



ESCUELA TÉCNICA SUPERIOR DE INGENIERÍA (ICAI)
INGENIERO INDUSTRIAL

Open Innovation in the Regulated Business

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Madrid
Junio 2016

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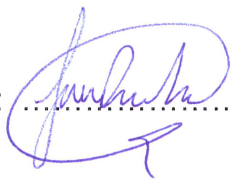
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INNOVACIÓN ABIERTA EN EL NEGOCIO REGULADO

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Entidad Colaboradora: SP Energy Networks

RESUMEN DEL PROYECTO

Introducción

Durante la mayor parte del siglo XX, el concepto Innovación ha estado intrínsecamente ligado a universidades, centros de investigación y departamentos de Investigación y Desarrollo de grandes empresas. Los procesos, investigaciones y resultados se ocultaban o protegían mediante Propiedad Intelectual para mantener la competitividad y posición dominante de la empresa en el mercado. Los cerebros más brillantes, la gente más imaginativa e innovadora pertenecía a la organización, y su permanencia en la empresa durante toda la vida profesional era un factor clave en el mantenimiento de la posición dominante de la compañía y evitando que el conocimiento escapase del control de la empresa.

El modelo arriba descrito, o modelo de Innovación Cerrada según H. Chesbrough, tiene gran éxito en el siglo pasado, y existen múltiples ejemplos de éxito de estas empresas a la vista, como compañías farmacéuticas, de armamento o de bienes de consumo.

Sin embargo, a finales del siglo XX este modelo se enfrenta a factores externos que erosionan sus resultados. El acceso a formación universitaria y la mayor tasa de doctorandos e investigadores; la mayor movilidad de los trabajadores entre empresas y la posibilidad de arrastrar los conocimientos y la experiencia adquiridos; el incremento del flujo de dinero disponible a través de las compañías de capital de riesgo (Venture Capital); y la mayor formación de los consumidores junto con la necesidad de reducir el tiempo de desarrollo son los principales factores que han reducido la validez del modelo de Innovación Cerrada.

Ante esta pérdida de valor, ciertas empresas han visto necesario aplicar un nuevo modelo que complementa al modelo anterior para conseguir una vuelta al crecimiento y a la innovación dentro de la compañía: el modelo de Innovación Abierta.

El modelo de Innovación Abierta busca incluir a actores exteriores a la empresa para ayudar a resolver los problemas o desafíos de la empresa bajo un punto de vista diferente y sin estar afectados por la cultura, valoración interna o la asunción del modelo de negocio de la empresa. Las soluciones o tecnologías presentadas desde el exterior serán combinadas con las internas para conseguir un desarrollo más rápido hacia el mercado de cualquier producto o servicio.

Además, el modelo de Innovación Abierta busca que las empresas distribuyan, de la manera que crean conveniente, aquellos desarrollos que, aún investigados dentro de los departamentos de I+D propios, no han sido utilizados o no constituyen una tecnología clave para mantener la posición de mercado o el futuro liderazgo.

Este proyecto define una estrategia de implementación del modelo de Innovación Abierta en la empresa de servicios públicos, en este caso de distribución y transmisión de electricidad, SP Energy Networks, con presencia en el sur y centro de Escocia y norte de Gales, donde sirve a más de 3,5 millones de consumidores de electricidad, para resolver los retos a los que se enfrenta la red eléctrica.

SP Energy Networks tiene un gran compromiso con la innovación para resolver los retos a los que se está enfrentando la red eléctrica actualmente y los grandes cambios que se esperan en el futuro.

El crecimiento inesperado en la generación renovable, el despliegue de generación distribuida, el salto de calidad y coste de sensores que permite una implantación masiva, el tratamiento y análisis de los datos obtenidos en la red y la introducción del vehículo eléctrico son, entre otros muchos, los retos que están cambiando el estado de la red, como esta se comporta y los perfiles de los usuarios.

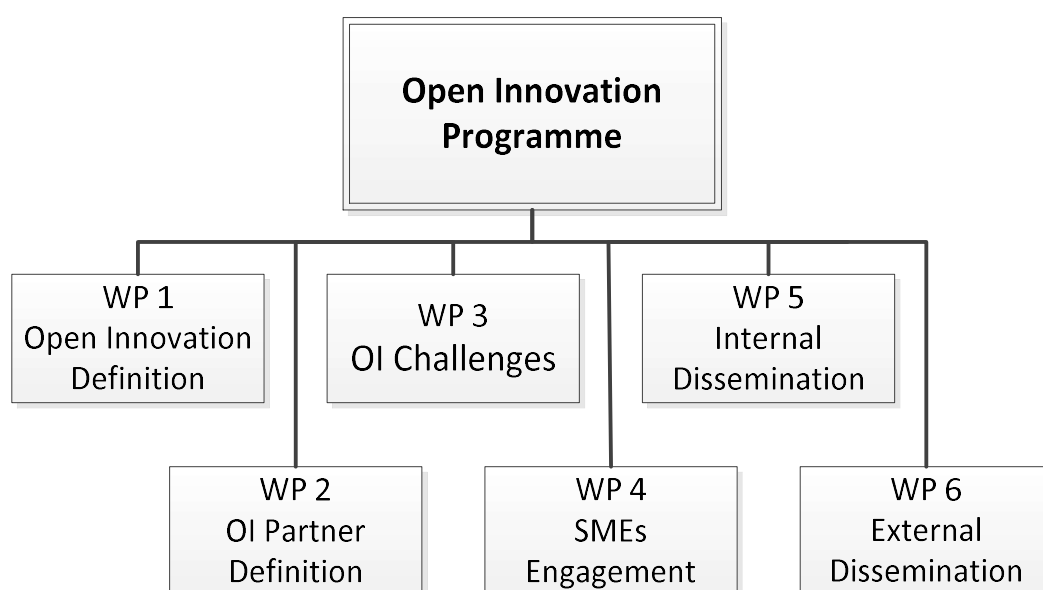
Metodología

El proyecto realizado por el alumno define una estrategia de implementación del modelo de Innovación Abierta en la compañía para buscar el éxito de esta iniciativa, y que el proyecto sirva como modelo para futuras implementaciones en otras empresas de la misma industria o de otras industrias.

Se estudia amplia literatura sobre Innovación Abierta, y tres casos de éxito en la implementación de procesos de Innovación Abierta como son Procter&Gamble, NASA y GE.

Posteriormente se lleva a cabo la preparación y definición de una estrategia de implementación de Innovación Abierta en SP Energy Networks, estudiándose los mecanismos, actividades y procesos necesarios a implementar, modificar, mejorar o eliminar, y los riesgos asociados al cambio de modelo de Innovación y la respuesta por parte de los empleados a dicho cambio.

La estrategia de implementación se divide en 6 Paquetes de trabajo que se puede observar en la imagen siguiente. El paquete WP1 incluye la definición de la estrategia, de la que es parte el proyecto *Innovación Abierta en el Negocio Regulado*.



Gracias a la estrategia preparada en este proyecto, la implementación de Innovación Abierta en SP Energy Networks ha comenzado, una vez firmado el plan y autorizado por las autoridades de la empresa. Esto ha permitido contar con el apoyo de la organización y tener acceso a los primeros resultados sobre la implementación, que permite de manera todavía muy ligera tener conclusiones sobre la validez de la estrategia.

También por ello se tiene muy en cuenta la necesidad de comunicar a los empleados de la empresa los cambios que el nuevo modelo puede suponer, como ellos pueden dar su apoyo o pasar a formar parte del nuevo modelo.

Esta parte de la estrategia ha supuesto el mayor reto, ya que una parte importante de los empleados no están enterados de los procesos, tecnologías o nuevos desarrollos que se hacen desde el equipo de innovación de SP Energy Networks, el equipo de Redes Futuras. Por ello se ha dedicado un paquete de trabajo solamente a dar a conocer las nuevas

oportunidades a los empleados y recabar su soporte, ideas y futuro uso de las tecnologías que el modelo introduzca en la empresa.

Resultados

La definición de Innovación Abierta precisa y única para el sector de los servicios públicos, donde se engloba SP Energy Networks, ha sido probada y validada.

“El principal objetivo de Innovación Abierta es cambiar la cultura innovadora en SP Energy Networks, ampliando la selección de proveedores para la compañía y la red eléctrica en Reino Unido, incrementando la conciencia y el apoyo de los empleados hacia la innovación, buscando siempre mejorar el servicio dado a los clientes, mejorando la calidad, la eficiencia y la eficacia, junto con un compromiso firme para reducir la huella ambiental de las actividades de SP Energy Networks.

El socio elegido ha sido, en un primer momento, y con la posibilidad de añadir alguno más en el futuro, Energy Innovation Centre (EIC), con el que se han llevado a cabo ya una Llamada de Innovación con éxito, relativa a un nuevo proceso para monitorizar el estado de cimentaciones de las torres eléctricas de transmisión y distribución.

EIC es una empresa sin beneficios cofundada por todos los operadores de energía en el Reino Unido, enfocado en buscar empresas que puedan resolver las necesidades de estos, ya sea como conjunto, o en forma de retos individuales.

El caso concreto de la Llamada de Innovación para la monitorización de las cimentaciones de las torres permite observar la gran oportunidad que presenta el modelo de Innovación Abierta. Debido a la falta de los resultados, se ha optado por un criterio conservativo respecto a las cifras tomadas y por confidencialidad, las cifras son todas indicativas del orden de magnitud.

Monitorización de la Cimentación de las Torres Eléctricas			
Concepto	Coste Unitario (£)	Cantidad Anual	Total
Coste anterior	£9.000	600	£5.400.000
Coste posterior (Innovación Abierta)	£6.000	600	£3.600.000
Anterior Total	£5.400.000		
Posterior Total	£3.600.000		
Ahorro estimado por año	£1.800.000		

Se puede llegar a conseguir un ahorro superior a 1,5 millones de libras por año, sin tener en cuenta las mejoras en el conocimiento del estado de las cimentaciones, lo que permite mejores decisiones respecto a las necesidades de reparación, inversión o renovación.

Respecto a la comunicación de la Innovación tanto interior como exterior se han llevado a cabo ya las primeras acciones con resultados muy prometedores, sobre todo en la aceptación por parte de los empleados de la compañía. El parcial desconocimiento anterior se ha visto sustituido por interés real por saber las posibilidades que la Innovación puede aportar a su trabajo del día a día.

Los resultados que se pueden mostrar en este proyecto son aún muy limitados, ya que la implementación se encuentra en sus primeras etapas, y únicamente según pase el tiempo seremos capaces de entender el valor real del modelo de Innovación Abierta en el caso particular de SP Energy Networks.

Conclusiones

Este proyecto sirve como introducción a una metodología adecuada y probada de éxito para la implementación de la Innovación Abierta, sin necesidad de grandes inversiones ni cambios dramáticos dentro de la empresa, minimizando por tanto el cambio para los empleados, pero fomentando su participación y realizando un cambio en la cultura interna de la empresa y en la comunicación entre las diferentes partes que la componen.

La estrategia presentada es válida, ya que se ha podido comprobar como el uso de un socio externo permite encontrar soluciones diferentes, muchas veces por empresas que no están muy lejos de la empresa interesada, pero que no ha entrado en ese sector por diferentes motivos.

El desarrollo de la implementación basado en la estrategia durante los próximos años servirá para confirmar de manera más documentada y extensa la validez del modelo y de la estrategia presentada.

OPEN INNOVATION IN THE REGULATED BUSINESS

SUMMARY OF THE PROJECT

Introduction

During the XX century, innovation concept has been linked with universities, research centers and large Research & Development departments inside the big corporations. Processes, researches and results were kept hidden to the rest of the world to maintain the competitive position and the leadership in their respective markets. Brightest brains, most imaginative and innovative people had to be maintained working for the firm for all their professional life, to keep the knowledge and know-how under the control of the company.

Closed Innovation model had a huge success, and there are multiple examples of companies that profited from the model, such as pharmaceutical, weaponry companies or consumer goods companies.

However, at the end of XX century, it is observed that the model faces external factors that erode the results. The growing mobility of highly experienced and skilled people; higher number of graduates and PhDs, allowing knowledge to spill out of the corporate central research labs; the growing presence of private venture capital (VC), experts in create companies that commercialized external research that can become competitors for established companies and fast time to market and customers with more knowledge are the main factors that erode the validity of Closed Innovation model.

Considering the loss of value of Closed Innovation model, and to face the external erosion factors, some companies have applied a model that supplement Closed Innovation model to return to constant growth rates and long-term profit: Open Innovation model.

Open Innovation model aims to add external actors to solve the challenges and problems that appear inside a corporation or company, under a different point of view and without being affected by the company culture or own valuations or business model. Solutions and technologies presented or submitted would be combined with internal developments to get a faster path to market for any product or service the company is willing to commercialize.

Moreover, Open Innovation model expects companies to distribute, in a convenient way, those technologies or processes that have been developed inside the company, but have not been found an internal use for products and services, and that are not part of a key technology to maintain leadership position in the market currently or in the future.

This project defines an implementation strategy for Open Innovation model in a utility, in the electricity distribution and transmission industry, SP Energy Networks, with presence in Central and Southern Scotland and Northern Wales, with more than 3,5 million customers.

SP Energy Networks has a great commitment with innovation to solve the challenges that electricity network currently faces and the drastic changes that it would have in the future.

An unexpected growth in renewable generation, the wide deployment of distributed generation, the quality of the new sensors with a reduced cost that allows a massive deployment, the processing and treatment of the data generated, or the introduction of the electric vehicle are some of the challenges that are moving forward the network, how it behaves and the consumption load profile of the customers.

Methodology

The project done by the student is pioneer, because it uses the opportunity given by SP Energy Networks to develop a strategy for the implementation of Open Innovation in a company in the regulated business. The project would serve as an example and case study for later implementations.

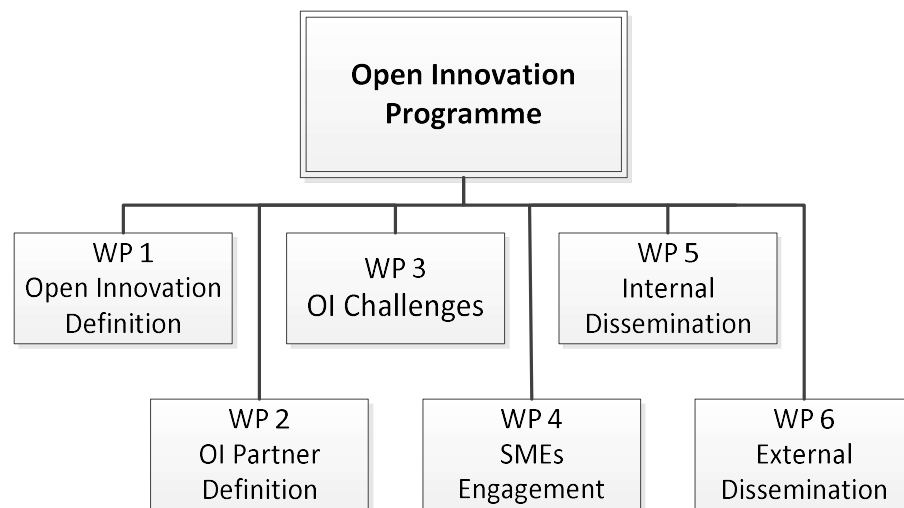
The project is inside an initiative developed by the government agency Scottish Enterprise to increase innovation in Scotland through SMES and get them more contracts with the big corporations participating in the Open Innovation Award initiative.

The report by the student takes a look about the literature about Open Innovation, and three of the most successful case of implementation of Open Innovation, Procter&Gamble, NASA and GE.

Then, the preparation, study and plan of a implementation strategy for Open Innovation in SP Energy Networks is done, studying the mechanisms, activities and processes

needed to be implemented, modified, improved or deleted. Also the risks related to the changes and to the innovation model are studied, together with the countermeasures to avoid their negative effects and to convince the employees of the need of change.

The implementation strategy is divided in 6 Work Packages that are showed in the following picture for the 4-year duration of the project. Work package 1 includes the definition of the strategy, from where *Open Innovation in the Regulated Business* appears.



In parallel to the drafting of the project, the student has start with the implementation tasks of Open Innovation in SP Energy Networks, at the moment the strategy was signed and approved by the management of the company. This fact has allowed to count on the support of the organization and to have access to the first implementation results that would allow reaching certain conclusions to the validity of the strategy.

The need to communicate the employees the change that the new model could mean to their normal work has been really important, as they can support and take part in the new model.

Gain the support of the employees has been one of the hardest part of the strategy, as they were not fully aware of the process, technologies and solutions that the innovation team has developed in last years, Future Networks team in SP Energy Networks. To solve this problem, a whole work package has been dedicated to spread and disseminate the work of the team, and gain support to the new model.

Results

The definition of Open Innovation for the utility industries, in which SP Energy Networks is part, has been proven and validated.

“Open Innovation main aims is to change the innovative culture in SP Energy Networks, broadening the pool of solvers for electricity networks challenges, and increasing the awareness and engagement of the employees on innovation, looking always to improve the service given to the customers, improving the quality, the efficient and the efficacy, together with the highest commitment to reduce the environmental print of the activity”.

The partner chosen is the Energy Innovation Centre (EIC) and the first Innovation Call has been successfully launched, related to tower foundation monitoring. In the future the use of other extra partner is possible as a different approach or pool of solvers could help.

EIC is a non-profit organization cofounded by United Kingdom energy operators, focusing its aims to search and scout for companies that could solve the need of the energy operators, as a whole or individually.

The concrete case of the Call for Innovation related to tower foundation monitoring allows having a first view of the opportunities Open Innovation model has. Due to the lack of real results, a conservative criterion has been used in the numbers taken, together with the need to maintain confidential part of the data.

Tower Foundation Monitoring			
Concept	Unit Cost (£)	Quantity	Total
Former Cost	£9.000	600	£5.400.000
Open Innovation Cost (Future)	£6.000	600	£3.600.000
Former Total Cost	£5.400.000		
Total Open Innovation Cost	£3.600.000		
Expected Annual Saving	£1.800.000		

Up to around 2-million-pound savings could be achieved per year, not taking into account the improvement in the knowledge of the real state of the assets that allows for better decisions to repair, invest or refurbish.

In respect to the communication of the change of model, both internal and external activities have been carried out with really promising results, mostly in the acceptance by

employees. The partial former ignorance has been substituted by a real interest to know more about the possibilities that innovation can contribute to their day-to-day job.

The results showed in this project are really limited, because the implementation is in its first stages, and only as the time goes by, we would be able to understand the real value of Open Innovation model in the particular case of SP Energy Networks,

Conclusions

The project serves as an introduction to a correct and proven methodology of success for the implementation of the Open Innovation model, without the need of big investments or dramatic changes in the organization, limiting the change for the employees, but promoting their participation and changing the internal culture of the company and the communication media.

Presented strategy is valid, as it could be confirmed. The use of an external partner allows finding different solutions, by companies that are close in distance but far away in terms of industry. The opportunity of Open Innovation allows them to enter in service with SP Energy Networks.

The development of the strategy during the following year would serve to confirm in a more documented way the validity of the model and the quality of the strategy.



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Madrid
Junio 2016

Quiero mostrar mi agradecimiento a todas las personas que han hecho posible este proyecto y la magnífica etapa que se acaba, 6 años de universitario.

En primer lugar, a mis amigos de Toledo, que me han acompañado desde que di el paso de ir a Madrid, y que continúan aún en sitios más lejanos como París o Glasgow. Siempre agradecido a Los Míticos, a Ignacio, a Miguel y a otros muchos con los que parece que no ha pasado el tiempo desde 2010.

Tampoco olvidar a los amigos madrileños, menos abundantes, pero no por ello menos importantes. Gracias Carlos y compañía.

A toda la gran familia ICAI, con los que he pasado grandes dificultades, pero también he ganado inmensas y únicas amistades que siempre seguirán. Gracias Chema, Cecilia, Vinicius, Gonzalo, Álvaro y un largo etc.

A todas las personas que conocí en Supelec, a la comunidad francesa que me acogió, y a los amigos españoles que hice. Pedro, Juan, Miguel, Baudouin, Valentin, Charlotte, Agathe, Tanguy et Killian, gracias por compartir dos años tan fantásticos juntos y que espero que futuras generaciones puedan repetir.

A toda la gente de Glasgow, donde he escrito este proyecto, y en especial a aquella de SP Energy Networks. No los puedo nombrar porque siempre me dejaría a alguno. Muchas gracias especialmente al equipo de Future Networks, por haberme acogido de una manera tan superlativa y haberme ayudado y especialmente a James y Eric como parte del equipo de Innovación Abierta.

A mi familia, mi hermana, mis abuelos, mis tíos y primos, que me han apoyado siempre, forzándome a dar lo mejor de mí, y buscando siempre mi felicidad.

Pero sobretodo quiero agradecer a mis padres la mejor educación posible que me han hecho recibir, mucha de ella por su parte, fruto de su esfuerzo y sacrificio, y que ha buscado no formar únicamente un profesional, sino una buena persona.

Muchas gracias.

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Glossary

DNO – Distribution Network Operator, a company that operates the electricity or gas distribution network, mainly in Great Britain.

EIC – Energy Innovation Centre, a non-profit organization created by British energy (electricity and gas) network operators to help with the search of new technologies that could be applied to the network and the scout of companies to address the main challenges and technologies development the operators could work on.

TO – Transmission Operator, a company that operates the electricity or gas transmission network, mainly in Great Britain.

GB – Great Britain

LV – Low voltage, 400V phase-phase or lower voltage in the British network.

Ofgem – Office of Gas and Electricity Markets, a non-ministerial government department and an independent National Regulatory Authority, recognizes by EU Directives.

OI – Open Innovation, concept developed by Henry Chesbrough.

SE – Scottish Enterprise, an economic development agency funded by the Scottish Government.

SPEN – SP Energy Networks, electricity distribution and transmission operator, subsidiary of Scottish Power, subsidiary of IBERDROLA S.A.

Chapter 1. - Introduction and Approach of the Project

Me, Javier Perez Sanchez, have been working for SP Energy Networks (SPEN) since January 2016 to June 2016. I have been part of Future Networks team, leading the Open Innovation Initiative award funded by Scottish Enterprise together with Future Networks manager and Project Director, James Yu. In the month of April, Eric Brunger joined the team as Senior Open Innovation analyst. The project is also part of the Network Innovation Allowance (NIA) that SP Energy Networks has assigned as a UK transmission and distribution network operator.

The opportunity to do this project appeared as ICAI, the School of Engineering of the Universidad Pontificia de Comillas, started a program of international internships for students in the last semester of 2nd year of the Master in Industrial Engineering. The program allows developing the Master thesis at a company whereas working on real projects and business as usual activities.

SP Energy Networks (SPEN) is a Britain electricity transmission and distribution company with licenses for transmission in Central and Southern Scotland, and licenses for distribution in Central and Southern Scotland, Merseyside, Cheshire, North Wales and North Shropshire. The number of clients depending of SPEN to be provided with electricity is over 2.5 million.

The business of SPEN is regulated by Britain's independent energy watchdog Ofgem. The price that SPEN charges to the electricity retail companies is given by the regulator, to protect customers from the natural monopoly energy transmission and distribution is. The price control sets in place currently is named RIIO.

As stated in RIIO price control, innovation has an important place in the revenues of SPEN and the Future Networks team has as major aims to study, develop and deliver projects with an innovative approach that cannot be developed inside business-as-usual activities due to their higher risk in comparison with usual network investments.

Innovation inside the transmission and distribution sector refers to improve the services and processes related with the electricity. Innovation has to focus on the quality of electricity, talking about voltage and frequency, or the surrounding services as energy storage, control of demand or other technologies that are under development.

Future Networks team is currently developing and delivering pioneer projects in Great Britain and Europe, such as: transformation of a medium voltage alternative current (AC) link to direct current (DC) reusing an existing AC line (ANGLE – DC); a new model of substation that introduce all the advances in electronics and optic fibre to reduce the environmental print (FITNESS); or a project to accelerated the connexion of new renewable generation as wind farms in areas with network constraints (ARC).

