipeitimes.com/News/taiwan/archives/2012/11/06/2003547019>



The protocol of cooperation signing ceremony

A couple of days later I travelled to Penghu to discuss our collaboration in more detail with the regions governor as well as other local officials. We also had a tour of the islands and visited a number of projects which are already underway.

### 5.3 Academic visits

I visited two of Taiwan's major research establishments during my visit, the Institute of Nuclear Energy Research (INER) and National Chen Kung University (NCKU). At INER and NCKU I visited a micro-grid research centre and a HEMS research project. Each of these projects aligns very closely with the needs of Cornwall and it is the learning from these research projects will be rolled out in the Penghu test bed in 2014.

Discussions with academics showed clear areas for further collaboration allowing universities in Cornwall to undertake joint R & D programmes to build on the protocol of cooperation.

I also visited a High-Concentration Photo Voltaic solar power plant with academics from NCKU.



## 6. Fellowship Outcomes

Since returning to the UK, the Smart Cornwall programme has developed significantly in terms of understanding the opportunity, gaining partner buy in, developing projects and of course developing overseas partnerships. The scope and scale of the opportunity for Cornwall and the Isles of Scilly is now potentially transformative for the region. This opportunity would not be there had it not been for the work undertaken through this fellowship.

From an individual perspective the learning I developed from industry pioneers during my visit has been invaluable not only personally but also in developing the strategic direction of the Smart Cornwall Programme. However, perhaps most significantly are the partnerships between companies, governments and organisations that have formed since my return. These are outlined in more detail below.

### 6.1 Japan

Since my return I have had an ongoing dialogue with a number of Japanese companies in particular Toshiba and Hitachi.

Work with Toshiba is now progressing well and we are currently developing a £30m pioneering Smart Grid demonstration project to be rolled out in the town of Wadebridge in Cornwall. In addition to this, we are actively exploring project ideas with Hitachi who have come to Cornwall to explore opportunities on a number of occasions.

### 6.2 Korea

Since my return a further delegation has visited Cornwall, in addition to myself and some academic colleagues recently returning from a second visit. This is a reflection of a number of very positive areas of collaboration currently being developed between Cornwall and Korea.



The letter of intent to collaborate signing ceremony with Jeollanam-do Provincial Government (June 2013)

Specifically, I, on behalf of Cornwall Council, have signed a letter of intent to collaborate with Jeollanam-do Provincial Government. This will be followed by a formal MoU signing when their provincial governor visits Cornwall. During this visit we also had a conference to share knowledge and identify specific collaborative opportunities. From this work we agreed to set up a formal academic / industry knowledge exchange programme.

Cornwall Council has also finalised a MoU with the Korea Smart Grid Institute (KSGI) which will be signed in the autumn during a visit to Cornwall. We have already discussed a number of project proposals with both the KSGI and individual companies which are likely to result in significant inward investment opportunities for Cornwall in the near future.

### **6.3 Taiwan**

We are still developing opportunities for collaboration with Penghu Islands to strengthen our partnership commitment. A delegation will visit Cornwall in August where this will be discussed in more detail.

## 7. Reflections from my fellowship

### 7.1 Tiger Nations

I visited three very different countries, but three countries which have a lot in common. They all have a rich and turbulent history, beautiful countryside and coast, but without a doubt for me the highlight was the people. They have a great sense of humour, are so friendly and helpful, and retain a sense of respect for each other which we can learn a lot from. This makes these countries not just a great place to visit, but also an easy place to travel, as there is always someone willing to help show you the way. Perhaps the most valuable thing I will take from my travels, are the new friends I have in each of the counties I visited.

I have also been very impressed with the aptitude of the people for business which has reaffirmed my view of the huge opportunities we can realise through collaboration with these areas. The economic miracle of Korea, in particular, is very impressive. To see what has been built in just 60 years following the Korean War and to see the pace of change still underway is quite remarkable. My fellowship has undoubtedly taken Cornwall and the Isles of Scilly in an exciting new direction.

### 7.2 The Fellowship

When I first got my fellowship I kept hearing from people who had been a part of this programme and thought it could lead to new and exciting opportunities. Personally, I thought; it would be a fantastic learning experience, I might be able to build some ongoing partnership and it would be great fun. This has been achieved and so much more .....

From the day I started doing my research for my application, I started building an additional professional focus. This focus has developed and grown to shape the Smart Cornwall programme and the scope and scale of my travels. Before I headed out, I had a clear idea of the broader opportunity for Cornwall I now have an even clearer idea of where our strengths are and how to utilise them. But the biggest impacts will be through the partnerships I have formed which will help Cornwall to become internationally competitive in Smart Energy delivery.

My fellowship has lead my career and expertise in a new and I have to say much more fulfilling direction. It has also acted as a catalyst for the development of a new strategic priority and focus for Cornwall and the Isles of Scilly. I am certainly excited about where we go from here.

As for the next steps for Smart Cornwall – watch this space!!

### 7.3 Thanks

Of course none of this would be possible without the kind support of others. I can't possible name everyone who helped me as there were so many people who generously gave their time to make my visit a success. In Japan my programme of work was facilitated by the Japan Smart Community Alliance, with particular thanks to Mayuko for all her support. In Korea the British Embassy and Taiwan the British Trade and Cultural Office provided me with a great deal of support for

which I am very grateful. In Taiwan, the Taiwan Smart Grid Industry Association was also a great help. I do, however, owe a particular thanks to Sam and Eunjeoung who did such a great job in organising my programme during my visit to Korea and Taiwan.

I would also like to thank everyone at the Winston Churchill memorial trust for all their support in making this possible. My employers at Cornwall Council, who during difficult times for Local Government, also saw the opportunities this could bring and gave me their full support. Last but not least a big thanks to my wife Liz who had to look after the kids for over a month whilst I was away.