Most of the projects inside Future Networks team are developed working together with the best industry experts, electricity-service companies and top-ranked universities. The partnership is based on the needs for the projects. The partnership is a win-win situation, where SPEN is provided with the latest advancements in technology and the partner has the opportunity to test its technology under theoretical and real circumstances, having afterwards enough data to improve it, and sell it for similar applications, with the reassurance that it would work.

Scotland, as a nation and the historic place where SPEN was settled, is in a very good situation to provide these partners. During its history, Scotland has seen the birth of many illustrious engineers, scientists and inventors, such as James Watt, Alexander Graham Bell, Alexander Fleming or Thomas Telford. From the logarithmic tables to the sheep Dolly, important innovations have been developed in these lands.

For this purpose, Scottish Enterprise, a Scottish government agency, is funding SPEN and a cohort of companies in Scotland to look at the possibility to expand their Scottish partners introducing Open Innovation model in their innovation strategy. Leading this project for SPEN I have developed my 6-months international internship and this dissertation.

The project in these pages describes the strategy develop for SP Energy Networks for the implementation of Open Innovation, as aimed by Scottish Enterprise. It is a pioneer project in the electricity network industry, as the strategy would be an open to all the interested companies that could use the project as a case study as a model for the implementation of Open Innovation in their companies.

The Open Innovation Initiative award would help to develop Open Innovation model inside SPEN, improving the pool of Scottish contractors, and to increase internal and external communication with the stakeholders of the different projects. The fund encourages to look outside the historic partners, to other industries and partners with technologies we have been

asking long for, and a new mind that could solve the challenges SPEN faces in a more effective and efficient manner.

The Open Innovation award given by Scottish Enterprise is a unique opportunity to make a cultural shift in the organization, SPEN, improving the internal and external communication of the company, a shift in the mind of the employees, and a future of better perspective for the business, as it could lead the change for being a more environmental-friendly industry.

The project here tries to understand what Open Innovation model means, and what is need to make a successful implementation in a company inside a regulated business, where innovation is a driven but it is not completely inside the core strategy. The risks of the implementation are also studied, to give a complete set of tools and activities that have to change for a successful implementation of Open Innovation model in any company.

This project is divided in three different parts. The first one involves the study of Open innovation model, what it means, who are the main actors and successful cases. The second involves the planning and study of an implementation strategy in SPEN, as there is not any public example of an implementation strategy that could be followed. The third part gives information about the current state of the implementation and the add-ones discussed to the strategy based in the information given by the rest of companies.

This report mainly focuses on the understanding of Open Innovation model, and the draft of a strategy for its implementation. A report about the advancement and progress would be included for the first six months' time.

As a worker on SPEN, I have had the opportunity to better understand the regulated business electricity transmission and distribution is, where solutions are already developed, with changes applied in a long term perspective and looking for the highest efficient and efficacy for the customers. In the case of electricity transmission and distribution industry, the major changes in the sources of electricity are meaning a total change in the network.

The electrical network was developed during the latest sixties of the former century, more than 40 years ago, with a centralized generation schema, where the generation of electricity was centralized in big power plants, fully controllable and an easy dispatch; and the consumption were big factories and citizens.

From the point of view of the generation, the irruption of renewable generation and distributed generation means the power flows are more difficult to control and the network has important constraints as it was designed for unique direction flows, that now can reverse depending on the situations.

From the point of view of customers, the proliferation of power electronics, together in the future with electric cars and self-generation means a variable load profile for each client. The government supports to heating pumps and reducing of petrol products consumption also would increase the consumption of electricity in the following years.

In the case of SPEN, the great deployment of renewable generation, new prices control framework by Ofgem and the fact to be owned by Iberdrola has created an environment where innovation is embedded in the company strategy. Innovation must return on investment and revenues to the business-as-usual of the company.

Innovation, research and development should be used to provide the core business of the company with solutions that can be applied in real situations to improve the service given to the customers. As an opportunity to have influence over the strategy of the company, I think this project can give a unique inside about how change management should proceed to achieve a durable and valuable shift in the organization.

To sum up, Open Innovation initiative is looking for giving support to the challenges the electricity network is facing at this moment, providing with efficient solutions already deployed in other parts of the world, or help to increase the number of research centres, universities, cross-industry developments or individuals that work with SPEN every day.

Moreover, *Open Innovation in a Regulated Business*, the project in these pages, expected to create a standard strategy for the implementation of Open Innovation in the utility sector that allows for spread the Open Innovation model to get its advantage in a worldwide basis for all kind of companies.

Open Innovation would support an increase in the number of Scottish SMES and individuals in contract with SPEN because of the innovative and highly educated society Scotland is; together with the fact that working together with other big multinationals based on Scotland would provide contacts and solutions they have already in place.

Chapter 2. - SP Energy Networks

In this chapter, the mission and vision of SP Energy Networks is stated, for better understand the importance of *Open Innovation in the Regulated Business* in the business plan and the strategy plan of the company

2.1. Mission of SP Energy Networks

SP Energy Networks is a UK electricity network operator in transmission and distribution level that aims to achieve the highest standards in safety, reliability and efficiency for the transport and distribution of electricity to the customers in our network area and the customers of other DNO's and TO's that depend on our network to achieve the same standards, minimizing the environmental impact of our service and helping to the developing of low carbon emissions generation in the UK.

2.2. Vision of SP Energy Networks

SP Energy Networks aims to be the highest rated DNO and TO in the UK energy network industry, being known for its commitment with the environment conservation, the efficient delivery of the energy, the continuous support to renewable electricity generation in Scotland and all the UK and an innovative approach for solving the challenges that are happening in the electricity network, reducing the cost charged to the customers for their energy and improving the environment conservation.

SP Energy Networks faces this commitment supporting innovation as one of its best developed characteristic, having an open mind to the new ideas and technologies that could lead to improvements in the network, aiming to be the first to propose and implement the technologies and to share the information and data obtained under theses researches to other partners in the industry, our employees and all the UK electricity customers.

2.3. Electricity Transmission & Distribution Networks in Great Britain

The electricity transmission business in Great Britain is divided among 3 players: National Grid Electricity Transmission, which controls Britain and Wales high voltage network and is the Britain's System Operator (SO); Scottish Hydro Electricity Transmission

(SHE), that run the high voltage network in the North of Scotland; and Scottish Power Transmission (SPT), part of SPEN. (Figure 1. Great Britain Electricity Transmission Networks) (OFGE15)

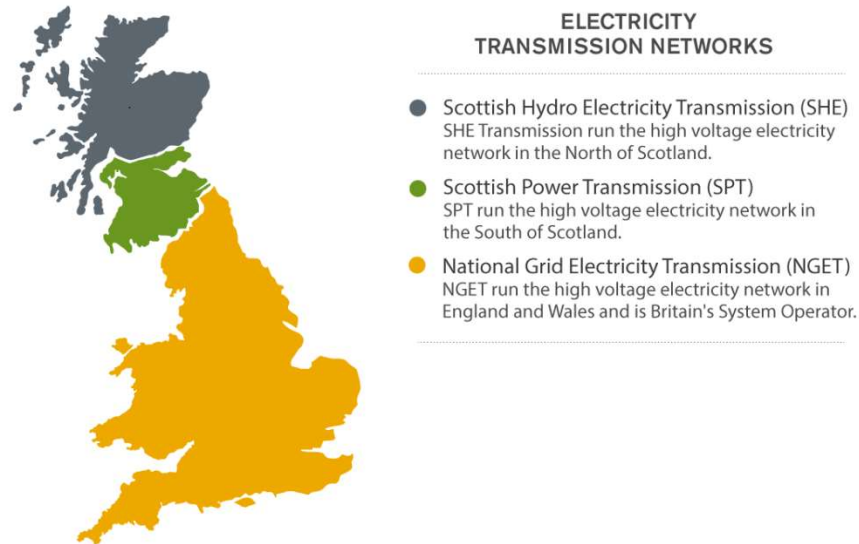


Figure 1. Great Britain Electricity Transmission Networks

The electricity distribution business in Great Britain is divided among 6 players with a total of 14 licensees: Scottish and Southern Energy Power Distribution in the North of Scotland and South of England; SP Energy Networks in the South of Scotland and North Wales; Electricity North West in the North West; Northern Powergrid in the North East and Yorkshire; UK Power Networks in the East of England, London, and South East; Western Power Distribution in the East and West Midlands, South Wales and South West of England. (Figure 2. Great Britain Electricity Distribution Networks) (OFGE15)

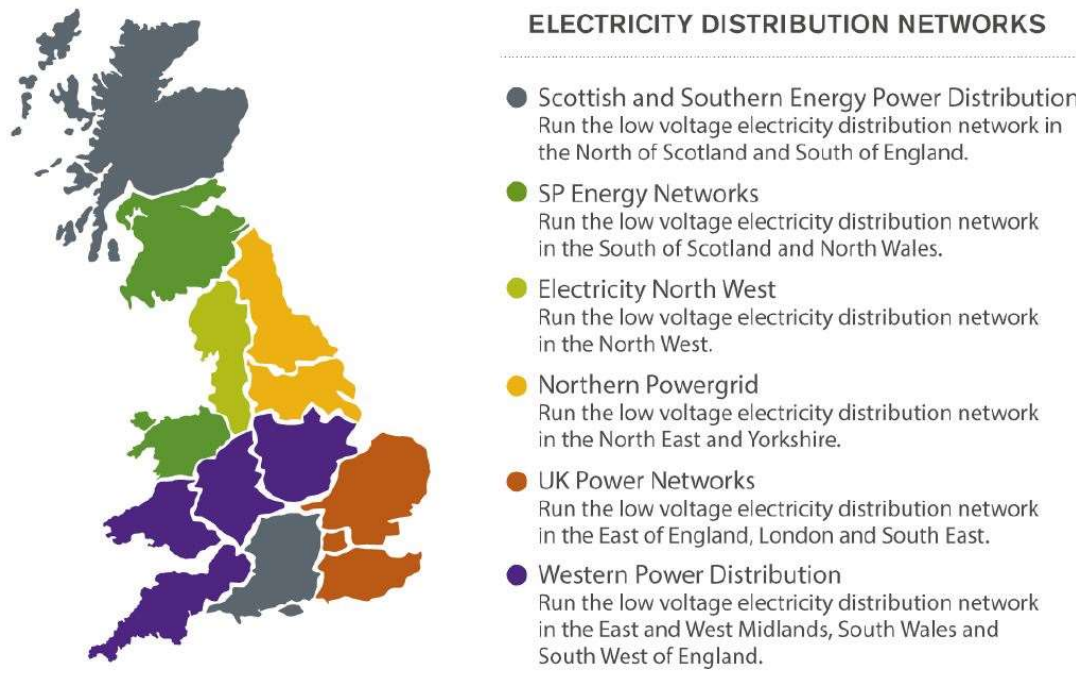


Figure 2. Great Britain Electricity Distribution Networks

2.4. Electricity Network Challenges

UK electricity networks is facing many challenges nowadays and it would face new challenges that would constraint its capacity, its control and the reliability needed for the correct transmission and distribution of electricity.

UK electricity networks are suffering the change of model in electricity generation. Former century model envisioned power stations that generated electricity with the consumption of non-renewables resources, such as coal, oil or natural gas. Moreover, in the UK, the existence of large water reservoir has allowed to generate an important part of the electricity through hydroelectric plant. The development of nuclear plants has also helped to satisfy the consumption of electricity by UK consumers.

But with the common awareness of the need of take care of the environment and to reduce greenhouse gas (GHG) emissions, the development of alternative renewable generation has been subsidized by the government, generating a huge investment in generation by these means. Also, the reach of the age limit for most of the nuclear plants and the turn to non-profit for coal and oil plants have totally changed the generation schema.

This fact is ever more extreme in Scotland, because of the large renewable resources it has, with constant wind, enormous water reservoirs and a low population density. Scotland has been for the last years and export country in terms of electricity, and it is a trend that would grow in the following decades.

Moreover, Scotland government has set ambitious goals to increase the share of Scotland energy consumption that come from renewable resources, that would increase the use of electricity for heating and transport. The goals for 2020 and current level on consumption in 2013 is showed in Figure 3. Renewable Energy Targets - Summary of Latest Progress SCGO15

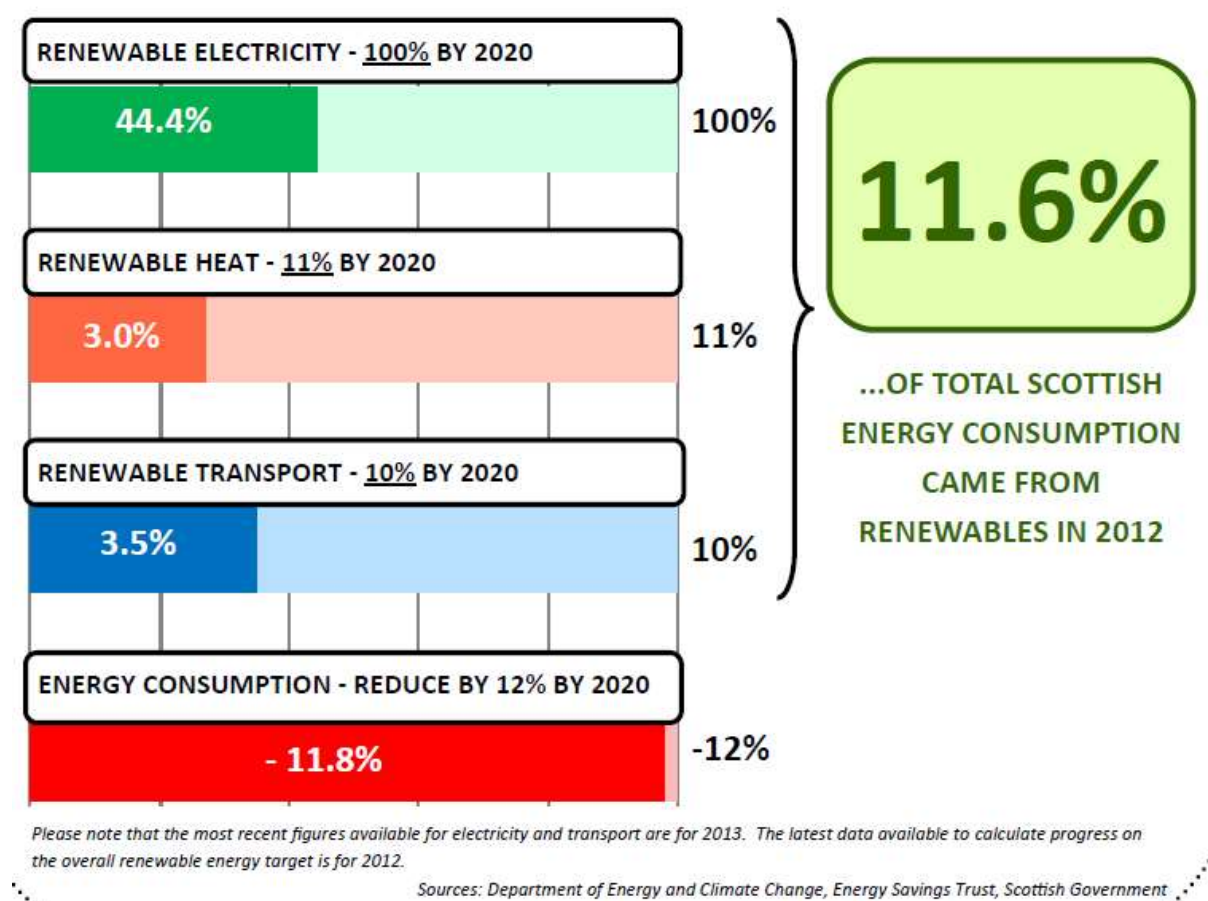


Figure 3. Renewable Energy Targets - Summary of Latest Progress SCGO15

The Renewable Energy Target by the Government of Scotland is to have 30% of total Scottish energy consumption from renewables by 2020, in comparison with the EU 20% target for 2020.

The fast increment in renewable generation has led to pass from a 20% of the electricity consumption from renewable at the beginning of 2008 to over 55% in 2015, just an 8 years' time period. At the goals set by the government are expected to increase more over the transition to renewable generation for electricity purposes, as could be seen in Figure 4. Share of renewable electricity in gross electricity consumption, Scotland, 2004-2015. SCGO15.

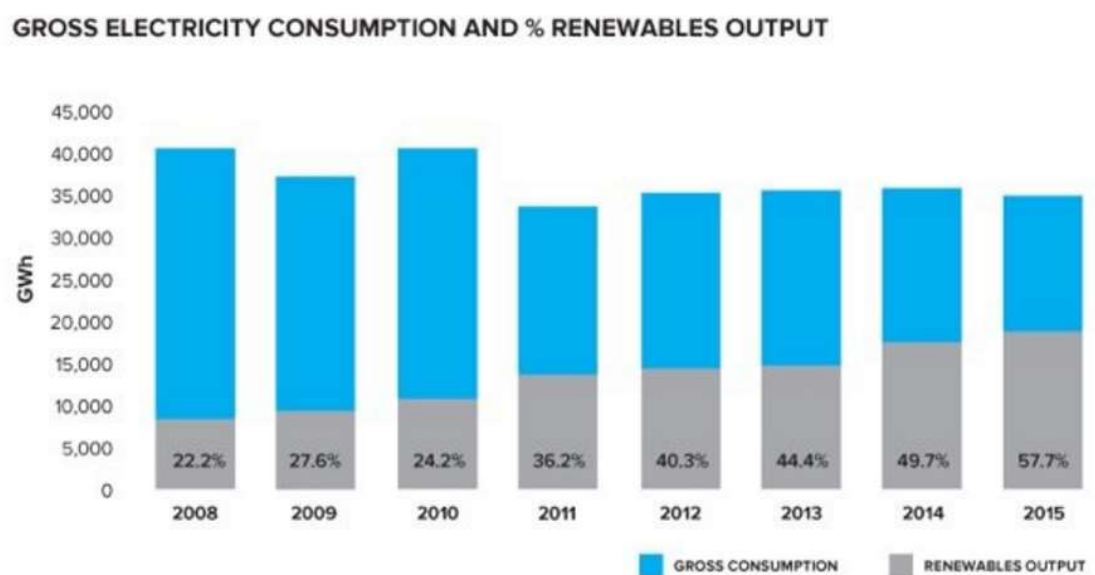


Figure 4. Share of renewable electricity in gross electricity consumption, Scotland, 2004-2015. SCGO15

As a consequence of the renewable generation boom, the higher cost of coal and other fossil fuel, the generation of electricity with fossil resources is really small in Scotland, and has been reduced even more with the recent closure of the two major coal plants, Longannet with 2,5GW and Cockerzie with 1GW, has led Scotland with an 1GW from fossil fuel plants, mainly from gas.

There are two nuclear power plants in Scotland, that account for over 2GW of capacity, and both of them are expected to be decommissioned in 2023, leaving Scotland in an almost total dependence of renewable generation.

The lack of huge power plant, usually fossil fuel or nuclear plants, make the network faces problems of inertia, voltage regulation, reactive regulation and increased variable generation. All these problems could increase the risk of disruption to the customers, and get a more unstable and uncontrollable network.

Also the current support from the government to renewable sources of energy would mean the generation of electricity would increase to transport the resources to the generation to demand areas, but the variability of these resources would increase the difficulty of the work for the operators. Forecasting expect a huge increase in the share of electricity as main energy consumption in Scotland for the next 30 years in Figure 5. Energy Intensity Forecast.

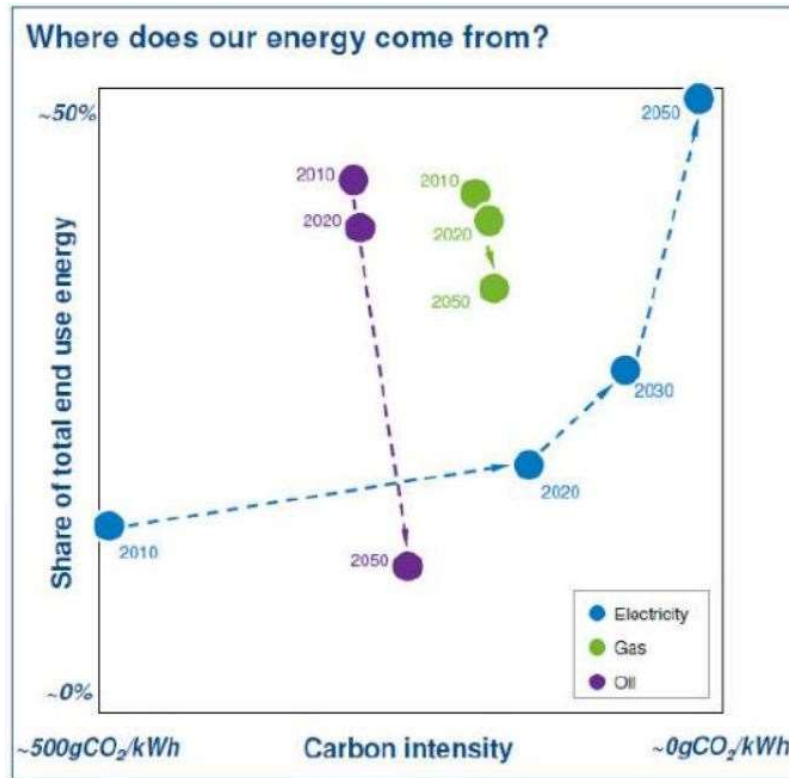


Figure 5. Energy Intensity Forecast

Moreover, the big increase in demand for renewable generation has led to a major surge in the demand of connections to the networks from wind farms, in areas where there were not a network with enough capacity to accept, under current limitations and policies, the full capacity of the generation without major investments.

All the topics that have been mentioned are the major challenges and problems the electricity network faces in the following years, and SP Energy Networks, as a TO and DNO would face and cope to solve all of them. The importance of innovation to solve the challenges is to help to reduce the investments to an effective and efficient level, maximize the capacity of the network to accept the maximum generation from renewable sources, and keep the quality of the service, the reliability and the control of the networks as the priorities of the company.

2.5. Price Control Framework – RIIO

Ofgem is the Office of Gas and Electricity Markets, the government regulator for the energy market in Great Britain. For the interest of this project, Ofgem has the power to control the price, investment and policy of the electricity transmission and distribution market in Britain.

The price controls are needed as energy networks are natural monopolies and therefore there is no realistic way of introducing competition in the sectors. Price controls are a method to limit the allowed revenue that can be earned by the network companies. Network Companies charge the energy retail companies, which pass the cost to the customers. The revenues control has to be set a level that allows companies to recover costs, earning reasonable return, to promote investment to get an efficient and reliable network but avoiding the abuse of the dominant position they held. (OFGE13)

A natural monopoly refers to a situation where the average cost of production, transportation and distribution in this case, is falling over the relevant range of consumer demand. In this case, having two (or more) producers in the same area would result in a significantly higher cost of network operation and be detrimental to consumer economy. (KAPL13)

RIIO is Ofgem's current framework for setting price controls, a performance-based model for setting the network companies' price controls. RIIO means *Revenue=Incentives+Innovation+Outputs*, and is designed to: (OFGE13)

- Put stakeholders at the heart of decision-making process
- Invest efficiently to ensure continued safe and reliable services
- Innovate to reduce network costs for current and future consumers
- Play a full role in delivering a low carbon economy and wider environmental objectives

There are two different price controls that apply for the different areas:

- Transmission RIIO-T1: Related to the high voltage transmission of electricity from 2013 to 2021, accounting for around 2% of a consumer's bill, as seen in Figure 6. Average Gas and Electric Bill Breakdown (OFGE13).

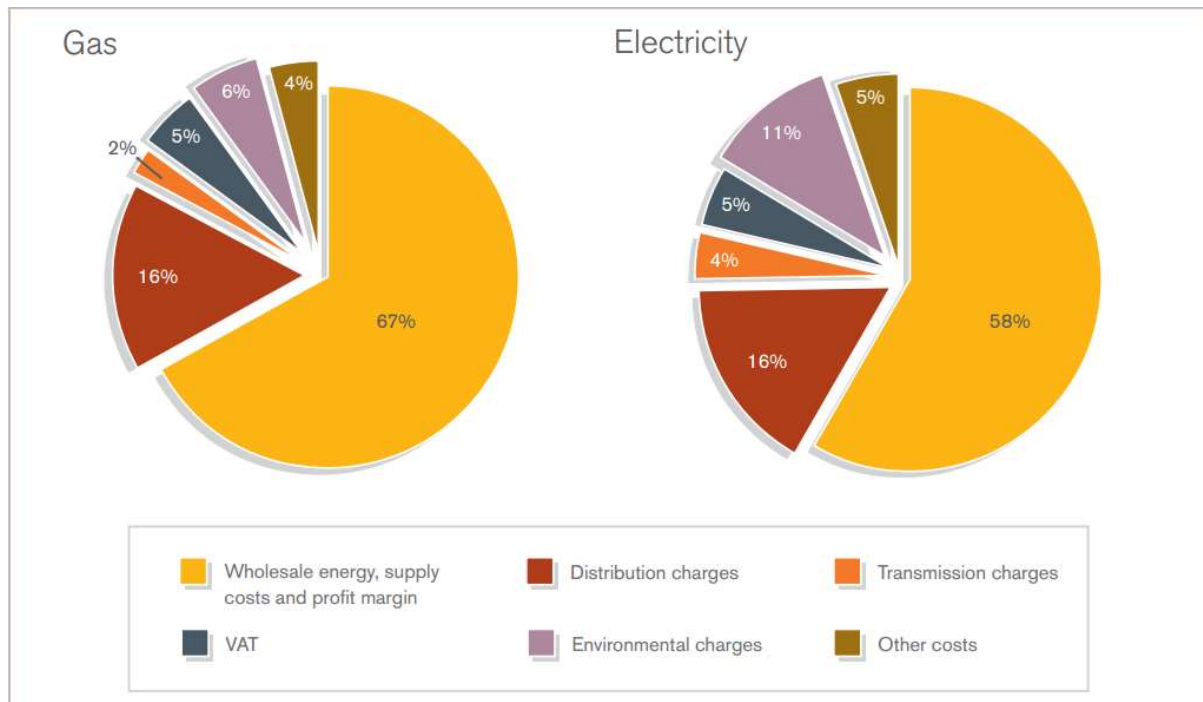


Figure 6. Average Gas and Electric Bill Breakdown (OFGE13)

- Electricity Distribution RIIO-ED1: Related to lower voltage to homes and companies for domestic and commercial use for the period 2015 to 2023, accounting for around 16% of a consumer's bill as seen in Figure 6. Average Gas and Electric Bill Breakdown (OFGE13).

RIIO-T1 would earmark around £7 billion of investment for Scotland's transmission network, delivering needed investment to replace and create new infrastructure that could face the increase in renewables electricity generation in Scotland with the massive deployment of wind farms.

2.6. Innovation Stimulus from RIIO price control

As stated in 2.5. Price Control Framework – RIIO, innovation is major point for the transmission and distribution companies in the price control framework to recover the allowed revenues. However, innovation projects are speculative in nature and right estimation about the commercial returns cannot be stated.

Ofgem has provided RIIO with three stimulus packages to support innovation and the projects that could be considered innovative:

- Network Innovation Allowance (NIA) aims to fund small-scale innovation projects. Value defaults to 0.5% of allowed revenues unless companies excel in demonstrating a well thought through innovation plan up to a maximum size 1% of allowed revenues; (OFGE13)
- Network Innovation Competition (NIC) is an open annual competition for all the Distribution Networks Operators (DNOs) and Transmission Operators (TOs), where they apply for up to £90m funding per year for flagship innovative projects that are too risky and innovative to be funded via the company normal investment path that would deliver low carbon and environmental benefits to customers; and (OFGE13)
- Innovation Roll-out Mechanism (IRM) enables companies to apply for additional funding to roll-out a proven innovation, which meets defined criteria. (OFGE13)

The three funds are the major forms of financing for the Future Networks team, having been awarded two NIC projects in last year competition (2015), and it is currently closing down projects from other years.

2.6.1. Network Innovation Allowance (NIA)

The Network Innovation Allowance has as its main purpose to provide a consistent level of funding to carry out smaller innovative projects. *Open Innovation in the Regulated Business* makes use of the allowance to fund part of the project. (ROSS15)

The fund provides a limited different funding for each Network licensees to use for two purposes:

- To fund smaller projects that meet the criteria in the Governance; and/or
- To fund the preparation of submissions to the NIC

The second purpose means that, most of the time, a successful NIC submission would have been prepared and/or involved several prior NIA projects. The difficulty inherent to NIC projects could be reduced if previous small studies about each of the different technologies that would be applied are done.

NIA projects would help for improve the technology readiness level (TRL) of a technology, usually from TRL 4 - technology validated in lab, to TRL 6 – technology demonstrated in relevant environments. (EURO14)

The fund is a set annual allowance that each Network Licensee must spend, being a maximum 80% given back if the projects meet with the criteria in the Governance document.

2.7. Innovation Strategy

SP Energy Networks believes innovation would help to enhance all the aspects of its business for the benefit of the electricity customers. Innovation is delivered to adapt the network to the 21st century challenges, reduce costs to customers and meet their future requirements through: (SPEN14)

- Technology innovation – operating the network more dynamically.
- Operational and process innovation – driving efficiency and service benefits.
- Commercial innovation – new contractual arrangements with customers and suppliers.

SP Energy Networks has a strong record of translating innovation trials to practical application and collaborating with the rest of Great Britain network companies to ensure that all customers benefit from customer funded innovation trials.

Innovation is one of the Iberdrola's biggest commitments. As a subsidiary of Iberdrola, SP Energy Networks shares with its parent company the willingness to innovate in its business, and has developed an Innovation Strategy to procure a support to this statement

SPEN is aware that funding sources from network customers. Therefore, innovation activity is focused on areas which customers most value and where the customers are willing to invest. Thank to stakeholder engagement feedback, SPEN has identified six priorities:

1. Managing an ageing network.
2. Reducing the number and length of power cuts.
3. Investing for storm resilience.
4. Improving customer service during power cuts.
5. Improving service to poorly served customers.

6. Preparing the network for low carbon technologies.

Based on SPEN experience and view of the electricity distribution and transmission industry, SPEN has mapped important topics for the industry in the short, medium and long term against the stakeholders' priorities, as showed in Figure 7. Electricity Distribution Network Innovation Topics.

Operating Our Network Safely – Providing Value for Money – Delivering Excellent Customer Service						
	Improving service to poorly served customers	Improving customer service during power cuts	Reducing the number & duration of power cuts	Investing in storm resilience	Managing an ageing network	Preparing the network for low carbon technologies
Short Term	Application of smart metering data			Alternative conductor materials	Demand side response as an alternative to asset replacement	
	Network visibility through online systems		Low Voltage Automation		LV Voltage control	
	Advanced automation			Remote asset tracking	Community led solutions	
	Tackling metal theft			Data processing and analytics		
				Future protection systems		
				Smart Grid Forum collaborative activity		
Medium Term	Smart metering data for active network management			Insulation failure detection		EV charging management
	Energy efficiency	Advanced mobile workforce capability			Remote asset inspection	Local energy management
	Energy storage			Research in asset management		Network optimisation to reduce losses
Long Term				Distribution system operator model		
				Power electronics technology	Superconducting technology	Hydrogen systems
				DC Systems		

Figure 7. Electricity Distribution Network Innovation Topics

The main point about SPEN innovation strategy is the fact that the main product that SPEN commercializes, electricity, cannot be improved, so only the services provided to the customers or the processes could be improved. This fact sets the trend through investing in assets management, new services to control demand or store energy and processes that reduce the environmental print of electricity transmission and distribution services, maximizing the use of the assets that are already in place all along the network.

Chapter 3. - Project Definition

This chapter sets the definition of *Open Innovation in the Regulated Business*, its scope, its objectives and its success criteria.

3.1. Project Definition

The scope of the project *Trial of Open Innovation Model in the Utility sector* as named under NIA or *Open Innovation in the Regulated Business* is to test, review and exploit Open Innovation model in the utility sector, being SPEN the representative of the industry among the several other industries presented in the SE trial. (YU15)

Innovation in the electricity transmission and distribution industry related to improve the service to the customers, adding new ones or improving the quality of the former ones. Moreover the new technologies related to power systems, renewable energy and energy storage are changing the landscape of the electricity industry, and SPEN needs to add them to its portfolio to improve the service, reduce the environmental print and help to the introduction and expansion of low carbon energy sources and a better control of the network and the assets in place.

SP Energy Networks applied for the Open Innovation Initiative Award of Scottish Enterprise (SE) in August 2015, asking for funding up to £***,***.** for each of the 4 years that the initiative is expected to be developing. After a partial funding of £***,***.** was granted by SE, SPEN backed more funds with the inclusion of the project under NIA (Network Innovation Allowance) terms using its Transmission license, for a total of £***,***.**.

The total funds dedicated to this project are around the hundreds thousands pounds for a 4-years period starting in October 2015. (*Real values are not given as it remains confidential information*).

3.2. Project Background

SP Energy Networks submitted the NIA project *Trial of Open Innovation Model in the Utility sector* after a proposition by Scottish Enterprise to produce a trial about Open Innovation together with several companies that are based in Scotland, or have a big presence in this country. (PERE16)

Scottish Enterprise awarded SP Energy Networks with funds to promote contracts with Scottish SMES by the implementation of Open Innovation model. SP Energy Networks works together with Devro Plc, Doosan Babcock, Edinburgh City Council, Glasgow City Council, NCR, NHS, Raytheon, Royal Bank of Scotland, Stena Line, Subsea 7 and Weir Group Plc to share the advances done in Open Innovation inside each company during the duration of the initiative. (PERE16)

Open Innovation initiative aims to evolve the concept of innovation in the companies working on this initiative. Innovation usually means focus on inside research and development to develop new technologies or processes to create new products to improve the current market or to open new markets for the company. But this model has proven no longer suitable, and a mix with the Open Innovation model is going to be tried. (PERE16)

3.3. Project Objectives

The scope of the implementation of *Open Innovation in the Regulated Business* is to prepare, test, review and exploit an Open Innovation model in SP Energy Networks, a Britain electricity transmission and distribution utility. (YU15)

The main objective of innovation in SP Energy Networks is develop new technologies and services that reduce the environmental print of the transmission and distribution industry, adding capacity for new renewable generation and improving the service to customers, reducing the investment need and maximizing the use of the current assets.

The main objectives of the project are, as defined in the submission for SE request for funding and the NIA submission:

1. The development of Business Plan
2. The implementation of the Open Innovation Business Plan
3. The preparation of a number of challenges to be defined that may be solved by SMES outside the usual contractors for SP Energy Networks.
4. The engagement of a number of SMES to be defined that were not in business contract with SP Energy Networks.

It has to be taken into account the singularity of SP Energy Networks implementation of Open Innovation model, as SPEN is a provider of electricity to the retail companies that

would sell it to the customers. SPEN has to innovative in the services, processes and technologies that is used for the transmission and distribution of electricity in its network.

Moreover, the services that are part of SPEN scope of work are changing really fast during the last years, and a major revolution is in its way for the distribution and transmission operators. New services include active control of the demand, energy storage or the provision of smart meters for all the consumers. Additionally, the fast and unexpected growth in the installation of renewable generation means the occurrence of stressful situations for a network that has not adapted to next electricity generation model.

3.4. Project Partners

This section aims to give a brief description of all the partners that are involved in the project, working together with SPEN to implement Open Innovation in their organization, or helping giving the tools, the academic support and the government support Open Innovation needs to develop in Scotland an Open Innovation model

Devro Plc

Devro is one of the world's leading suppliers of collagen casings for food, used by customers in the production of a wide variety of sausages and other meat products. Collagen is a naturally occurring polymer which is transformed into gel, tubular casing and film at Devro's manufacturing sites in the USA, UK, Czech Republic and Australia.

Devro employs over 2,200 people, with skills and knowledge ranging from chemical and electrical engineering to food technology, meat science and environmental health. Over 100 staff is in daily contact with more than 1,000 customers, providing specialist technical advice and support for sophisticated food manufacturing operations in more than 100 countries. (DEV16)

Doosan Babcock

Doosan Babcock is a specialist in the delivery of engineering, aftermarket and upgrade services to the thermal power, nuclear, oil and gas, petrochemical and process industries. Using best-in-class technical expertise and an industry-leading project management capability, the company builds, maintains and extends the life of customer assets worldwide. (HUNT16)

Edinburgh City Council

Edinburg is the capital city of Scotland, located in the East coast, being the second most populous city in Scotland and seventh in the United Kingdom, with an approximate population of half million.

It serves the city and their surroundings, employing over 19,000, being one of the city's leading employers. Services provided by the Council range from refuse collection to art galleries; parks to planning; schools to social care. Budget expected for 2015-2016 fiscal year is below 1,000 million pounds, collected via different processes.

Glasgow City Council

Glasgow is the largest city in Scotland and the third largest in the United Kingdom if Great Glasgow area is taking into account. During Industrial Revolution became one of the world's preeminent centres of chemicals, textiles and engineering, notably shipbuilding and marine engineering industry.

Glasgow City Council provides education services, social work, land & environmental services, financial services, development & regeneration services and other services, with an expected expense of 1.20 billion pound on 2016/2017 fiscal year.

NCR

NCR is a global tech company that runs everyday transactions that make life easier. IT is the world leader in consumer transaction technologies, turning everyday interactions with businesses into exceptional experiences. NCR's software, hardware and portfolio of services, make nearly 550 million transactions possible every day.

NCR is helping its customers respond to the demand for fast, easy and convenient transactions with intuitive self-service and assisted-service options. Its solutions help businesses around the world increase revenue, build loyalty, reach new customers and lower their costs of operations. NCR_16

NHS Scotland

The National Health Service Scotland is the publicly funded healthcare system for Scotland. It is an independent body from the rest of NHS of UK (England, Wales and North

Ireland), but they work together for co-ordination and co-operation where cross-border emergency care is involved.

Raytheon

Raytheon Company is a technology and innovation leader specializing in defence, civil government and cybersecurity solutions. Founded in 1922, Raytheon provides state-of-the-art electronics, mission systems integration, capabilities in C5I (command, control, communications, computing, cyber and intelligence), sensing, effects and mission support services. Raytheon is headquartered in Waltham, Massachusetts.

Royal Bank of Scotland

Royal Bank of Scotland (RBS Group) is based in Edinburgh, Scotland. The group operates through offices in Europe, North America and Asia. In UK and Ireland, its main subsidiary companies are The Royal Bank of Scotland, Natwest, Ulster Bank and Coultts.

Revenue in 2015 reached 12.923 billion pounds with a negative operating income of 3.430 billion pounds.

Scottish Enterprise

Scottish Enterprise is Scotland's main economic development agency and a non-departmental public body of the Scottish Government. It is the agency leading and funding the Open Innovation award that gave form to this project.

They work with partners in the public and private sectors to identify and exploit the best opportunities to deliver a significant, lasting effect on the Scottish economy. SCEN16

Stena Line

Stena Line, an ABTA (Association of British Travel Agents), is an international transport and travel service company and one of the world's leading ferry operators.

Stena Line operates in three business areas: Scandinavia, the North Sea and the Irish Sea with a network of 22 ferry routes. Stena Line is a stable and profitable group and is committed to providing passengers with the best service and experience possible.

Subsea 7

Subsea 7 is a world-leading seabed-to-surface engineering, construction and services contractor to the offshore energy industry.

Subsea 7 provides cost-effective technical solutions to enable the delivery of complex projects in all water depths and challenging environments. Our vision is to be acknowledged by our clients, our people and our shareholders as the leading strategic partner in our market.

University of Strathclyde

The University of Strathclyde is a Scottish public research university located in Glasgow. It was awarded University of the Year 2012 and Entrepreneurial University of the Year 2013 by Times Higher Education.

In the last complete year, it has 21,210 students and 3,200 administrative staff. University of Strathclyde Business School is advising as academic partner the development of the Open Innovation Initiative.

Weir Group Plc

Weir Group is an engineering company headquartered in Glasgow. They design and manufacture highly-engineered products and services for minerals, oil and gas and power industries.

Weir employs around 14,000 people operating in more than 70 countries, serving markets with good long-term prospects. Their main mission is to be a partner of choice to their global customers while strengthening and extending the Group's position in their core markets. WEIR16

Chapter 4. - State of Art

This chapter would look at the definition of Open Innovation, what it means, and what are the main characteristics of Open Innovation. Moreover, it would make a review of three success cases of Open Innovation implementation, Procter & Gamble, NASA and GE. At the end, a review of the literature about the risks of Open Innovation has been included.

4.1. Open Innovation

Henry Chesbrough, currently adjunct professor and executive director of the Garwood Centre for Corporate Innovation at the Haas School of Business at the University of California, Berkeley, is known for coining the term Open Innovation model.

Henry Chesbrough wrote several publications about the Open Innovation model, and he is considered the father of the theory around Open Innovation. Publications from him are:

- Open Innovation: The New Imperative for Creating and Profiting from Technology. HBS Press. 2003
- Open Business Models: How to Thrive in the New Innovation Landscape. HBS Press. 2006
- Open Innovation: Researching a New Paradigm. Oxford. 2008
- Open Services Innovation: Rethinking Your Business Growth and Compete in a New Era. Jossey-Bass. 2010
- New Frontiers in Open Innovation. Oxford. 2014

Before he coined the term, Open Innovation was already in use by several companies, but after his research and publications, Open Innovation has been seen increased its popularity and the use inside the industry, as the many advantages are promoted if added to the usual path to innovation, Close Innovation in Chesbrough vocabulary.

i. Open Innovation Definition

Henry Chesbrough first defined Open Innovation in 2003 in the following terms:

“Open Innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market, as the firms look to advance their technology. Open Innovation combines internal and external ideas into

architectures and systems whose requirements are defined by a business model. The business model utilises both internal and external to create value, while defining internal mechanisms to claim some portion of that value. Open Innovation assumes that internal ideas can also be taken to market through external channels, outside the current businesses of the firm, to generate additional value” CHES03

A more recent definitional 2006, Henry Chesbrough defined Open Innovation in the following words:

“Open Innovation is the use of purpose inflows and outflows of knowledge to accelerate internal innovation, and expand markets for external use of innovation, respectively. [This paradigm] assumes that firms can and should use external ideas as well as internal ideas, internal and external paths to market, as they look to advance their technology.” CHES06

The two definitions share the common point that companies have to use not only internal technology and internal developments, but to increase the use of external technologies and external development to develop new products or improve the current ones.

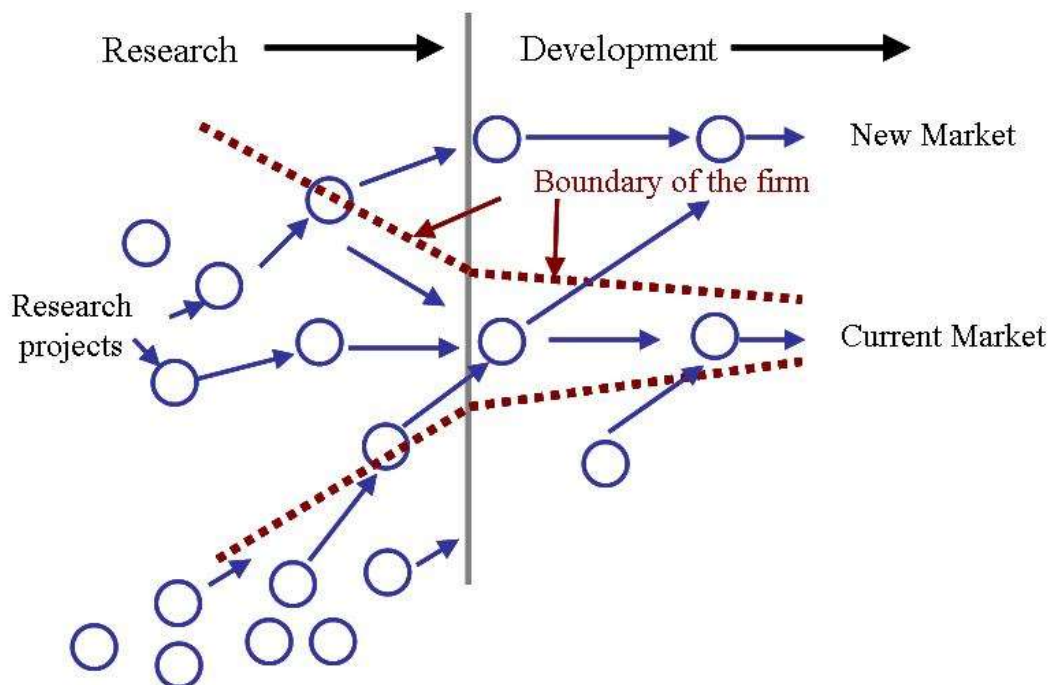


Figure 8. Open Innovation path to market

Open Innovation model is based on the change in the path to market of products and services of a company from the very beginning as a research concept to the launch into the

market. The market where the final product is launched could be a known market for the company, a completely new or recently created market or a market that other company opens through a licensing agreement to make full use of the development in other markets.

Figure 8. Open Innovation path to market shows the Open Innovation path to market of a variety of products, services or technologies in inside and outside a company. A dotted line symbolises the boundaries of the company. A dotted line is used instead of a simple line to show the need of spaces in the boundaries of the company's departments and employees to allow information, expertise and technologies flows to go outside and into the company; as well as allow not used technologies, products or ideas to be developed outside the company in their path to market.

For the purpose of Innovation, in the XX century there was mainly a unique path to Innovation, called Closed Innovation under Chesbrough terminology. Companies invested high quantities of money in internal Research and Development department, and contract the brightest people to have access to their expertise and knowledge. Some of the rules of Closed Innovation were: CHES03

- Companies should hire the best and brightest people, so smartest people in our industry work for us.
- To bring new products or services, they have to be discovered and developed inside the company.
- If the company discover first, the company will get to market first.
- First on the market, usually wins.
- Our intellectual property has to be controlled, so competitors cannot profit from it.

Closed Innovation model worked very well most of the twentieth century, with example as the German chemical industry, the Thomas Edison laboratory or the famous Bell Laboratories. The companies that created the laboratories and R&D centres used what is called the Virtuous Circle to justify the need of more R&D and how it would benefit the company, as showed in Figure 9. Closed Innovation Virtuous Circle

The circle shows how an increase in the quantity invested in R&D would generated to new technologies or products inside the company that could be launched to the market,

disruption the competition and improving sales and revenues for the company, allowing for more money to be invested again in R&D.

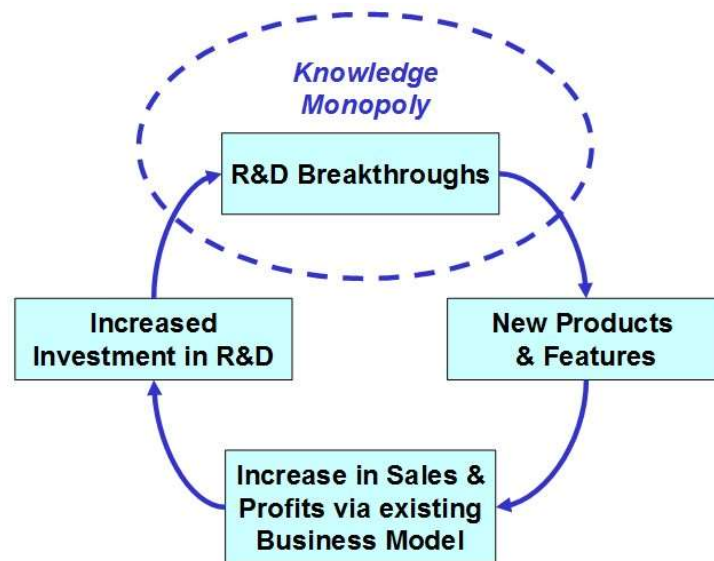


Figure 9. Closed Innovation Virtuous Circle

However, in the last decades of the twentieth century, factors that erode the circle appear. The virtuous circle was broken, and R&D Closed Innovation model was challenged. The factors that have led to Open Innovation model are: CHES03

- The growing mobility of highly experienced and skilled people.
- Higher number of graduates and PhDs, allowing knowledge to spill out of the corporate central research labs.
- The growing presence of private venture capital (VC), experts in create companies that commercialised external research that can become competitors for established companies.
- Fast time to market required and customers with more knowledge.

Because of the apparition of these erosion factors, Closed Innovation model was no longer sustainable. The company that originally funded the breakthrough did not profit from all its investment in the R&D that led to the breakthrough. And outsider companies that profit from the breakthrough generally did not reinvest its proceeds to finance the next generation of discovery-oriented research.

Open Innovation model could be used alone funding external R&D, or working together with Closed Innovation model, as defined in before.

As shown in Figure 8. Open Innovation path to market allows both the reduction in costs from development, a faster way to market, and to increase the use of all the knowledge and expertise developed in R&D.

Following the book by Henry Chesbrough, Open Innovation still have false positives, referring to technologies or developments that look promising and brilliant but finish without a real application. However, the main point about Open Innovation model is that allows the recovery of false negatives, projects that initially seem almost worthless, but turn out to be surprisingly valuable. The projects could be valuable in a new market or in combination with other projects in the same market with other company's perspective.

With regard to Open Innovation activities, different works has distinguished technology exploration, retention and exploitation. [LIER06] These activities can be both internal and external, meaning that both sides of the equation have to be looked. LINC__

- Internal technology exploration refers to the generation of new knowledge inside the firm. LICH05
- External technology exploration relates to technology sourcing from external partners. VRAN06
- Internal technology retention stems from the need for storing technological knowledge over time. DIAZ06
- External technology retention refers to knowledge that is maintained in a firm's inter-organizational relationships, such as alliances. GRBA04
- Internal technology exploitation describes the internal application of technology in a firm's own products. LIWA04
- External technology exploitation refers to outward technology transfer. LICH09

Internal and external activities are complementary, as the company needs to do both at the same time to get the maximum profit, as collaboration may outweigh the potential positive effects of individual actions.

However, the interdependencies of these activities pose major and complex risks to the company to Open Innovation, that must be understood by the management to apply countermeasures to get the maximum benefits reducing the risks related with Open Innovation, as can be read on 4.2. Open Innovation Risk.

ii. Procter & Gamble

One of the most successful cases of the implementation of Open Innovation model is Procter and Gamble, with its program Connect + Develop.



Figure 10. Procter & Gamble Connect + Develop logo

In 2001, P&G was in a period with sales growing at a slower path than latest years of twentieth century. P&G has always been considered a leader in its market and a very innovative company. Inside the firm, everybody knows that the solution is always innovation, but they understood that P&G needed to accelerate its innovation development and increase its rate of innovation success.

P&G uses innovation to create value with retail partners, satisfy customers and to create new business models to maintain sustainable growth. The company uses a unique design for innovation comprising of five major statements: DATA09,

- Defining innovation broadly
- Investing in innovation at industry levels
- Managing innovation with discipline
- Delivering innovation that builds consumer trust and loyalty over time
- Using global brands and an outstanding team of innovation leaders to lead innovation

P&G innovation strategy is not technology focused but consumer focused, looking along all the production chain and the contact with the customer, from packaging to shopping experience. The company supports sustainable innovation investing in R&D.

Indeed, the company leadership predicted that, with the advance in communication and conveyance, solutions for some internal problems would be found in collaboration. The

leadership chose to launch Connect+Develop, implanting the seed for a systematic, company-wide open innovation program charged with bringing the outside in, and taking the inside out. POPY__

P&G Connect+Develop program is not the unique strategy towards innovation. The company believes innovation should be sustainable and all the people in the organisations have the skills, expertise and knowledge to help sustain innovation. For capture 360-degree innovation, other complementary innovation strategies are: PVPZ09

- User driven innovation: User driven innovation mainly focuses on developing products based on customers need. The company engages their customers as co-designers. DATA09
- The Corporate Innovation Fund: It is an in-house venture capital (VC) firm which hands over successful innovations to the relevant business units in the company. The firm carries out the initial concept, design, engineering and qualifications work prior to handing over the ideas. It specialises in high-risk, high reward ideas. DATA09
- Innovation Net: A knowledge sharing solution that provides access to 18,000 knowledge workers at P&G from all the departments, from R&D to Legal. It allows users to catalogue locate and maintain employee knowledge.
- Enterprise 2.0: P&G version of web 2.0, a set of web based software service that helps increase the involvement of employees in establishing and managing data. It also allows personalising the web via RSS feeds.

Looking back to Connect + Develop, to lead the successful implementation of the program, and to get a shift in the culture of the employees of the company, P&G set itself a goal in 2001 to get 50% of its innovation through a significant component of external collaboration. To work towards achieving the goal, P&G set 6 main innovation hubs in China, EMEA (Europe/Middle East and Africa), India, Japan, Latin America and North America, and also they launched an innovation portal in 5 languages for attract people to submit their solutions or possible ideas.

The program was a success, achieving its goal (50% of innovation through external collaboration) in 2005 from around 15% in 2001. In October 2010 two new goals were set:

- Delivering \$3 billion toward annual sales growth through Open Innovation.
- Become the Partner of Choice for innovation collaboration by consistently delivering win-win relationships.

Connect+Develop decided to launch a website (www.pgconnectdevelop.com) to bring together external research institutions, customers, suppliers, individuals and even competitors to develop the market for new products. C+D posts all the needs classified by categories and anyone who is interested or has the solution could propose their ideas and get assessed by a specialized team. If P&G successfully looks into your submission a reward is expected.

PVPZ09

P&G is currently looking for innovation in the following areas, if looked in C+D website (last checked on May 2016):

- Personal and Family Care
- Beauty and Grooming
- Packaging
- Industrial and Manufacturing
- Digital, Business and Retail
- Other innovations

Connect+Develop initiative and P&G Open Innovation also work in other direction to cover a high spectrum of possible partners and collaborators via:

- Academia partnership: Examples are University of Leeds, Durham University, both in UK, Fraunhofer in Germany and CSIR in India.
 - Joint Ventures: With Inverness Medical, currently Alere to enter in the consumer health-care business. With Glad Products Company, a company selling trash bags and plastic food storage containers, supporting with technology internally developed when working on disposable diapers.
- OZKA15
- Trademark Licensing: Working together with Disney to sell Oral-B teeth brusher to kids, or with Honeywell to introduce its Freeze products in the fans.

- In-Out Licensing: Licensing a fabric-care solution in order to deliver fabric softener for clothes in the dryer from an independent inventor and mixing his work with internal R&D.

Connect+Develop is not only used for solve current or future needs of P&G but also to receive propositions of ideas for products or materials that people prepare. They would check the submission and get the Solver valuable insight about the vision of the idea inside the company.

Looking at the C+D initiative leaflet, the results attained via Open Innovation are:

- 70% higher than average Net Present Value (NPV) from C+D enabled projects in 2009.
- 40% of C+D partners have multiple deals with P&G.
- About \$3 billion in annual sales at partner companies driven by P&G shared innovation.

Last results show how Open Innovation model, if applied successfully, is a win-win strategy, when both the company and the external partners highly profit from the sharing of information, development and techniques.

In addition, P&G attempts to increasingly license the own technologies and developments, because it only used around 10% of its internally developed technology for products and services in 2006. HUSA06

Examples of Connect+Develop success products cases are, attending to the initiative website (www.pgconnectdevelop.com) and the Leaflet:

- Mr. Clean® Magic Eraser®

In Japan, a C+D scout discovered a multi-purpose sponge in a grocery store. The sponge turned out to be melamine resin foam made by BASF of Germany for construction soundproofing and insulation. The foam became a strong cleaning tool when it is wet; P&G negotiated purchase of the foam from BASF with terms for further collaboration. Right now is sold globally; the line includes a variety of cleaning sponges. The floor mop was in 2015 the #1 in North America in selling mop. OZKA15



Figure 11. Mr. Clean® Magic Eraser®

- Dunkin Donuts Retail Coffee

Dunkin Donuts is a competitive market leader in coffee sales in the USA. But consumers could not buy the packaged product. P&G Research & Development developed a roast that delivered the same, good taste of a brewed cup of Dunkin’ Donuts coffee at home and at a value price point, and distributed in stores across North America. OZKA15

iii. NASA

The National Aeronautics and Space Administration is the agency of the United States Federal Government responsible for the civilian space program. NASA’s vision is to reach for new heights and reveal the unknown for the benefit of humankind. WILS15

In the early 21st century, NASA is extending our senses to see the farthest reaches of the universe, while pushing the boundaries of human spaceflight farther from Earth than ever before. WILS15

Founding legislation on 1958 instructed NASA to “...provide for the widest practicable and appropriate dissemination of information...”. To keep this part of the legislation, NASA established a solid foundation with the following principles: PHIL15

1. Increase Agency transparency and accountability to external stakeholders.
2. Enable citizen participation in NASA’s mission.
3. Improve internal NASA collaboration and innovation.
4. Encourage partnerships that can create economic opportunity.
5. Institutionalize Open Government philosophies and practices at NASA.

NASA has more openly embraced Open Innovation model during the last 5-10 years as budget restrictions appeared, and the NASA had to compete with start-ups and technology companies for the best brains in the world.

To find where the current revolution around Open Innovation started inside NASA, it is necessary to look at Dr. Jeffrey Davis, who leads the team responsible of solving human health issues in the outer space (Human Health and Performance Directorate). Dr. Davis recognized the tighter budget and the limit in the researches would mean not all the answers could be found in-house. He realised the team needed to start thinking differently, and lately let him to implement a culture of “open innovation” throughout the entire agency. KNOW13

NASA has mainly focus to open its innovation process via challenges, using a focused problem-statement approach to obtain solutions and/or stimulate innovation from a broad, sometimes undefined, public rather than a specific, named group of individual. The two techniques for implementing challenges inside NASA are: BRYA16

- Prize competition, intended to stimulate innovation with potential to advance NASA’s mission through the offer of a competitive award. Benefits to sponsors range among, paying only for results, exploring wide breadth and depth of potential solutions to bringing out-of-discipline perspectives to bear.
- Crowdsourcing, intendeds to solicit products, services, ideas, or content contributions from many people, and may result in the making of award(s).

The approach by NASA has been to use multiple crowd-sourcing platforms, adapting the choice of the platform to the kind of challenge and the solution or output expected. Dr. Davis has proven that the answers to the toughest problem can come from people who have no experience with space travel. KNOW13

For NASA, crowdsourcing is different from ordinary outsourcing because a task or problem is outsourced to an undefined public rather that to a specific, named group or individual. BRYA16

The crowd-sourcing initiatives at NASA are built on several different platforms, including competitions that award prizes and such open-innovation services as TopCoder; who launched in 2011 the NASA Tournament Lab (NTL) to centralize all the crowd-sourcing platforms and provides an online, virtual facility that facilitates the use of crowdsourcing to

tackle NASA challenges. Platforms included in the NTL can be observed in Figure 12. NASA Tournament Lab partners. LEWI15.

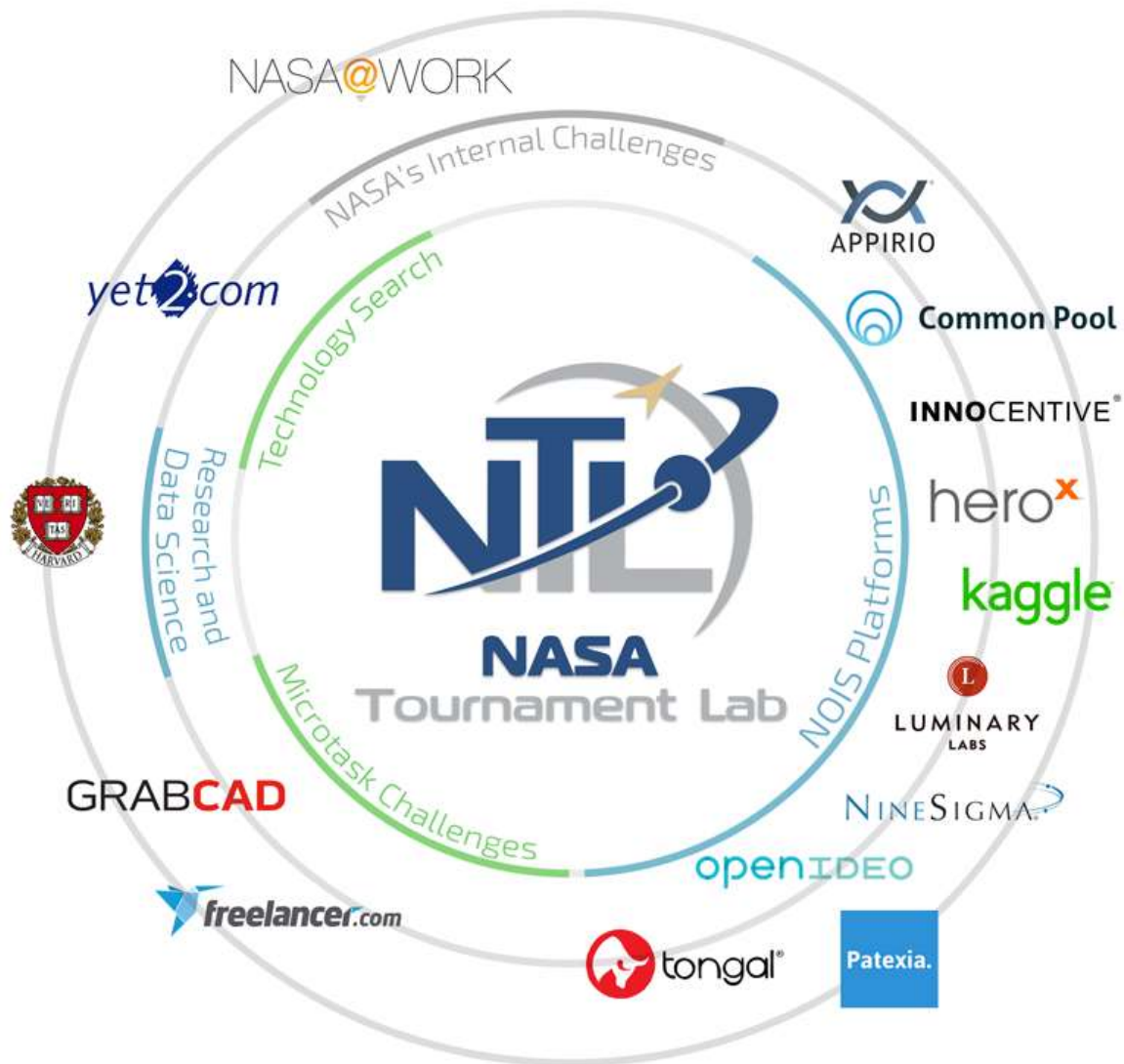


Figure 12. NASA Tournament Lab partners. LEWI15

The following is a list of other programs and platforms that NASA uses for prize competition and crowdsourcing activities as described in the NASA website. BRYA16

- **NASA's Centennial Challenge Program:** NASA'S Centennial Challenge Program directly engages the public at large in the process of advanced technology development that is of value to NASA's missions and to the aerospace community.

- **NASA's Center of Excellence for Collaborative Innovation:** NASA's Center of Excellence for Collaborative Innovation serves as an integrator of government agencies to form a "Collaborative Innovation Community of Practice". The initial focus is on open innovation, with the intent to include other innovation methodologies and related and/or supporting communities of practice (e.g., legal) in the future. – The CoECI administers the NASA Innovation Pavilion, NASA Tournament Lab and NASA@work for the agency.
- **NASA Innovation Pavilion:** NASA Innovation Pavilion shares individual challenges within an established network of solvers on the InnoCentive platform, providing financial award if the solution is deemed viable by the sponsoring organization.
- **NASA Tournament Lab:** Is an operational virtual facility developed between NASA, Harvard, and TopCoder and other competition platforms like Tongal, established to enable communities to compete to create the most innovative, efficient, and optimized solutions for specific, real-world challenges being faced by NASA researchers.
- **NASA@work:** NASA@work is an internal collaboration platform that connects the collective knowledge of individual experts from all areas within the NASA organization via a private web based environment supported by InnoCentive. *[NASA Internal Only]*
- **Challenge.gov:** Challenge.gov is an online challenge platform administered by the U.S. General Services Administration (GSA) that empowers the U.S. government and the public. This platform is the latest milestone in the Administration's commitment to use prizes and challenges to promote innovation. NASA is using Challenge.gov to list challenge opportunities provided by Centennial Challenges, NASA Tournament Lab, and others to collocate opportunities with the rest of the federal government.

On October 2015, NASA's Technology Transfer Program announced that it's opening up its patent portfolio and waiving the cost associated with using the patents for at least the first three years of a company's product development. Once a start-up has brought the

product to market, NASA will start collecting a “standard net royalty fee”, but otherwise inventors will be able to use the patents however they like. FUNG15

Some of the inventions that appear looking inside the IP are already known to the humankind and has its influence on the human experience. Insulin pumps, water filters are NASA inventions. MOFT15

A known and highly disseminated success case where Open Innovation has made the different providing a solution over the expectations is:

- Data-Driven Forecasting of Solar Events

Solar flares pose a major risk for the mankind, as they could affect communication systems and electricity networks among others, provoking blackouts and difficult situations to recover from. They were also very difficult to forecast and there were not tool available when the challenge was launched.

For the challenge, no data sets were provided, and people were expected to find their own way to construct the algorithm. The solution was provided by a retired radio frequency engineer, Bruce Cragin with no experience working with the NASA or any specific knowledge of heliophysics. KNOW13,

The challenge was launched via Innocentive with an award of \$20,000. Before the challenge was solved, there has been no method available to predict the onset, intensity or duration of a solar particle event. JEFF10

The solution got accuracy and time-windows of predictions, giving a prediction capability of up to 8 hours with 85% accuracy, and a 3-sigma confidence interval. Cragin’s solution also allows for a 24-hour forecast window of event onset with 75% accuracy. INNO14, JEFF10.

iv. General Electric

In 2005 Jeff Immelt, chief executive of GE, announced a strategy called “Ecomagination” that aimed to double GE revenues from environmentally friendly products. GE saw environmentally friendly products and services as a big growth industry but its interest was also spurred by the environmental and natural-resources challenges facing the world. CHES12

Ecomagination initial commitment in 2005 was \$700 million annual investment in cleaner R&D, and has matured into a cumulative \$17 billion of investment in cleaner research and development since its start. Ecomagination aimed to develop solutions that offer GE customers the capability to enhance resource productivity, reduce environmental impact and improve business performance. GE__16

The interest in renewable, “green energy” or “clean energy” was very high in 2005, and much of the interest came from organisations and individuals that GE currently did not do business with. Because of the high level of interest, a significant amount of venture capital investment was flowing into green energy space, with over \$1 billion in 2007 and over \$2 billion in 2008, representing around 15% of VCs money flow.. CHES12

GE’s energy business serves a variety of customers in power generation, industrial, government, and other customers worldwide. The energy business offers both products and services related to energy production, distribution and management. The business offers customers total solutions to meet their needs through a complete portfolio of aftermarket services, and is making new investments in areas of technology that comply with more stringent environmental regulation and in water treatment solutions. CHES12

To reach the goal set by the CEO, GE has to face the challenge that its energy business was dispersed and complex. GE invests high quantities of money in internal R&D, but fresh ideas tender to develop from smaller, external organisations and individuals. CHES12

Moreover, there was a big problem, in order to really develop the clean tech space, GE needed to develop an ecosystem of companies, so they needed ways to forge partnerships with companies or individuals they have not worked before with. Also the rapid increase in activity was challenging for GE to cope with. Their development cycles were getting shorter and shorter, making hard to rely only in internal resources. CHES12

As it has been seen in Open Innovation Definition, some of the erosion factors that led to the Open Innovation model appear also in the energy business that GE wanted to continues leading. To go over these factors, the idea of creating a challenge in the green and renewable energy space for outsiders to offer their own idea to GE began to take shape. In 2010 GE would ask for ideas and it would commit \$100 million of its money to fund the companies responsible for the most promising ideas.

However, GE took a different approach, and decided ecomagination Challenge needed outside support, and was a good opportunity to do more by working with VCs already active in the sector. For GE management, having VC to invest alongside GE in the initiatives would make them more effective. VCs look at the market with a different perspective, as they are not conditioned by GE business model and previous experience. CHES12

GE was concerned about the turnover of VCs and if they would agree to participate. But VCs understood the opportunity that was working with GE, as are large companies which really drive the development of the energy markets. Four of them were selected for joining the GE ecomagination Challenge, Kleiner Perkins, Foundation Capital, Rockport Capital and Emerald Capital. GE agreed to let VC discretion at their investment committee, without trying to influx the decisions made by them. CHES12

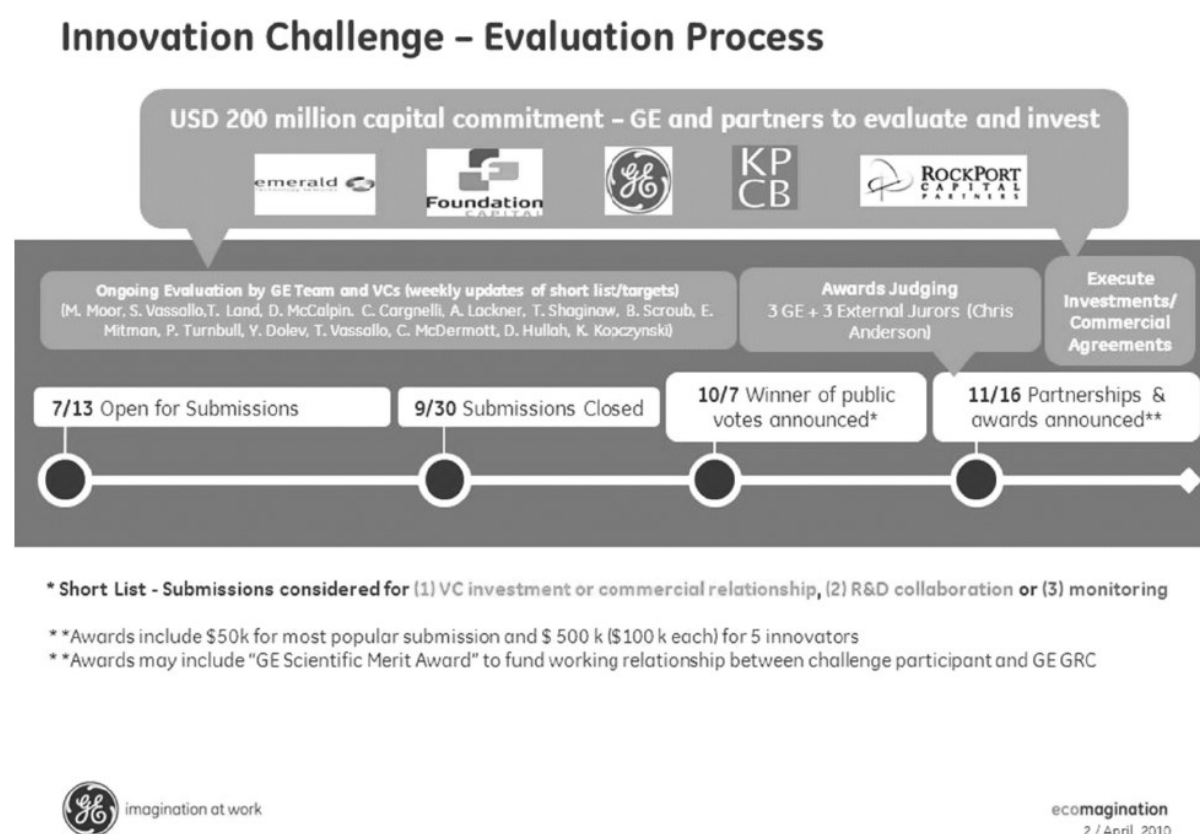


Figure 13. GE ecomagination Challenge 2010 evaluation process CHES12

The first challenge, in July 2010, looked for promising ideas in three broad categories: Renewables, Grid and Eco Homes/Eco Buildings. Selected entrants would be offered the opportunity to develop a commercial relationship with GE through: FALO10

- Investment: the \$200 million capital pledge of GE and the partners
- Validation: through in-depth discussions with GE's technical and commercial teams
- Distribution: explore opportunities to scale a business
- Development: leverage GE's technical infrastructure and GE Global Research Centers to accelerate technology and product development
- Growth: utilizing existing GE customer to take products to the market.
- An independent judging panel selected five recipients of a \$100,000 innovation challenge award to develop their ideas.

The expectancies of GE when on July, 2010 publicly announced its ecomagination Challenge and the turnaround was expected around the hundreds submissions, as GE is a Business-to-Business (B2B) company. The pool of reviewers was composed of GE employees, VC collaborators and external independent experts and the challenge development follow the process in Figure 13. GE ecomagination Challenge 2010 evaluation process CHES12.

4,000 submissions were received over the course of 10 weeks, 10 times above the expectations. Each idea was reviewed by an individual, who judged it as any potential venture investment for the fund or for GE, without a common framework for all the judges.

A second phase was held in January of 2011, focused on ways to connect the smart grid to the home. Around 1,000 responses were received and more than 75,000 people participated in the process. To increase the number of people reviewing the ideas an award for people choice project or idea would be awarded with \$50,000. Although it didn't take time for GE or the VCs and was the lower in cost, this award received huge amount of coverage. GE__10

As a result of the challenge, 12 companies were awarded with GE funds. Some of them are: GE__10

- ClimateWell, Stockholm, Sweden (Efficient Appliances). Energy-efficient cooling and heating systems run on solar-powered hot water rather than electricity, maximizing energy efficiency. GE is working with ClimateWell on

deploying the technology in additional markets served through GE's appliances business.

- Consort, Raleigh, NC (Energy Management Systems and Software). Demand site energy management solution empowers utilities, municipalities and co-ops to manage load curtailment, increase operations efficiency and act as a virtual plant. It complements GE Digital Energy's existing solutions.
- SecureRF Corporation, Westport, CT (Utility Security). It provides security solutions that address lower-powered embedded devices that will be used throughout the Smart Grid. GE's Digital Energy business can draw on this security technology for the smart grid to help utility customers alleviate consumer privacy and data security concerns.

Other 5 companies received the innovation award of \$100,000 to develop their ideas and another set of companies were given \$10,000 for being "best in show". An example is:

- IceCode: Wind Turbine Blade Anti-icing and De-icing, West Lebanon, NH. High power pulses remove ice from turbines, limiting the downtime of turbines. The technology could be applied in refrigeration and others.

The completed picture of all the companies awarded in the 1st Ecomagination challenge could be seen in Appendix C – Awards from GE Ecomagination Challenge 2010.

Ecomagination strategy tries to bring companies to partnership with GE that would sell their development through its customers, improving its services and the results to the customers, and, at the time, provide the company with the latest technology in the market, reducing the need of development in some areas to focus in the main important ones.

Moreover, GE has opened some of the design process to crowdsource solutions. An example is when in 2013, GE aviation engineers turned to GrabCAD, an online community of more than a million engineers and designers and presented a challenge: Whoever could redesign a bracket that reduced the most the weight while still supporting the engine would win \$7,000. More than 1,000 entries came in, with the winning design by M Arie Kurniawan, a young Indonesian engineer who reduces the weight of the bracket from 4.48 pounds to 0.72 pounds, a whopping 84%. STIN14

Following the information made public by GE in its website for 2015, during the 10 years of the Ecomagination strategy the numbers are the following:

- \$17 billion spent in R&D
- \$232 billion revenue generated with ecomagination products and services
- 4 times overall growth of GE, double its target of 2x in 2005
- 12% reduction in greenhouse gas (GHG) emissions by GE products and services
- 17% reduction in freshwater
- 6 global Open Innovation challenges launched since 2010
- Sustainable practices in GE own operations has saved \$350 million compared with to 2004 baseline:
 - Cut greenhouse gas emissions by 32%,
 - Energy intensity by 31%,
 - Freshwater consumption by 45%.

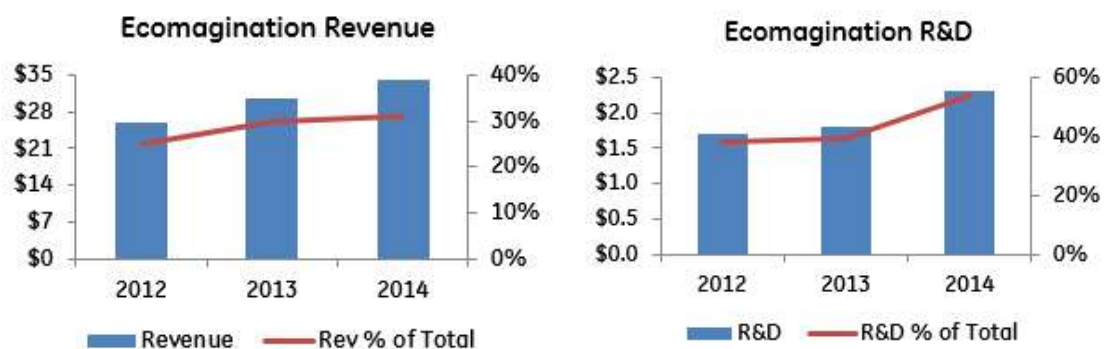


Figure 14. Ecomagination Strategy Main Numbers

The ecomagination main subjects for the following years are:

- Development of new natural gas ecosystems for the oil and gas, power generation and transportation industries;
- Deployment of next generation renewables that are both lower cost and better integrated into larger power networks;

- Increased efficiency and alternative fuels for global transportation networks;
- Improved industrial and commercial productivity through the deployment of smart machine-to-machine software and analytics; and
- More optimal, integrated systems at the home, building, and municipal levels.

GE also thinks that the journey towards a lower carbon and water intensive future is a worldwide initiative that would only be successful if all the governments, companies and individuals work together. For that it has 7 global research centres and several additional Customers Innovation Centres across the globe. GE__16

The partnerships with companies within the industry and cross-industry are the only way to achieve the transformation and the next industrial era via disruptive innovation. Some of more important partnerships of GE could be shown in Appendix B – GE Ecomagination Infographics, with companies as Statoil, Intel, Walmart or Goldman Sachs.

The commitments for the next 5-years period of Ecomagination are until 2020:

- Investments of an additional \$20 billion in R&D in cleaner technologies and business models for its customers.
- Reducing GE GHG emissions and freshwater use by an additional 20% compared to 2011.
- Expansion the focus of Ecomagination beyond individual technologies to working with industry partners to develop and scale global solutions.

GE Ventures is the part of GE that makes venture capital investments in innovative companies within Software, Healthcare, Energy and Advanced Manufacturing sectors. The main goal of this part of the business is to be the global partner of choice to accelerate the commercialization of world-class ideas and technologies by providing capital as well as access to GE's expertise, resources and global scale. GE__16

GE Ventures is other initiative by GE to work with companies in different steps of their development, depending of the size of the company, the current development of the products and services, and the need of the company. The possibilities range from new business creation to scaling. GEVE16

GE Ventures New business creation is a team of entrepreneurial investors working to create and build new businesses of strategic value to GE. Their solutions connect the dots among GE as a partner of choice, external parties, and experienced management teams. GEVE16

GE Ventures Licensing accelerates innovation and growth for partners by providing access to GE technologies and inventions through licensing and joint development partnerships. It offers unique opportunities to bring GE's large and diverse portfolio of intellectual property out of GE's global research labs and into the world to solve partner's challenges. Licensing could be done through technology transfer of the expertise and know-how from GE's proven technology or patent licensing of one of the more than 48,000 active patents. GEVE16

Scaling is done through the program EDGE that works to leverage the global scale, expertise and resources of GE to provide its partners with programs, tools, information and education to help build, grow and scale the enterprise. It does through 3 steps: GEVE16

- Develop: Harnessing GE expertise and tailors it to the need of the partner.
- Operate: Leveraging GE's internal and external resources to help achieve efficiencies and operational excellence as the company is built and scaled.
- Amplify: Creating opportunities and new channels to drive messaging, partnerships and sales around the world.

All the different approach of GE for getting in contact with more companies from outside, and the powerful results of the different strategies helps to take into account the relevance and importance of looking outside the own company for better improvement in the market of the company, or in new markets to be developed.

4.2. Open Innovation Risk

Open Innovation model is a really promising path to market for the companies, as they could get extra developments and thinking for a fraction of the cost to develop following traditional R&D path to development and get a different perspective and view about how to use their external R&D.

Moreover, Open Innovation moswl gets the idea of licensing-out technologies or developments done by internal R&D departments that are not useful currently, getting an extra benefit to the company.

But Open Innovation is not exempted of risks, and it should be used together with high investment on Research & Development departments and by academic partners such as universities, research centres or private companies to get a sustainable growth of Innovation.

Following the study *Open Innovation: potential risks and managerial countermeasures* (LINC__), the risks that appear and the possible countermeasures are described. In addition, a more detailed risks list is given by the case study of Procter and Gamble Connect+Develop initiative.

i. External Technology Exploration Risks & Countermeasures

Concerning external technology exploration, the major risk is the limited internal development of critical technology knowledge if all the research is done outside the company. Too much external technology exploration can harm company revenues in the long term as absorptive capacity decreases, together with lack of prior technological knowledge to identify external technology sources. Moreover, a major dependence of external technology could reduce motivation in the internal R&D department. LINC__

To limit the risks in this activity, the company must continue with sufficient investment in internal R&D as a basis for future internal and external exploration. External and internal technology sourcing are complementary, and external technology adaptation needs of internal technology to get the expected output. Open Innovation has to be an add-on to internal R&D projects. A corporate strategy on R&D should be stated.

ii. External Technology Retention Risks & Countermeasures

There are several potential risks in the area of retention. The statement of potential is used here because many of the risks never appear as the company does not open up to innovation because of the fear to receive the negative effects of the risks.

The major risk founded in the retention activity is the possible dependence on external partners in a firm's network. Relationships with partners are not stable, and the control a firm can have of its external partners is limited.

Countermeasures to reduce the risks are, for example, to maintain a strong internal knowledge base, critical for profit with external base, being focus on maintain and strength intrafirm and interfirm learning processes. Knowledge bases inside the company are kept to maintain flexibility enough in dynamic environments. Other solution could be keeping several collaboration agreements with different partners for the same technology or field, reducing the risk of failure of a single partnership.

iii. External Technology Exploitation Risks & Countermeasures

Following the data obtained in LINC__, and after the knowledge of companies applying Open Innovation, it is stated that external technology exploitation is limited yet. The risks of licensing technologies for outside exploitation are well understood because they limit the increasing exploitation of technologies outside the firm. Management fear transferring technology that could be used to generate potential competitors, or develop new markets where the firm is not the leader.

Current countermeasure is to block the transfer of technology to other companies. But to fully embrace the benefits of Open Innovation, transfer of internal technology is expected to be supported. For avoid the risk, management could proactively handle the risk with the formulation of a long-term strategy that contemplate the technologies that would be basis on the development of the company and the technologies that could be exported. Also guidelines for individual decisions in the one-by-one process to decide if technology may be exploited outside the company has to be set. Business units have to be coordinated among them and with the corporate to seek and look around all the technologies developed inside the company.

iv. Integrated Perspective Risks & Countermeasures

Open Innovation integrates the three activities, and risks appears if all the activities are embraced and supported by a firm in its way to fully maximize the interrelation between internal and external technology.

Excessively opening up the innovation process may deteriorate a firm's competitive position relative to its major competitors. In addition, the firm may have difficulties to develop critical complementary assets or know-how. Also a faster path of innovation via external technologies or outsourcing may take out of the R&D the time to develop promising

opportunities. To remain innovative in a market the firm should adapt, adapting also the business model and transforming its core business. LINC__

The main risk an Open Innovation strategy has is that the effects, positive or negative, will be only known in the long-term, as at the beginning most of the actions would increase the return of the company. To avoid the different risks that appear with a complete Open Innovation strategy, the company needs a central coordination of Open Innovation activities at the corporate level. The centralized function oversees to capture the benefits and limits the effects of the risks. The corporation should prepare a long-term strategy to capture the maximum benefits, but always remain flexible and dynamic to the changes that would appear. LINC__

4.2.5. P&G Risks Case Study

Below are described some of the most critical issues related to Open Innovation, that can damage the long-term growth and existence of any company implementing Open Innovation based on the case study of P&G Connect + Develop initiative:

- The dangers of “outsourcing” innovation

Outsourced innovation might become fragile innovation and lead to a progressive lose of internal capabilities to develop inside innovations. There is a competitive advantage that can be lost in the long term future, the expertise to innovate. PVPZ09

- Managing the intellectual property

Although Open Innovation has been proved a leading innovation model since the beginning of the current century, suspicious has surged around the treatment of Intellectual Property and how it is applied. As a development is nurtured by both internal and external collaboration, and all the parties involved share their knowledge and expertise, is difficult to know the property of the IP. In the Open Innovation model, there are many in-licensing and out-licensing of technology and innovation. The companies have to consider before entering in an Open Innovation model how they are going to protect their inventions, and how they are going to protect outsiders’ innovation to attract partners that trust the company. PVPZ09

- Negotiations burden

As the number of partners and collaborations increase, also increases the burden need to properly manage the relationships and negotiations among the several parties. Lot of small

providers, with a short-term relationship with the companies, have to be fairly treated, and an ad-hoc negotiation has to be handling for each individual, increasing transactional costs, increasing the cost of the innovation. PVPZ09

- How to select and filter innovative ideas

In the same way that happen with Close Innovation model, there has to be a committee or a set of expert individuals that filter and then select the innovative ideas that are passed to further steps of development. False positives and false negatives can appear but it is a risk that inside the normal business of any company. Companies would mainly try to select technologies that are mature and proven, or these that lack little steps for their commercial deployment of launch. The reduction in implementation and technological risks is good, but it reduces the chances of customization and to launch radical innovations, because R&D department capabilities are less exercised, and limits the potential of Open Innovation model. PVPZ09

- Identifying the “Serial Innovators”

According to the Pareto Principle (80-20 rule) most valuable ideas would come from a reduced group of individuals with a different thinking and a bright expertise and knowledge of specific topics. The difficulty appears because the number of potential individuals exponentially increases with Open Innovation. The companies, although committed to continue the Open Innovation implementation, should try to identify and nurture the especially valuable group inside the community. PVPZ09

- The complexity of the new system and the interactions

The implementation of Open Innovation inside a company leads to increase the complexity of the interactions among employees and outsiders, challengers and solvers, researchers and developers. Positions should be created to control the management system and provide the company with the variety of tools and automatic protocols to reduce the burden for the normal users. PVPZ09

Chapter 5. - Description of the Developed Model

This chapter describes the strategy chosen for the implementation of Open Innovation in SP Energy Networks, breaking down the different ideas to work packages, and later on to specific tasks that can be stated and time measured.

Moreover, this chapter looks at the risks each work packages face and the countermeasures needed to reduce the possible negative effects of each risk.

5.1. Objectives and Specification

The scope of the *Open Innovation in the Regulated Business* project is to prepare, test, review and exploit an Open Innovation model in SP Energy Networks, a transmission and distribution electricity utility in the United Kingdom. (YU15)

The main objectives of the project are, as defined in the SE request for funding and the NIA submission, the following:

1. The development of a business plan to work with more SMES
2. The development of an Open Innovation Business Plan
3. The implementation of the Open Innovation Business Plan
4. The preparation of a number of challenges to be defined that may be solved by SMES's outside the usual contractors for SP Energy Networks.
5. The engagement of a number of SMES to be defined that are not currently in business contract with SP Energy Networks.

Key Performance Indicators (KPI) have been defined for each one of the objectives:

Objective	Key Performance Indicator (KPI)
Development of Business Plan	Check every month to keep on track
Development of OI Business Plan	Check every month to keep on track
Implementation of OI Business Plan	Check every month to keep on track
Number of challenges	2-3 per annum
Number of SMES engaged	Minimum 5 per project

The Success Criteria Indicators are the following:

- Developing an OI model and project initiative that is fit for purpose and suits the nature of the utility sector.
- Ensure that collaborative innovation is undertaken in a reliable, coordinated, efficient and cost effective manner.
- Identification of two or three business challenges a year that will benefit from the Open Innovation initiative, and innovative products, processes or services well suited to addressing these challenges.

The main owners of this project are:

- James Yu, Future Networks manager at SP Energy Networks. James has lot of expertise leading electricity transmission projects related to innovation.
- Eric Brunger, Senior Open Innovation analyst, joined the team in April 2016 and it is one of the full-time positions defined in the Scottish Enterprise submission. He has previous experience working in project management for Scottish Power Generation.
- Javier Perez Sanchez, student of final year of Master in Industrial Engineering and person preparing the strategy for the *Trial of Open Innovation in the Utility sector* for SP Energy Networks during a vocational placement from January 2016 to end of June 2016.

The stakeholders for this project are:

- SPEN, as company testing Open Innovation model as a new approach for the utility sector innovation,
- SE, as the government agency that partially funds and leads the OI initiative,
- The rest of companies in the cohort as partners in the implementation of OI in each industry,
- SMES, which will have the opportunity to access to challenges from SPEN, propose solutions and go into contract with SPEN and the rest of companies in the cohort,

- SPEN employees, who have to support the efforts to open SPEN, propose challenges they face in their day-to-day business and who would be affected by the solutions proposed,
- Ofgem, as the control organization of NIA projects, which would be in charge of approving the project results and accounting for the benefits delivered to the electricity customers.

There are also several interested parties that would profit for the results and work done in this dissertation:

- Rest of Britain DNOs and TOs which would received the reports submitted to NIA aproval.
- Iberdrola, as the parent company of SP Energy Networks would also have the opportunity to review and follow the progress of the implementation.
- Electricity customers, who would see improvements in the electricity services and a more cost-effective service.

5.2. Project Strategy

The main aim of this project is to prepare and implement a strategy of Open Innovation model for the utility sector. The plan should provide a successful approach for the implementation of Open Innovation in SPEN, where it should endure and change the way problems and challenges are approached and solved.

Open Innovation may mean a major change in the organization, introducing concepts, processes and services that there were not available before this project.

The objectives of the Open Innovation initiative are achieved working on different tasks that attack each of the points that have to be developed:

- Search about Open Innovation model; prepare a definition that fix SPEN and the utility sector.
- Look for a partner with experience in Open Innovation to help with the preparation of the challenges, spreads the challenge around and makes a first selection of the possible solutions.

- Search, prepare and launch challenges from problems that affect business-as-usual processes and for which a solution has not been found. The process may be automatized, recollecting ideas from all the level of the hierarchy of the company.
- Get in contact with SMES that are not partners at the moment of the start of the initiative, inviting them to look at the challenges proposed by SPEN and to propose solutions to other problems they expect SPEN to have.
- Increase the awareness about the innovation projects among SPEN employees, though the use of subliminal messages, presentations and more presence in the social networks.
- Generate a major improvement of the SPEN Innovation website, looking for a common framework for all the projects to be described and upgrade the updating process to make it easier and more intuitive.
- Share and comment the advance of our project with the rest of the companies in the cohort and TOs and DNOs.

Following the Work Breakdown Structure, each main part is divided in smaller tasks that allow estimating durations and costs more accurate. For the main project, the division would be among Work Packages

Figure 15 shows the six work packages of the Open Innovation initiative. It is the first division to be done among the different tasks that are included in the Open Innovation Initiative.

The work packages include the main activities the owners of the project have considered keys for the success of the implementation. Most of the activities were not included in the submission for SE, but the current knowledge of what Open Innovation means, the review of the available literature and the understanding of the processes of successful implementation have showed the importance of do all these processes in the strategy.

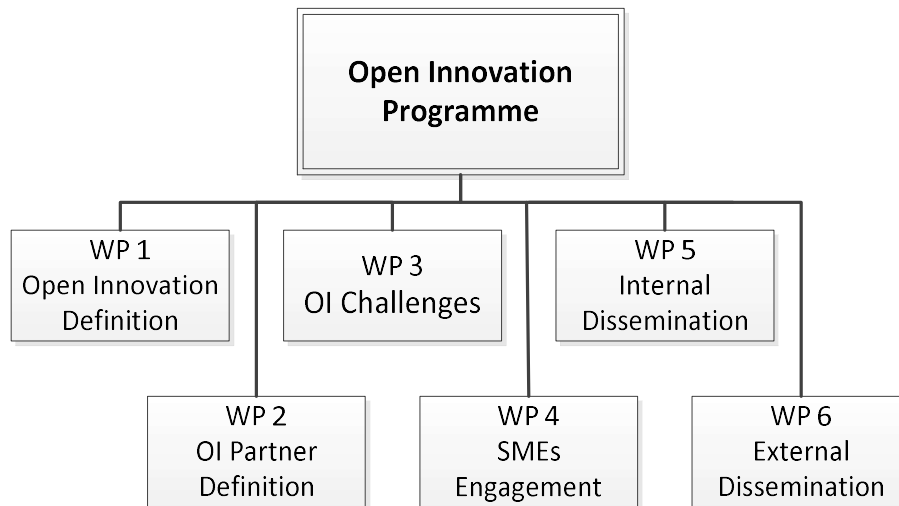


Figure 15. Open Innovation Initiative Work Packages

Each work package is going to be analysed in detail to list the tasks that are going to be done, helping to understand the whole process and the main activities done for the implementation of Open Innovation in SPEN.

i. WP 1: Open Innovation Definition

As Open Innovation is a quite new conception of innovation and it is necessary to understand its meaning, trying to specify the concept for the utility sector, due to the distinctive features the sector has, and the most relevant success cases of implantation would be studied too.

The Work Breakdown structure for Open Innovation Definition can be found in Figure 16.

Open Innovation search and analysis look into the definition of Open Innovation, to identify the important points to take into account for the initiative implementation. There are differences between the formal or theoretical definition and the definition that applied to our initiative, because it has to be adapted to match the utility sector.

Information and example of the implementation of Open Innovation in other industries would help to understand the processes follow for the deployment, the results, and what are the major concerns about Open Innovation. The focus may be about successful and unsuccessful initiatives to implant Open Innovation to anticipate risks and frictions in the implementation.

From the information found in the two former tasks plus the terms of the fund submissions a strategy would be chosen for the implementation of Open Innovation in SPEN. The objectives, the tasks and the planning and management would be stated and prepared.

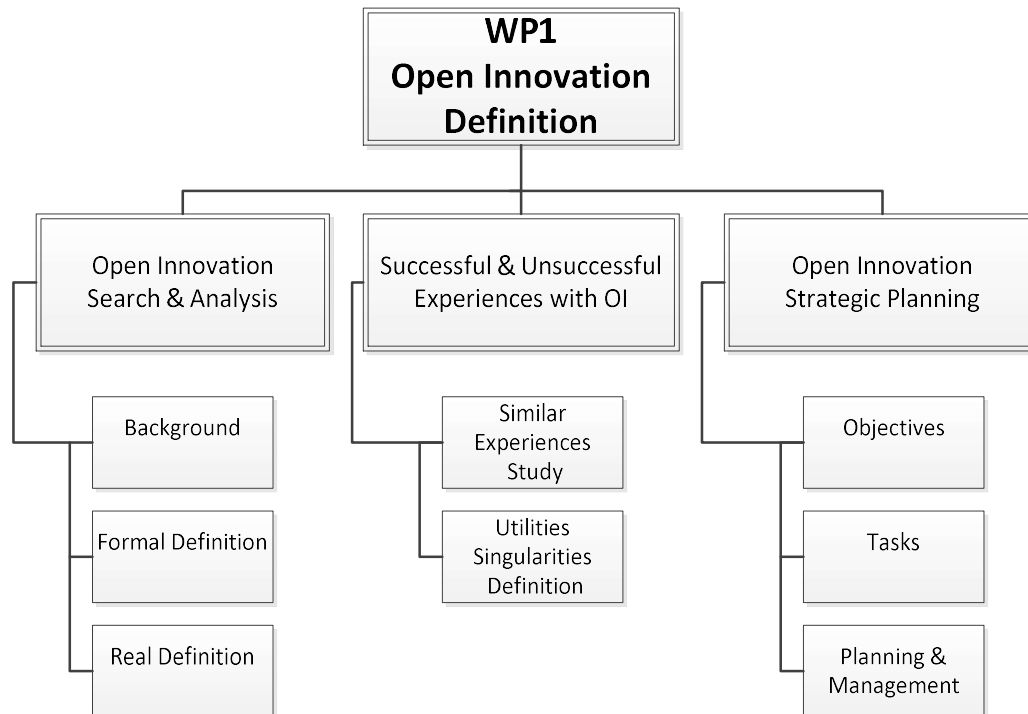


Figure 16. WP1 OI Definition Tasks

ii. WP 2: OI Partner Choice

For the correct diffusion of challenges and better profit from prior successful cases, it has been stated that a partner with experience may be the best approach. The expected partner has to have a background working on Open Innovation; has access to a wide pool of businesses that are able to submit quality and achievable answers to the challenges launched and be capable to make the problem understood for people with no background in the electricity distribution and transmission industry.

The WBS of the election of the partner is shown in Figure 17.

The market is scoped to produce a shortlist of possible candidates. The possible candidates for being the partner of SPEN are divided between crowdsourced challenges companies and platform companies, taking into account the kind of processes they offer. A study and an analysis of the services offered for each firm may be done to better understand their scope.

As the partner is one of the major points of the Open Innovation, due to its experience and more knowledge on Open Innovation, the experience of the shortlisted candidates has to be checked, trying to discuss with companies that have used their services.

After a first research about all the candidates, some of the candidates may be shortlisted; having commercial contact with the companies that better fit for what SPEN is looking for.

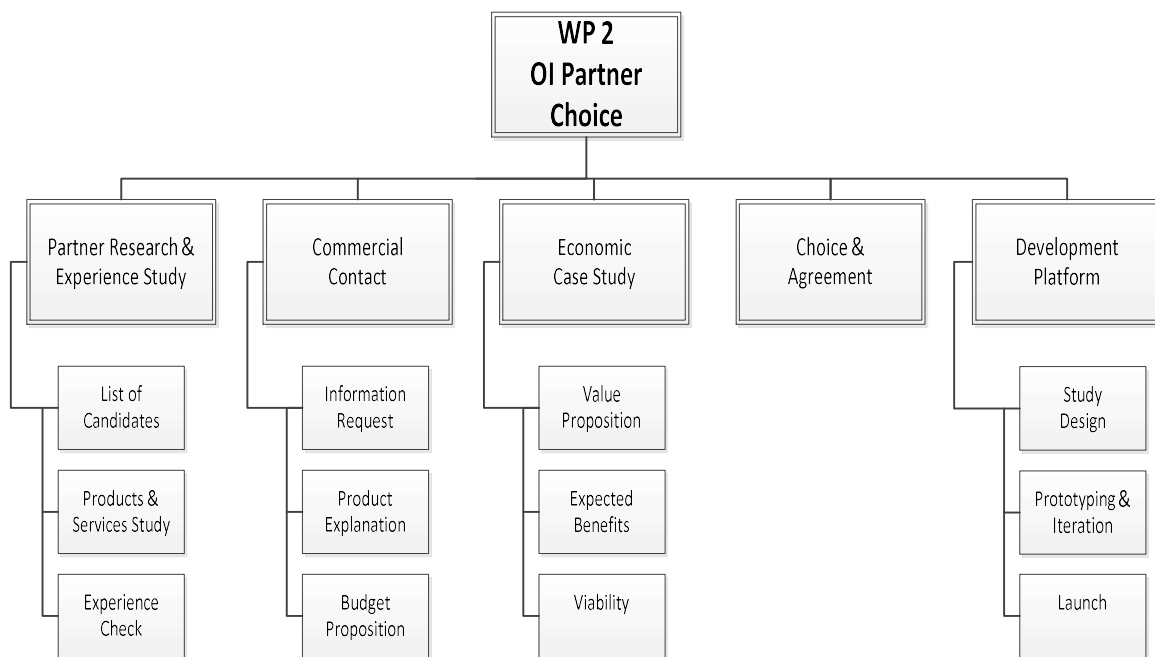


Figure 17. WP2 Partner Choice Tasks

After the information is recollected, an economic case study would be prepared, looking at the value proposition of each possible partner, their strengths and weaknesses and the processes followed. The candidates that obtained a positive output would be shortlisted for the choice.

A choice has to be done for one partner to work with. The complication and difficulty of this project makes the choice of just one partner the correct answer to reduce the division of work and to get focus on the launch of challenges several times a year.

Part of the time would be used to prepare and launch the platform SPEN would use to share ideas and collect solutions, being possibly the same that would be used to launch the challenges, with or without the help of the partner.

iii. WP 3: Open Innovation Challenges

The main approach for the implementation of Open Innovation under the SE initiative is to provide internal problems of the company to be solved by SMES or individual from outside the company. The problems could range from R&D needs to day-to-day business problems that are not take into account but whose resolutions could improve the work of the people involved.

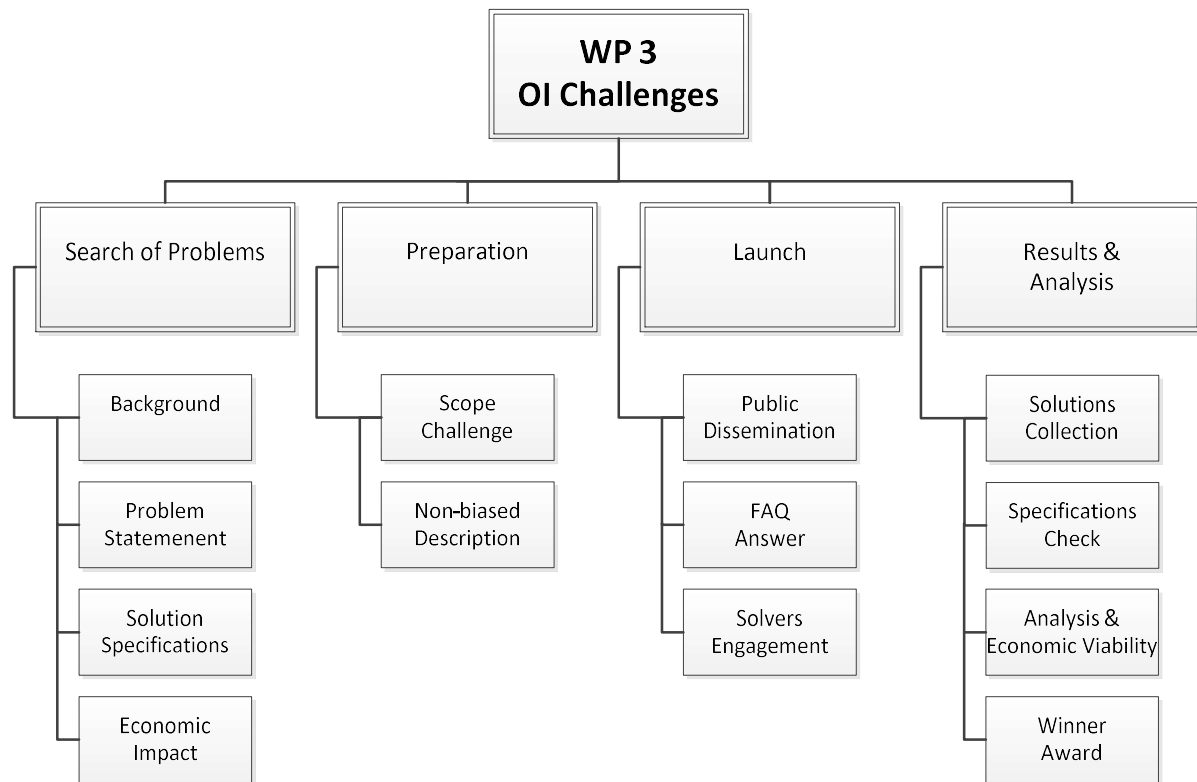


Figure 18. WP3 OI Challenges Tasks

Figure 18 shows the Work Breakdown Structure of the challenges and all the subtasks that must be achieved for a challenge to be successfully launched and awarded.

The problem that the challenge wants to address has to be found inside the company, so a process of search has to be set in place. The search process may be automatized for receive problems from all the hierarchy of the company, from the electric districts that maintain and manage the distribution network to transmission engineering or IT team.

The problem has to be stated, take a look of its background, the effects of problem in the stakeholders that get affected by its resolution and the economic impact is solution may have.

The preparation of the challenge means to work in partnership with the OI partner to prepare a draft of the challenge, where the specifications are clearly defined, the language is adapted to non-experts, and the general information is not biased by the SPEN view.

Once the draft of the challenge is prepared, the moment to launch the challenge has arrived. Using the tools offered by the partner, the challenge is opened to the world, expecting for a good number of solvers to contribute. The team may help to answer the questions asked by the solvers. Also it should disseminate the challenge, advertise the challenge by SPEN communication tools and engage employees to spread the word.

After the solutions have been submitted and the challenge got offline, a full revision of all the submissions is done by the partner, which would shortlist some high quality solutions that fulfil the specifications of the challenge. Then SPEN team must decide a winner, or spread the prize among the several best propositions.

iv. WP 4: SMES Engagement

Contact with more SMES is the main goal of the *Open Innovation in the Regulated Business* project. One unique Work Package has been dedicated to SMES engagement, and the tasks would help to complement the efforts done in the rest of Work Packages.

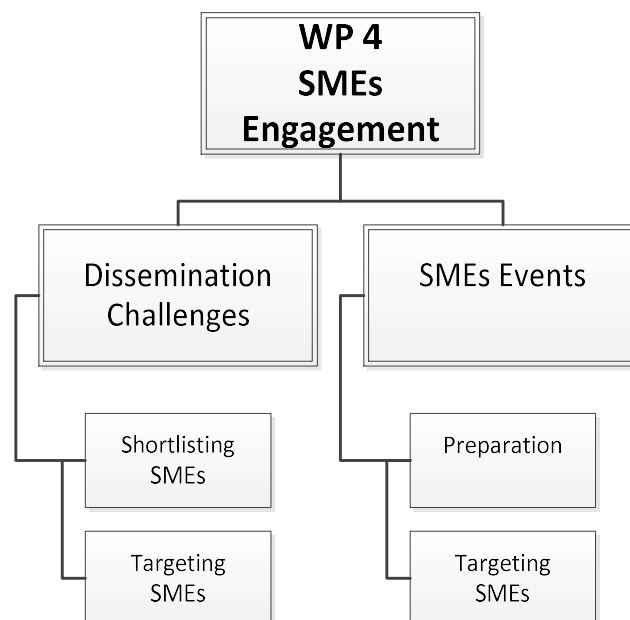


Figure 19. WP4 SMES Engagement Tasks

The SMES should be given information about the challenges SPEN is preparing. Scottish Enterprise has access to a large pool of enterprises and they may be able to send information to them about the opportunities inside SPEN.

Moreover, SMES events are expected to be held by the members of the cohort. Their preparation and organization responsibility is shared among the companies, looking for common issues that all the members would like to make a priority.

v. **WP 5: Internal Dissemination**

Innovation inside a company cannot be successful if the employees do not fully support the efforts of the initiative. They have to help giving feedback about the problems they find. Also they have to validate the solutions and they have to use them one time the solution is deployed. A company in which the employees do not use or make a profit of the innovation is not an innovative company.

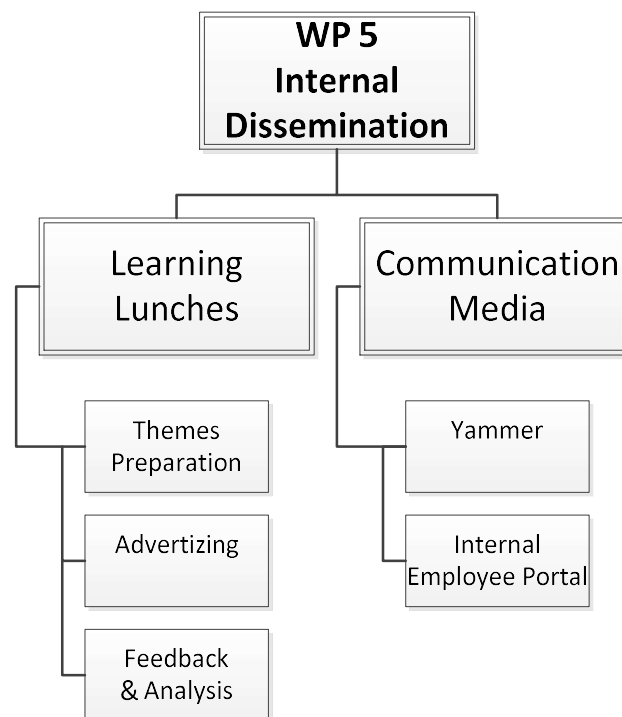


Figure 20. WP5 Internal Dissemination Tasks

SPEN leadership tries to increase the awareness of innovation in all the employees and the Learning Lunches is an initiative that aims to explain the goal of the Future Networks team, the projects that are currently under development, the results of the finished projects and how employees could be involved with innovation. For starting, it is necessary to look at the more important themes that the team has developed in last years. The time of the

presentation is limited to 20 min and a 20 min questions round. The Learning Lunch has to be advertised all along the company, providing seats for the people interested.

The current communication media of the company are not fully used to provide employees with a constant flow of information and updates about the projects. Yammer is used inside the organization to inform about the latest refurbishment, building constructions, awards or whatever is interesting. This channel has to be used with information from innovation to attract attention over Future Networks team's work.

Communication team has come with the proposition to create an innovation portal in the Internal Employee portal where a constant flow of updates for dissemination projects can be placed.

vi. WP 6: External Dissemination

As a project funded by a government agency and NIA funding scheme, certain requirements in terms of public dissemination and papers writing has to be achieved.

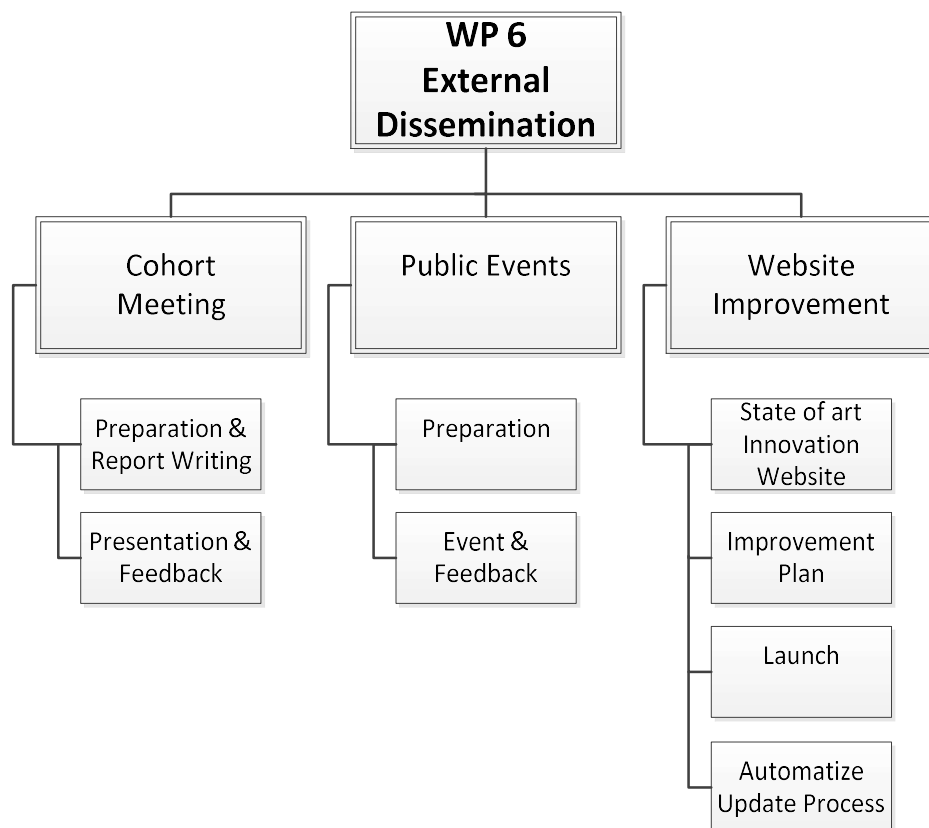


Figure 21. WP 6 Public Dissemination Tasks

The cohort meetings are set to share the development and advancement of each company, work together to advertise and make public statements to improve the use of the resources of each company. For each cohort meeting a report is prepared with the advancement done in the last 3 months, and the future steps to give. The feedback from the rest of companies and SE is collected and analysed to increase the rate of successful of Open Innovation in SPEN.

The current state of the SPEN Innovation website is not adapted to the current expectations of the public. Information is difficult to find and most of the projects are not displayed. A major improvement is expected during this initiative to boost the information share with customers, stakeholders and interested people.

5.4. Implementation

In this part, the tasks in each work package would be explained, calculating the time spend in each part. The use of the Work Breakdown Structure would help to estimate a better approximate of the time need for the successful implementation of Open Innovation in SP Energy Networks.

In Appendix A – Gantt Diagram there is the Gantt diagram and the grade of completion of each task at the moment of drafting and submission of this report in June 2016.

i. WP 1: Open Innovation Definition

Open Innovation is a term that has not a unique meaning. As the project is totally focused on Open Innovation model, the term has to be defined. The project aims to adapt the Open Innovation model to the utility sector, as it faces regulation from the governments due to its control of goods and services that are essential for the inhabitants of a country. To reduce the difference gap, a definition for the utility sector has to come up, as it would serve for future utilities implementing Open Innovation.

Firstly, Open Innovation term, meaning and development have to be searched to know the foundation of the term and the wide literature it has been written last 10 years. The background of the person coming up with the term, Professor H. Chesbrough, the meaning he gave to Open Innovation and papers and description that have been written on this topic have to be searched and studied. SE would help with this first step, recompiling, summarizing and tidying the information for SPEN with the academic partner, University of Strathclyde. After

the most about the term has been understood, a formal definition for SPEN would be published.

Secondly, a major research of companies which have implemented Open Innovation need to be done. It is a fundamental task to understand how major corporations have incorporated Open Innovation in their Innovation strategy, how it has modified the company culture, and the major changes that are expected to be done to produce a successful result.

Thirdly, the strategy and planning of the implementation has to be done to promote the objectives that have been declared in the submission. The objectives comply with the rule to set SMART objectives: specific, measurable, attainable, relevant and time-bound. The tasks needed to achieve each objective have to be described, taking into account the strategy to be followed and it is one of the major improvements done in this writing.

Table 1. WP 1 Time Table

Task	Time (days)
<i>WP 1: Open Innovation Definition</i>	<i>70</i>
1. OI Search & Analysis	20
1.1. Background	10
1.2. Formal Definition	5
1.3. Real Definition	5
2. Real Experience	10
2.1. Experience Search	10
2.2. Utilities Successful Case	10
3. OI Strategic Planning	50
3.1. Objectives	5
3.2. Tasks	10
3.3. Planning & Agreement	35

ii. WP 2: Partner Choice

Although the main objective of SE is that SPEN and the rest of companies in the initiative are able to implant Open Innovation alone inside the firm, it is understood the use of a partner at the beginning of the implementation.

An Open Innovation partner would have experience preparing and launching challenges. Most of the companies are what they call crowdsourced challenges facilitator. They have grown a community of solvers that would answer back the challenges you prepare. They also could help you to set a strategy for the research of problems.

Other kind of companies to review is these that deploy a platform to centralise the different efforts on Open Innovation. They have developed a platform with tools that help to engage employees and outsiders to solve the challenges. Each platform has special features but most of them provide the same tools: anonymous posting, voting for the best ideas, a framework to promote and develop an idea, and a common place where all the ideas could be placed, reducing the burden to order and receive the ideas and solutions.

Firstly, the market has to be researched to find companies that are offering these kinds of services, and what services and products they offered. As each one has its own strengths and weakness, a major research has to be done about number of solvers they have access to, background of the solvers, experience working with big companies.

Secondly, a reduction of the list to possible candidates would be done. For the companies SPEN decides to make a first contact, a deep explanation of the products has to be provided. SPEN would produce some examples of possible challenges, to be sent back with the product that could be suited our description. A tentative budget would be demanded to understand the pricing of each company.

Thirdly, an economic and viability study has to be done to understand the real benefit of the partner. If the price charged is too high, and they cannot reassure results, there will be no payback to SPEN. Moreover, it is important to understand how to use the value proposition of each company and how it can affect the development and launch of the challenges.

Table 2. WP 2: OI Partner Time

Task	Time (days)
<i>WP 2: OI Partner Choice</i>	<i>100</i>
1. Research & Experience Study	20
1.1. List of candidates	10
1.2. Products & Services Study	10
1.3. Experience Check	10
2. Commercial Contact	20
2.1. Information Request	5
2.2. Product Explanation	15
2.3. Budget Proposition	15
3. Economic Case Study	15
3.1. Value Proposition	15
3.2. Expected Benefits	15
3.3. Viability	15
4. Choice & Agreement	5
5. Platform Development	40
5.1. Study design	15
5.2. Prototyping & Iteration	25
5.3. Launch	1

After the shortlisted companies have been studied, a decision has to be taken for only a company to work for. Only a very difference approach or major strengths of each partner in one area of SPEN interest would make the decision to take two companies a viable option.

Later on, the digital platform for Open Innovation would be developed together with the partner, following the Iberdrola policy for websites, but using all the tools that the partner

makes available to SPEN. Using the AGILE method development, small little steps would be tested to improve the design of the website since the first prototyping to the final model.

After it, training would be pursued by two members of the team to control the platform and get the most for the different tools. Also engagement training could be pursued to get in touch with communication tactics and tools that could boost the response inside the company.

iii. WP 3: Open Innovation Challenges

This work package includes the major task used for the implementation of Open Innovation in SP Energy Networks. With the implementation of open challenges SPEN would be able to contact with more SMES, receive solutions to problems in the day-to-day business and scouting for new technologies all over the world.

For a successful challenge all the tasks have to be done and an automatic system of recollecting challenges may be studied in further steps. This work package would be repeated for each challenge, so here it is explained for one challenge.

Firstly, a search of problems inside the company, among all the departments has to be done. The districts, in charge of the maintenance of the distribution network and substations, are a very good start point to look for challenges, as they are in contact with the network every time and now what problems have lack a solution for long time. Also customers, Engineering Services or Asset Management team could produce challenging problems.

The search would be ideally automatic in the future, with the implementation of a communication tool that allow the people inside the company to propose challenges and contribute with solutions.

Problems have to have an economic impact for the company, for the contractors, or a social impact in the life of the workers, the customers or the society in general. The study of the impact has to be included in the search of problems, to better prioritize the different challenges. Environmental improvement, better services, and increase in the supply or stability of the networks and better asset management are subjects that could produce challenges.

Table 3. WP 3 OI Challenges Tasks Time

Task	Time (days)
<i>WP 3: OI Challenges</i>	<i>75</i>
1. Search of Problems	25
1.1. Background	10
1.2. Problem Statement	10
1.3. Solution Specifications	5
1.4. Economic Impact	5
2. Preparation	15
2.1. Scope Challenge	10
2.2. Non-biased Description	5
3. Launch	30
3.1. Public Dissemination	30
3.2. FAQ Answers	30
3.3. Solvers Engagement	30
4. Results & Analysis	5
4.1. Solutions Collection	5
4.2. Specifications Check	5
4.3. Analysis & Economic Viability	5
4.4. Winner Award	1

Secondly, possible challenges would be shortlisted and a preparation phase would start, writing of details of the background of the problem, the scope of the solution, defined specifications for the solution and a set of information to give a better picture of the real conditions. The draft would be not biased from the writer point of view through the revision of the final challenge by a pool of experts or employees.

Thirdly, the challenge is launched to the public, and it would be open for a time to be determined, from 1 month to 6 months, dependant of the difficulty. The team may prepare a list of the most frequent questions that are expected for giving more information to the potential solvers.

SPEN would publicize the challenge in the online website, via the SE news feed and other media. Also the solvers who have showed interest but have not submitted an answer may be contacted to help to submit a solution.

Lately, the quantity of answers and possible solution are collected and order in function of their quality. A check about the specifications fulfilling is done at the beginning to shortlist the solutions that answer completely the SPEN challenge. A winner must be awarded but all the solutions have to be analysed and pass to the team as some ideas could be useful in other projects.

This Work Package is the major step in the implementation of Open Innovation in SP Energy Networks, and the steps must be well documented, to implement an automatic process that could be repeated for all the challenges.

Conclusions for the first challenges and improvements that the stakeholders may offer would be taken into consideration to provide a continuous flow of challenges to the SMES and an inbox to SPEN employees to send problems they find and solutions they propose to be developed.

iv. WP 4: SMES Engagement

The principal aim for *Open Innovation in the Regulated Business* or the Open Innovation Award initiative funded by Scottish Enterprise is to bring more Scottish SMES in contact with SPEN and the rest of cohort companies. The development of innovative companies in Scotland will help to develop the industrial sector and lead a major increase in innovation in the country.

The tasks on this work package would be supported by Scottish Enterprise knowledge of the industrial and services sectors and the trust that companies has in SE as a partner to work with.

The first task is the dissemination of the challenges. For this task SPEN must work for mailing list of ancient providers, and new ones developed and provided by SE with the

players in Scotland for each industry. Although it is not the aim, for certain challenges, SE could focus on different sector to increase the chance of success for the challenge.

Later on, the own prestige and recognition of the SPEN mark as a trustful company for Open Innovation should let to high number of submissions and positive response to each challenge. A common framework for collaboration may be written to serve as model.

Table 4. WP 4 SMES Engagement Tasks Time

Task	Time (days)
<i>WP 4: SMES Engagement</i>	<i>180</i>
1. Dissemination Challenges	30
1.1. Shortlisting SMES	30
1.2. Targeting SMES	30
2. SMES Events	180
2.1. Preparation	120
2.2. Targeting SMES	60
2.3. Event	1

Second task is to held SMES event together with the rest of members of the cohort, to provide SMES with the opportunity to know the cohort members, the major challenges area members are working on, and the challenges in development at the moment. The preparation will be lead for one of the companies, with the rest targeting companies they are interesting at and proposing further development areas.

However, for the contact with SMES, it must be stated that SE provides fund for working with Scottish companies, but the main vision of Open Innovation is open the company to possible solutions to all over the world. So the challenges would be publish for open responses with no country restriction, although the fact to be based in Scotland would make easier to local companies for contributing to the challenges.

v. WP 5: Internal Dissemination

Internal dissemination of Innovation is one Future Networks team goal. Employees are currently not fully aware about the leading innovation projects that SPEN is doing at the current moment or has done in the past. The increase in the awareness of the employees about innovation can help to facilitate the implementation of Open Innovation and receives major support from the organization, receiving more ideas from the employees and increasing the acceptance of the projects, with a better rate of use in business-as-usual.

Both tasks in this work package are expected to be done in parallel, being a repetitive task that is expected to do over and over for improving dissemination in the company.

Learning Lunches is a presentation of an innovation projects done inside SPEN where the speaker would focus in a point of an innovative project. The theme has to be chosen and a smaller description given to the potential audience to introduce them to the topic and provide an explanatory leaflet that could be shared among people that is not aware of the project.

The lunch has to be promoted to the whole organization, expecting all the employees to be informed about the possibility to assist. The collection of feedback and its analysis is of a very importance, and it would help to increase the quality and to promote the innovative mind of SPEN along the employees. It would be repeated in monthly basis.

Table 5. WP 5 Internal Dissemination Time Task

Task	Time (days)
<i>WP 5: Internal Dissemination</i>	<i>120</i>
1. Learning Lunches	30
1.1. Themes Preparation	18
1.2. Advertising	6
1.3. Feedback & Analysis	5
2. Communication Media	120
2.1. Yammer	120
2.2. Innovation Employee Portal	-

The second task is the use of communication media, such as social tools or emailing, to raise the knowledge of news from innovation projects to the employees, to know their worries and questions, and provide a tool of communication of problems, challenges and solutions. Two tools have been studied to one that better suits the need, Yammer and the Employee portal, and both of them will be studied to improve their use, giving the Innovation team a website to post news or needs from the business.

vi. WP 6: External Dissemination

The second part of the divulgation strategy is external dissemination. A major point of the Open Innovation initiative is having outsiders looking at the problems in the industry, and asks them to submit solutions to them, looking for a different perspective. The different point of view could help to solve the problem in an unexpected way, with other technology or reuse a solution we have had under our eyes.

Table 6. WP6 Time Table

Task	Time (days)
<i>WP 6: External Dissemination</i>	<i>142</i>
1. Cohort Meeting	10
1.1. Preparation & Writing Report	5
1.2. Presentation & Feedback	5
2. Public Event (Table 4. WP 4 SMES Engagement Tasks Time)	-
2.1. Preparation	-
2.2. Event & Feedback	-
3. Website Preparation	20
3.1. State of the Art	2
3.2. Improvement Plan	2
3.3. Launch	12
3.4. Automatic Updating Process	4

The cohort companies meeting is an event happening each quarter to share in common all the updates and changes done in the last quarter for each company. Also some courses and activities are organized by SE and University of Strathclyde, helping the companies to define their strategy, to develop correct challenges and to successfully implement OI. A report is writing to help claiming SE funds.

Events are held to inform the public and the customers about SP Energy Networks innovation initiatives and projects, in line with the requirements of Ofgem. Open Innovation would have an important place in the events, and it is a good moment to create awareness about the challenges in place, the ones to be launched and the ones which have been already solved.

The third and most important task is the refurbishment of the Innovation website for SP Energy Networks. A major study of the state of the art for the rest of DNOs and TOs is expected would be done, together with the study of the process to update the web and who is the responsible in SPEN.

An improvement plan is draft about the future of the website, with ideas about what is expected. The launch of the new page must be agreed with the communication team, who is in charge of the page. The process of updating the website is held outside Future Networks team, reducing the speed of updates and making difficult to keep a constant flow of documents to the website. This process is expected to be changed for a more reactive update process and to reflex the events in place.

5.5. Economic Budget

The project for the implementation of Open Innovation in SPEN is being funded by the Scottish government agency Scottish Enterprise and SP Energy Networks, with charge to its Network Innovation Allowance (NIA). The submission for the fund of Scottish Enterprise describes in general terms where money is going to be expended, but as the strategy was not defined, there is not a very detailed budget.

The budget presented to Scottish Enterprise is:

Table 7. Budget Submitted to Scottish Enterprise

Initiative Expenditure	Annual Cost (£)
OI Staff member (Internal work)	£60,000
OI Staff member (External work)	£60,000
Other expenses	£100,000
Total initiative expenditure per year	£220,000

The total funds secured by SPEN from Scottish Enterprise are £***,***.**, related to the Open Innovation Initiative Award. The total budget given to SPEN is expected to give funding support for 2 years, and later on, the Open Innovation initiative would support itself with the benefits given to the company for 2 more years at least.

The budget presented to Ofgem for the NIA project *Trial of Open Innovation Model in the Utility sector* only included the total amount expected to be expended, as part of the Network Innovation Allowance SPEN is allowed each year to spend.

Table 8. NIA Expenditure for Open Innovation Project

Indicative Total NIA Project Expenditure	£***,***.**
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The total budgeted expenditure for the project, for the 4-years of the project is expected to be the sum of both funds. However, this is the maximum quantity that is saved for this unique project. The budget per year is in the range of the hundred thousand pounds, but cannot be disclosed due to a confidential agreement with Scottish Enterprise.

Table 9. Total Budget per year

Open Innovation Initiative Budget (4 years project)	
Scottish Enterprise Fund	£***,***.**
NIA Allocated Expenditure	£***,***.**
Total Budget per year	£***,***.**

The expected budget per year would be half of it for paying the salary of the two analysts working on Open Innovation, and other half to the preparation, development and launch of a platform for the challenges of SPEN, and the prizes for these challenges.

Any further funding requirement to develop the solutions proposed on the challenges would use the usual funding mechanism provided by Ofgem, NIA and NIC, for further works in the project.

To quantify the expected budget that would be used during the 4 years of the project, estimation of the cost of the challenges and the platform for their publications has to be done.

As the point of writing of this report, SP Energy Networks is already working with the Energy Innovation Centre, whose annual fee is already covering in the operational cost of SP Energy Networks. But the future direction of the project would mean the work with at least one more partner, from outside the energy sector.

For this reason, the budget would analyses the different business models of the possible partners. The main cost that is unknown is the fee paid to the partner for each challenge or the use of their OI platform. Taking into account the confidentiality of the prices given by the partners in the first round of contacts, the estimated business case would be done without naming the company that proposed the price.

A main revision of all the possible partners that the team has contacted with, and information about what they offer could be found in Chapter 6. – Implementation Process.

The main costs that would be taken into account for the proposed budget are:

- Salary of Open Innovation staff: possibly one senior position and a graduate or entrant level position.
- Part-time salary of Future Networks manager: James Yu, who led the initiative.
- Open Innovation Partner fee: Depending of the platform, it would mean the creation of an individual platform for SPEN or the use of the website and technology of common access together with the community of solvers.
- Challenge fee: The fee may change with the number of challenges.

- Challenges' reward: Each challenge would have a reward that would depend of the kind of solution proposed, the specifications given, and the kind of technology needed. It may vary from money to recognition or further development of the idea with the SMES.
- Other expenses are related to travel, presentation events, and communication expenses.

For the budget three cases are going to be studied:

1. The Open Innovation partner proposes to use its own platform, without the need of special modifications for the use of SPEN. They help with the preparation of the challenge, after the launch providing support to engage its community of solvers that have been created during year, and a review of the submitted solutions.

In this case, the fee is divided between:

- A fee for the right to access the pool of Solvers, or the community the Open Innovation partner has developed during the multiple years online.
- A fee for each challenges that SPEN launch. They help to prepare the specifications and the information given to the pool of Solvers. They manage the questions that could appear during the time the challenge is open, and then they review all the solutions before shortlist them for SPEN.

Table 10. Budget for Case 1

Open Innovation Programme Budget per Year			
Item	Quantity (unit)	Annual Estimated (£)	Total (£)
Analyst Salary	2	£35.000,00	£70.000,00
Manager Salary	0,25	£60.000,00	£15.000,00
Partner Cost			
Partner Fee	1	£30.000,00	£30.000,00
Challenge Fee	3	£10.000,00	£30.000,00
Challenge Reward	3	£15.000,00	£45.000,00
		Total Partner	£105.000,00
Expenses	1	£10.000,00	£10.000,00
		Total per year	£305.000,00

The cost per year is £305,000.00, well above the £220,000.00 that was estimated in the submission to SE and Ofgem. The different in price comes from the fact that each challenge has a double cost, the fee to the partner and the reward to the winner. If the reward is further development of the product or services funded by NIA the budget would be reduced to £260,000.00, much closer to the estimated.

Also the main fee to the partner would possibly reduce with the time.

2. Open Innovation partner proposes to adapt the platform it has to the needs of SPEN. Each platform has its own advantages or features, but SPEN usually would receive an Open Innovation website to direct people, a complex platform where users would login and participate in the Open Innovation challenges in different ways, and a Big Data analysis platform for understand how users are engaging with the platform and with challenges SPEN should look at.

The fee usually includes training for 2 people of the team and total support. It may include help for developing the first steps of the platform in the company.

In this case, the only fee is a flat fee for the preparation, modifications, launch of the platform, the training of the team and the support. Usually the fee would be lowered with the years of use of the platform, or major updates would be put in place.

A reward to each challenge has to be decided by the company. In this case, there is not extra fee or extra cost for the preparation of a challenge, as the platform usually allows for an unlimited number of challenges.

Table 11. Budget for Case 2

Open Innovation Programme Budget per Year			
Item	Quantity (unit)	Annual Estimated (£)	Total (£)
Analyst Salary	2	£35.000,00	£70.000,00
Manager Salary	0,25	£60.000,00	£15.000,00
Partner Fee	1	£60.000,00	£60.000,00
Challenge Reward	3	£15.000,00	£45.000,00
Expenses	1	£10.000,00	£10.000,00
		Total per year	£200.000,00

In this case the budget gets inside the expected range of the budget presented to Ofgem and SE. But it has to be stated that SPEN would lack access to a big pool of possible solvers, in comparison with the other option.

3. In talks with some start-ups that are starting in the Open Innovation business, they take smaller fee per challenge basis. Moreover, as the team is small, they don't ask for big contracts, and they can provide with a more individual and personal communication.

The start-up proposes to charge by challenge basis. Each challenge is charged individually, plus the award given to the winner. It includes help for developing the first steps of the platform in the company.

The fee is a thousand fees for the preparation, modifications, launch of the challenge, the help to find the solver, and to publicly disseminate and advertise the Open Innovation opportunities inside the company and prepare any internal event.

Table 12. Budget for Case 3

Open Innovation Programme Budget per Year			
Item	Quantity (unit)	Annual Estimated (£)	Total (£)
Analyst Salary	2	£35.000,00	£70.000,00
Manager Salary	0,25	£60.000,00	£15.000,00
Fee per Challenge	3	£5.000,00	£15.000,00
Challenge Reward	3	£15.000,00	£45.000,00
Expenses	1	£10.000,00	£10.000,00
		Total per year	£155.000,00

It this case the budget is lowers that for the two former options. The expected budget for the company could be matched with the money given together by SPEN and SE to fund the 4-years project.

It has to be seen that the major costs in any of the budget are:

- Platform or data-base access fee: For having access to the main value proposition on the first two cases, the price to pay is high, and mostly of the time not variable. Companies are expected to pay because of the reputation and high experience with the business model.

- Salary of SPEN staff: Open Innovation needs to be coordinate and supervised constantly to avoid losing the momentum. The need of two staff to divide between internal and external work is important. Also the presence of an Innovation champion inside the company helps to convince the reluctant people.
- Reward per challenge. To get good ideas, and possibly better solutions if companies with products under production appear, the rewards has to be high. In the case of SPEN the reward is more in the area of ideas challenge, but with the options to enter into business contract with the company, or provide further funds for the development and production of the technology.

It is expected SPEN and the rest of companies of the initiative run the challenges by their own in the future, the budget to be allocated would be reduced with the advancement of the project.

5.6. Risk Analysis

For management purposes, the possible risks of each task in each work package are analysed, the cause of this risk, the effect and what measures the risk. Lately a probability of occurrence would be given and an impact in economic value for the risks that involved cost as measure of the risk.

To classify each risk, the tables given in the subject Project Management in 2nd course of the Master in Industrial Engineering would be used. Each risk is going to be described, then, as a risk prompt, then cause, effect, risk measure, probability, impact and risk will be calculated. Countermeasures would be also studied and the new probability, impact and risk as the countermeasure are applied.

P = Probability, 1-5.

I = Impact, 1-5.

R = Risk = Probability * Impact, 1-25

The typical risks for highly innovative companies may not appear in SP Energy Networks, as there isn't a R&D department, and the final product is a service, the electricity, and not a product that would change with the time.

Moreover, the current path for innovation mostly is supported by the technical and technological knowledge of the contractors, and the developed products or services pass to teach to the employees of SP Energy Networks. This path mostly avoids suspicious about Intellectual Property rights, and companies involved usually gains the right to the patent and the know-how of the project developed.

This is the reason why the next risks assessment looks more at the risk of the process of implementation as employee fear of critical and extreme changes, management refuse to the change, or delays or difficulties with the partner.

i. WP 1: Open Innovation Definition

The definition of Open Innovation in SPEN and the preparation of the initiative have the added task of an important revision and investigation of all the literature that exists about Open Innovation and its implementation. The preparation includes an initiative and the statement of the innovation vision of the company.

Table 13. WP1 Risk assessment

Risk Prompt	Cause	Effect	Measure	P	I	R	Countermeasure	P	I	R
Open Innovation Definition	Inadequate literature survey and investigation.	Incorrect definition or incorrect strategy.	Initiative	1	5	5	Revision of the abundant literature.	1	2	2
Implementation Strategy	Lack of unsuccessful cases of implementation or bad steps given.	Risks are unknown or not very known. Unsuccessful ideas.	Cost	5	3	15	Prepare a risk assessment and revise risks case studies.	2	3	6
Objectives	SPEN long-term objectives are not defined.	Delay to set and fix with the management SPEN long-term objectives.	Initiative	2	5	10	Research of SPEN innovation strategy.	1	5	5
Initiative	Lack of knowledge of time management.	Planning is not realistic. Delays happen.	Initiative	3	4	12	Study of time management in other projects.	2	2	4
Initiative	Tasks are added during progress of the project, to achieve new goals.	Initiative changes and delays in the initiative.	Initiative	2	4	8	Prepare a prior plan of all the activities expected.	1	4	4

ii. WP 2: OI Partner Choice

The revision of the Open Innovation implementation in several companies has stated the good option having a partner is. The pool of companies working on Open Innovation is huge in these days, after the popularity of the term. A revision of the partners and their products and services has to be done, reaching the one that better target the research community looked by SPEN.

Table 14. WP2 Risk assessment

Risk Prompt	Cause	Effect	Measure	P	I	R	Countermeasure	P	I	R
Partners	Too many different products and services.	Delays in the choice of a partner, and in the project on general.	Initiative	5	5	25	Divide partner review and ask rest of companies for advice.	5	3	15
Partner	Lack of visibility of the challenges process and its real success.	Delays contacting users of the partner to check the experience.	Initiative	5	5	25	Plan longer time and share information with cohort members.	4	3	12
Partner	Lack of unsuccessful experiences.	Lack of the whole picture of a partner. Bad choice	Cost	4	5	20	Research and contact users.	4	2	8
Economic Study	Difficult estimation of economic impact.	Partner choice not based on economic study.	Cost	4	3	12	Establish a minimum savings threshold for each challenge.	4	2	8
Partner Platform	Adaption to SPEN policy is difficult.	Delays in the launch of the platform.	Initiative	4	2	8	Early contact with Communication team.	3	2	6

iii. WP 3: Open Innovation Challenges

The challenges are the major output of the Open Innovation initiative, as they are the contact point with SMES, individuals and research centres or universities. The risks involved the unknown solution, the public success and the perfect understanding of the solution need by SPEN. The transmission of the IP rights has to be defined to avoid unnecessary risks.

Table 15. WP3 Risk assessment

Risk Prompt	Cause	Effect	Measure	P	I	R	Countermeasure	P	I	R
Problems search	Lack of problems as people is reluctant to recognize faults.	More time to collect challenges and problems, and less variety.	Time	2	4	8	Management and public dissemination policy to encourage participation.	1	4	4
Challenge description	Biased description of the solution searched by the experts.	Possible solutions are biased by the engineer vision.	Objective	2	3	6	Revision by non SPEN employee to eliminate bias.	2	1	2
Community response	Low community response to challenges.	Lack of quality of the solutions and not review by many individuals.	Objective	3	5	15	Use SE SMES data base and partner data base.	1	5	5
SPEN trust	SPEN is not trusted as a company to work with on Open Innovation.	Good companies do not take the time to review SPEN challenge.	Objective	3	5	15	Follow IP right transparency and promote prior projects.	1	5	5
Solution selection	Shortlisted solutions lose good solutions.	Possible collaborators get uninterested	Objective	3	5	15	Revision by SPEN of the submissions.	2	5	10

iv. WP 4: SMES Engagement

SMES engagement represents the aim of the Open Innovation initiative, and this work package is very risky, as SPEN is not sure of the existence of SMES capable of solve the challenges and problems the electricity network would face during the following years. Also the response of the SMES could be limited by the speed of SPEN to respond to their needs and the implementation of new technologies.

Table 16. WP4 Risk assessment

Risk Prompt	Cause	Effect	Measure	P	I	R	Countermeasure	P	I	R
SMES Event Turnaround	Lack of connections and lack of interest because of prior experience.	Turnaround of SMES is small, facing problems to find challenge solution.	Objective	3	5	15	Promote SPEN prior work and targeting via SE and partner.	1	5	5
SMES Event Topic	No shared technology problems among the members of the cohort.	SMES are not invited in according to the need of the firms.	Cost	3	4	12	Working on common topics and sharing SMES lists.	1	4	4
Success case	Delay in the partner choice and challenge development.	No success case can be presented, losing the momentum with SMES	Objective	3	4	12	Push challenges ahead and force to solve at least one before.	1	4	4

v. WP 5: Internal Dissemination

Internal dissemination is part of the shift in the innovative culture inside SPEN, and the risks in this package all related to the reluctance of employees to change, and led to a most innovative culture. In companies as SPEN, with lot of work inertia and a repetitive pattern of work to do, any change would mean some inefficiency for a while.

Table 17. WP5 Risk assessment

Risk Prompt	Cause	Effect	Measure	P	I	R	Countermeasure	P	I	R
Learning Lunch attendees	People not interested in innovation.	Not employees based to work on OI	Initiative	2	4	8	Inviting individual better than mail listings.	1	4	4
Learning Lunch Dissemination	Not understanding of the aims	People do not come back and not spread the word.	Cost, initiative	3	3	9	Professional presentation and variety of topics.	2	3	3
OI selling process	Management fears to lose good people to OI.	Lack of support of management.	Initiative, objective	4	5	20	Management of change / success cases preparation.	3	5	15
Culture shift	People want routine.	People do not collaborate neither support OI	Objective	2	5	10	Management of the change.	1	5	5
Yammer	Low utilisation of Yammer.	Difficulties to spread the words and updates.	Cost	5	2	10	Inform about Yammer and Sign In campaign	4	2	8
Internal Employee Portal	Delay in the launch and lack of control.	Lack of public information	Initiative	4	2	8	Set deadlines and improve update process.	3	2	6

vi. WP 6: External Dissemination

External dissemination is very important to engage the highest possible number of SMES and give information to the regulator, Scottish Enterprise and the rest of members of the cohort about the activities developed in SPEN.

Moreover, due to its lack of highly recognized mark all over the world, SPEN must build a set of information to back its experience as a trustful and good partner to work with. Trust is very important in Open Innovation as companies, individuals, universities, research centres and SMES would be only interested to work with firms that could provide a stable and known contract, with a possibly long relationship and pay the fix reward.

Table 18: WP6 Risk assessment

Risk Prompt	Cause	Effect	Measure	P	I	R	Countermeasure	P	I	R
SPEN website	Not updated website and low search tools indexation.	Innovation projects are not known by the public.	Objective	4	2	8	Overhaul of the website and change update process.	2	2	4
People interest	Low innovation profile of SPEN.	SMES and public do not turn to SPEN.	Cost, initiative	5	3	15	Communication strategy to improve position.	4	3	12

5.7. Update to the Strategy

Last months of the project, the student has had the opportunity to assist to several Open Innovation conferences and the 3rd Cohort meeting with the rest of companies involved in the Open Innovation initiative. Also, during the selection of the partners, meetings have been held with current and former users of the possible partners.

This fact has given access to different experts and people with experience in the subject that have provided insight about the difficulties that they have found implementing Open Innovation in their organizations. Also they have provided with really valuable advice to help to understand the steps that have been done by the Open Innovation team.

Following the advice and to get a written proof of the provided words, the student writes here some modifications or additions that have been suggested to improve the strategy for the implementation of Open Innovation in SP Energy Networks.

- WP1 Open Innovation Definition

Open Innovation definition has to include the fact that SP Energy Networks is only the provider of a service to customers, electricity and not a consumer goods maker. Innovation in SP Energy Networks improves the quality, efficacy and efficiency of the transmission and distribution, together with the introduction of new services as energy storage or faster and better connections to renewable generation.

- WP2 Open Innovation Partner Selection

To avoid the risk of bias of the information given by possible partners, a contact with the leading person of organizations that have already worked with them has been added. That allows a better consideration of the advantages and disadvantages of working with a company or a platform.

Also the choice done by the rest of companies in the cohort ahead of SP Energy Networks would be taken into consideration, together with sharing information about the partners that have been contacted by them.

The first strategy aims the choice of a unique provider, but the current relation with Energy Innovation Centre (EIC), where SPEN is a founder partner, allows thinking about the possibility of having a second partner that help to open the challenges and problem resolution

to a bigger and wider pool of solvers. EIC is focused on energy related companies, mostly based in UK, and Open Innovation goal in SPEN is to open to company of all sectors with interesting ideas.

In the case a partner that develops a specific platform for SP Energy Networks is chosen as the main partner, a planning and risk assessments about the feasibility to allow sign in with the business login has to be done. The reduction of login would lead to more employees aiming to collaborate as the sign in barrier is eliminated.

- WP3 Open Innovation Challenges

This part of the project should include challenges both for employees and to external providers. Opening the process to employees help those to be aware of the Open Innovation initiative, and also to share information about possible solutions they have already develop.

Moreover, employees' knowledge of the network, processes and services provided could help to the reception of solutions that could be easily applied to the network, reducing the cost and investment in the particular challenge, generating a pool of internal solvers.

Then, Scottish Enterprise has proposed, as already stated in the strategy, to provide the cohort companies with access to the complete list of SMES registered in their data base. There are other government-funded agencies in the national and international level that may be used to spread the word, as Public Contracts Scotland, Innovate UK and Enterprise Europe Network.

- WP4 SMES Dissemination

From the comments and discussions with SMES that have been contractors of SP Energy Networks to that have tried to access to the procurement list of possible suppliers, Open Innovation team has understood the difficulties and delays SMES face.

As an SMES, the labour intensive, time-consuming and long-term process of get approved to supply SP Energy Networks is very costly in terms of money, and the investment done to get this position does not assure to get a contract. For that, they were receptive to Open Innovation initiative, as it provides a faster path to work with SPEN and also tests its technology or products under real conditions.

IP rights terms have been also discussed, as the current agreement done by Energy Innovation Centre asks for a total confidence that the product or services does not infringe any patent or IP right. For companies different that start-ups, with a pool of workers, this part of the agreement involves a major risk as the cost of paying a complete research on IP is very costly and time consuming.

- WP5 Internal Dissemination

After receiving feedback from the attendees to 1st Learning Lunch, the agenda has been updated to include a 10-minutes presentation of the current state of the Open Innovation initiative, trying to get an outside speaker to talk about a challenge developed through the Initiative or a person for the companies involved to talk about their point on Innovation.

Internal communication through Yammer has to include a new campaign to grow sing in among the employees. Also, after discussions with Scottish Water, where lot of employees work on the field, SPEN has to design tools and platforms that have easy access via smartphones or unwired hardware.

- WP6 External Dissemination

Reports have to be written for Ofgem approval of the project under the Network Innovation Allowance (NIA). For this purpose, and to claim for the funds to Scottish Enterprise, several documents are being written, together with the project dissertation. The contents would be similar as some of the words are reproduced.

This report would be part of the documents provided to Scottish Enterprise to show the willingness of SPEN to set a deep strategy to work on Open Innovation.

- WP7 Innovation Champion

After several talks with people who have implemented Open Innovation in their organisations, the student has received the advice to get some management or director to support and lead the project, to get more visibility by the rest of the employees.

A new work package could be added to get support by the management. It is important enough to have a work package, because the director would ask for data, approximate savings, and business case and employees turnaround to Learning Lunches and Yammer post to start supporting the initiative. Supporting an initiative that it is risky could be understand as damaging for his future career if it fails.

Chapter 6. – Implementation Process

6.1. Project Progress Summary

The advance of the project has been well documented up to this moment. During the duration of the project, most of the time has been used to prepare the strategy of the implementation, and to contact with different possible partners to understand their experience, their services and how they interact with the client.

An important step has been the start on the team of Eric Brunger as Senior Open Innovation analyst. The background in project management and project planning, together with the experience in the company, has led to major advances in the contact with partners.

However, as a consequence of the incorporation of Eric, some delay has appeared in the project. The time to taught and get him comfortable with Open Innovation has delay the project by a month. Moreover, some changes have been made to adapt Open Innovation implementation to add his vision.

The review of the partners has been extended because of new information coming from the assistance to Open Innovation conferences where other possible partners have gotten contacted, with interesting proposals different that the only-challenges approach taken at the beginning of the project.

Also, information about the use of external partners to contact providers inside SPEN has been found, following a revision of the solution development process for NIA projects.

i. WP 1: Open Innovation Definition

The final definition of what Open Innovation means for SP Energy Networks is:

“Open Innovation main aims is to change the innovative culture in SP Energy Networks, broadening the pool of solvers for SP Energy Networks and UK electricity networks challenges, and increasing the awareness and engagement of SP Energy Networks employees on innovation, looking always to improve the service given to the customers of the company, improving the quality, the efficient and the efficacy, together with the highest commitment to reduce the environmental print of the activity”.

Electricity networks challenges refer to all the challenges that could appear as SPEN provides customers with electricity. The network, asset management, investment and refurbishment are the main processes that would use Open Innovation to solve the challenges that appear.

For the correct and long-lasting implementation of Open Innovation, the culture of the company has to embrace the new development, and most of the employees have to accept that what they have been doing since they joined the company could be improved.

At the beginning of the project, due to the information provided in the submission, the preparation and launch of outdoor competitions for addressing the challenges SPEN faces was the main idea. After the study of the need of Open Innovation, the culture shift was considered, meaning an important delay in the start of the challenges, as a new strategy has to be written.

Open Innovation in the Regulated Business is a first in its type project that would allow the rest of utilities, and companies and organisations in general around the world to have a reference point for developing Open Innovation model inside their organisations.

The project strategy could be found in 5.2. Project Strategy, and this whole document stated and write the advance and progress done under Open Innovation, together with the improvements done to the strategy after review with partners and experts.

ii. WP 2: Partner Choice

SP Energy Networks, as most of the rest of companies in the cohort of Scottish Enterprise, has decided to look for a partner with experience in Open Innovation and launching challenges.

The partner is expected to improve the speed to reach the market via its own platform or an individual platform for SPEN, help with the promotion of the challenges outside the SPEN industry, and give advice and help to engage SPEN employees for a successful implementation of Open Innovation.

The resources inside SPEN concerning external communications are overcrowded, due to the lack of resources. Also, most of the work is done by the central services of Scottish Power, the parent company. Moreover, the website of SPEN has limitations, due to the preservation of a common design and layout with all the Iberdrola group websites. These

reasons mean any step would take longer and its result would be limited by the capacity of the Communication team.

The use of an external platform reduces the need of maintenance by SPEN, provides with analysis tools to understand the interaction of the people with the platform and clarify the framework to use for each challenge.

SPEN has been working, as a founder member, with the Energy Innovation Centre, a centre launch in 2008 to accelerate the discovery, development and deployment of innovation among the UK transmission and distribution network operators. As network operator, SPEN helps to fund the EIC and the membership allows passing as many calls of innovations or challenges as SPEN needs.

Up to this moment, different possible partners have been contacted to ask for more information, know their products and what their experience is. The partners are the following:

- Innoncentive: An American company that prepares and launch challenges for corporations to its community of Solvers and the scientific communities it has engaged with, using its own platform common to all its customers. Its value proposition includes PhD industry experts that help to prepare the information for the challenge to avoid boasting by the expected solution, and a description wrote for full-crowd understanding. Innoncentive offers different kind of challenges regarding the expected advance of the result, from an idea to a prototype.
- Nine Sigma: An American company that offers different solutions for outsourcing or find the technology to the problems SPEN faces. It could prepare challenges, providing a platform that could be adapted to each individual need, or via a common platform. Nine Sigma also offers scouting services for new technologies, market researches about different disrupting technologies or a direct linking with companies in the new sectors or industries the client is interested at.
- Ennomotive: An Spanish start-up that launch engineering crowdsourced challenge to its own community of Solvers. They are focus on engineering problems and they work with Spanish multinationals. The team helps and engages with the Solvers to increase the tax of conversion of interest to

submissions. The solutions are usually defined by the specifications of the client, as they look for solutions more than ideas.

- Energy Innovation Centre (EIC): A British non-profit organization set down by the British energy network companies to divulge and provide solutions to the specific or generic challenges the British energy networks have. It is paid by a contribution of the different partners and has access to a pool of more than 5,000 SMES around UK. SPEN has already being involved in several challenges with EIC, with successful results. It provides a common platform where the challenges are exposed and then EIC targets specific sectors that could help for each individual challenge.
- Spirit: A London based company that provides an Open Innovation platform that allows engaging both people from outside and inside the company to provide ideas to the challenges proposed. The platform includes a private SPEN website for innovation and a complex automatic analysis tool to help the selection of the best ideas and marketing tools. The platform may be adapted for share the login users and password of the business account.
- Be-novative: A Hungarian start-up that provides a platform to communicate within the organization and allows employees to share the problems or challenges they are facing. Also, the executive level can provide horizontal challenges and asks for the collaboration of all the company to provide ideas and choose the best ones. Be-novative also engages later with the client for the preparation of Hackathons where prototypes of the ideas could be developed during a weekend or a two-days meeting to confirm the viability, usefulness and chances of the ideas to solve the challenge.
- Power Network Demonstration Centre (PNDC), part of the University of Strathclyde, has been contacted to know the chances of access to the pool of researchers of University of Strathclyde. The centre has an 11kV network that can be isolated from the network, helping to test new technologies or products under real conditions not comprising the service to the rest of customers. It is funded by SPEN as a Tier 1, having access to all the data and research done in cooperation with the rest of Tier 1 members.

After a further discussion among the Open Innovation team, and up to the moment of the drafting of this report, the choice has been to continue with the Energy Innovation Centre as main partner.

The current membership paid to IEC allows to complete as many challenges as we have, being that part of a strong economic case, as not further investment in this part is needed. Some settings have to be changed, to allow a faster response by the EIC to launch the challenge, not depending in a unique person for contacting them.

Moreover, SPEN expects EIC to launch a platform that allows for easy submission of a challenge, as at the moment several barriers and steps can discourage possible solvers. Human Interface is an important requirement for any platform that SPEN would use.

EIC currently counts with around 5,000 SMES in its registry, needing a further increase to allow SPEN to open to innovation in Scotland and all over the world. Also, some investment has to be done to increase the visibility and engagement of the community, to allow a wider and more varied pool of solvers.

SPEN would continue to closely regard the other partners, in case an opportunity to work with them appears. In a short future, it is possible one of this partner is contacted again to lead internal Open Innovation activities if other tools failed. PNDC could be useful to develop a platform or partner that gives SPEN access to researchers, PhDs and universities as it led by personal from University of Strathclyde. Some of the challenges that SPEN expects to launch would need specialist expertise to be solved.

iii. WP 3: Open Innovation Challenges

Several challenges have been drafted and prepared during the six months of development of the Open Innovation initiative. The challenges affect main parts of the company services, providing an increase in the safety of workers, better respond to faults, longer life for assets, a better comprehension of the ageing of the assets, or a reduction in the costs of deployment or refurbishment.

Up to this moment, the main path for finding and developing a challenge is personal interaction with employees from the different parts of the business. They think or ask around for problems they face or ask for a solution to a known problem.

In the case of NIA projects, a normal path of a project is shown in Figure 22. NIA Project Process. The process of acquisition of the idea is not really clear and open for employees of the company, and there is not currently any platform, email address or mail box open for receiving project propositions.

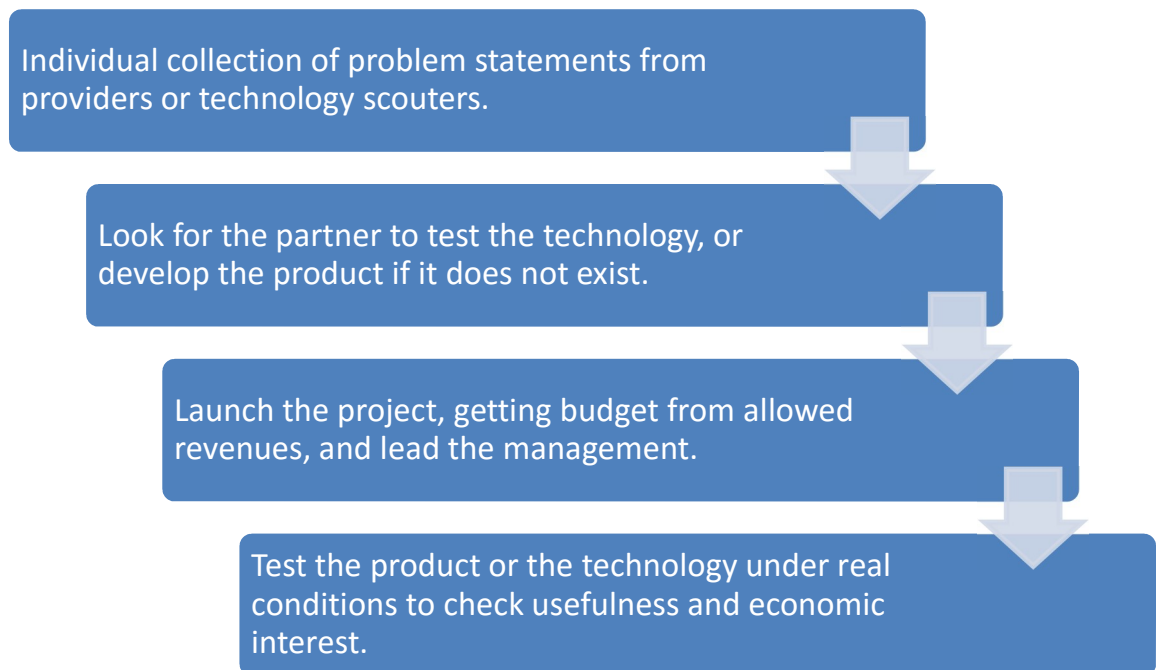


Figure 22. NIA Project Process

A normal employee is not informed that he can go to Future Networks team with a proposition of a project or a technology to try. It is necessary to change this as employees can understand how the use of a new technology can improve the company, the networks or the works done. They are the perfect technology scouts for SPEN.

A second path, mainly used for NIC projects, is the test of a technology that helps to solve a fundamental problem of SPEN due to changes in the network and electricity generation. An external company has developed a new technologies and it would use the project to test its usefulness and real benefits. Often, NIC proposals are done looking at the long-term strategy or vision of SPEN as DNO and TO, as currently happen with the DSO (Distribution System Operator) idea.

There is a first phase of development, funded by NIA funds, and then, if the project could deliver benefits to SPEN, the customers and the environment, it would be submitted for NIC funds.

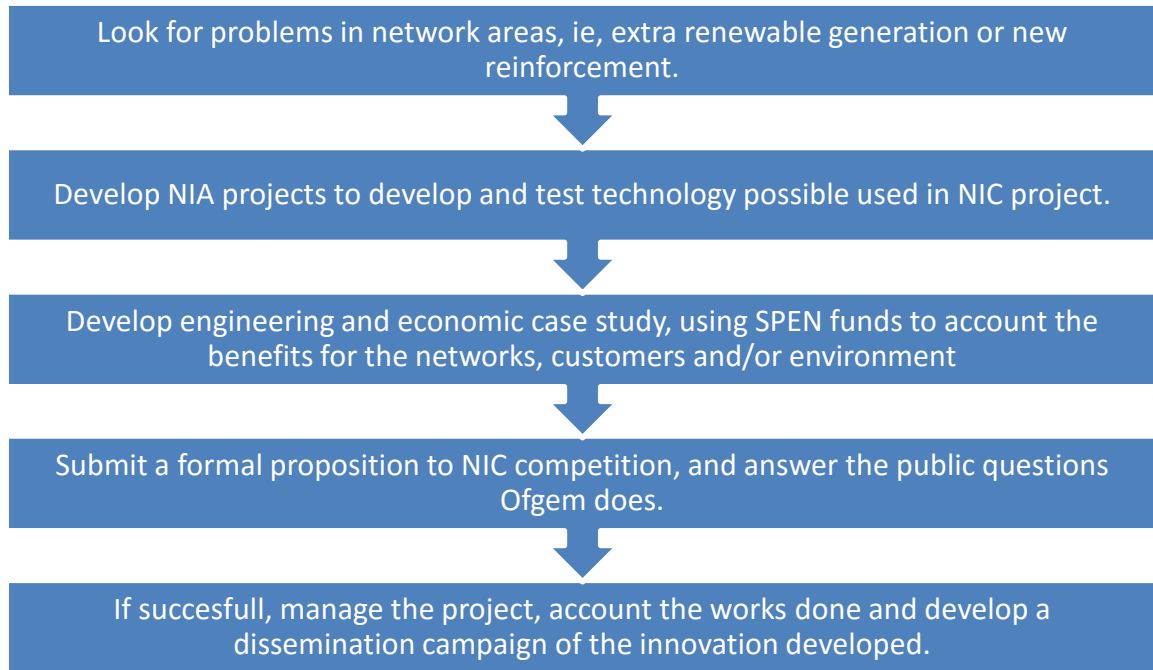


Figure 23. NIC Project Process

Following the strategy, and looking for a long-term solution, the challenges acquisition process wants to be redefined. An automatic tool is envisioned to collect the challenges, problems and expected solutions; a tool that every single SPEN employee can have access to, engaging with the furthermore solution as an expert or as a consultant for the winning SMES. Also recognition and rewards may be provided to engage and show the importance of the small acts to implement an iterative innovation path.

The tool fix for this purpose may be provided by the partner chosen or an alternative inside SPEN can be reviewed. The priority is reduced the complexity of the communication of ideas, make more agile the collection of solutions and the iterative process of prototyping and communicating the employees about the development, and engage the employees with the solutions as a way to promote innovation, advance and led the success of Open Innovation inside the organization, and get a solution that is delivered directly to business-as-usual.

The challenges defined since the beginning of the project are:

- Metal tower protective coat that provides longer lasting protection against corrosion and mechanical efforts.

- Wood pole varnish that effective covers against humidity and weather conditions with a reduced environmental print.
- Cover or protective shield for a distribution overhead line below a transmission overhead line whose conductor is being refurbished.
- Low voltage fault detector to reduce the response time to faults in the distribution cable network and reduce KPI Customer Minute Lost (CML).
- Development of alternative portable generators to assist the network when faults isolate an area for longer period of times.

A project has been already awarded via the Energy Innovation Centre partnership, *Tower foundation monitoring*. The project has been awarded to a Scottish company with expertise in the noise and vibration analysis for wind turbines.

The project started as a need inside SPEN, as the current monitoring of the metal tower foundation makes use of invasive techniques to check the state of each leg foundation. Moreover, the information gets by the traditional method is scarce and makes difficult to compare from one inspection to another. The current cost of the analysis of each tower varies from £6,000 to £12,000, and the rate of year inspection is around the hundreds 4-legs metal towers a year. The scope of work is expected to adapt the technology of the company to the variable types of foundations in SPEN network, and reduce its complexity and price to make affordable and interest to use by SPEN teams. The expected duration of this trial is 6 months and would be founded via NIA project funds.

Further challenges are expected to be launch before the student leaves the company. There is a special interest to solve one problem from inside the company before the SMES event is held to prove the success of the Open Innovation implementation to the attendances, and boost support internally and externally.

iv. WP 4: SMES Engagement

First challenge has been successfully launched as explained in WP 3: Open Innovation Challenges. This particular challenge related to tower foundations attracted a possible solution from 7 different providers.

A second challenge, *Metal Tower Protective Coat* has been run through Energy Innovation Centre to get a new protective coat to protect the metal towers, as the current

formula dated from 50 years ago. Optimal solutions were provided by three companies, and one of them would be rewarded with a purchasing order when test analyses the lasting and anticorrosion power of the coat formulation.

Cover for a distribution overhead line challenge is near to be launched via Energy Innovation Centre in the following weeks. It is expected that a solution comes after the end of the summer for further testing of the specifications provided.

The SMES event, as will be disclosed in 6.7. WP6: External Dissemination, is expected to be placed at the end of October or beginning of November in cooperation with 4 other companies of the Scottish Enterprise Open Innovation Initiative.

The main topics that would be developed by the companies in the meeting would be related to:

- Industry 4.0: digitization of customer service, remote monitoring, Big Data analytics, Internet of the Things (IoT), digital twins/smart sensors.
- Energy Efficiency and Sustainability: energy consumption reduction, resource consumption reduction, energy recovery, energy storage.
- Advanced manufacturing

v. WP 5: Internal Dissemination

Internal communication among the different departments of the companies is driven by common projects or the need to contact experts that would help in a punctual moment or continuously for a project. Otherwise there is not a constant communication about the projects or public dissemination events to make people aware of what each team does.

Graduates have the best opportunity to know about most of the SPEN teams, because during the 2 year graduate initiative they rotate around teams, developing the skills needed in the future to lead the company.

Moreover, the existence of districts that are placed in the areas where SPEN network is, means there is certain disconnection among them and the main office. Districts are an important target for the Open Innovation initiative as they work day after day with the network, know the problems or lack of technology that is affecting it, and may have developed solutions for them that have not shared with the rest of the company.

After the study of the communication tools, Yammer is the main functionality provided by SPEN for communication inside the company. Yammer is a social network focus on business application that provides with communications to all the employees and allows updating the rest of the people with news from inside the company or affecting it.

Nevertheless, as a register has to be done before starting using it, and there have not been a major campaign for improve its use, only around 50% of the employees are registered, and not further information about active users has been founded.

To attack this problem, first, a more active communication strategy has been planned telling about the advances done in the different projects. This campaign has already starting, with the Future Networks, and specially the Open Innovation team, posting information in a week basis. Information about the Open Innovation meaning, definition, related activities is also shared in Yammer to update the community.

Secondly, events would be prepared once a month to update about the project of Open Innovation, and share information about the rest of projects of the Future Networks team, to grow understanding to the results, and make employees think about how to incorporate the innovation under study in their business-as-usual work.

The first meeting or Learning Lunch has been held on Friday 20th May, at 12:00pm, offering lunch to the assistants. The second was held on 17th June. The Learning Lunches provides a unique opportunity to talk about Open Innovation although the main topic would be one of the projects that Future Networks team is doing, and how they can be implemented in business as usual.

In each of these meetings the general agenda is shown in Table 19. Agenda for a Learning Lunch,

Table 19. Agenda for a Learning Lunch

12:00	Presentation of the Future Networks team
12:03	Speech about one of the projects Future Networks team is working on.
12:25	Questions and answers round
12:40	End of the presentation and lunch

The main topic will not be a general explanation of the project, but a focus on one part of the project where innovation has been used, relating the problems faced and how the work with the rest of SPEN has been important, and what points of this relation could be improved.

After holding the 1st meeting it has to be said it turned to be a success, as 17 people from outside Future Networks attended. The main topic discussed was Open Innovation project, to make attendants understand that we are looking for them to come to talk with the team about possible projects to be done, or new technologies that the team may look at. Also it was a good moment to show the advance done in other innovation projects.

A survey was filled in, showing the results that most of the attendees were happy to support Open Innovation activities, and that they would like to further engage in this activities. Also the survey opened the door to provide challenges to Future Networks team.

During conversations with the Communication team of SPEN, they have showed their interest in develop and disseminate the work of Future Networks team, meaning Open Innovation has total support to use the tools, frameworks and mechanisms that they have.

The main proposition was to design a portal inside the SPEN employee portal where the different updates, documents and materials obtained and prepared during the progress of the projects could be updated. Also the Employee Portal is the first page that opens each time an employee login in his computer, giving a good moment for increase the attractiveness of the team, and the engagement.

vi. WP 6: External Dissemination

Communication with the customers, solvers, SMES and funding organisms is an important part of the Open Innovation initiative. The progress done in the initiative is updated to Scottish Enterprise and Ofgem in a constant rate, via written report and presentations. Also University of Strathclyde, as the academic partner, receives constant updates about the path follows and the different tasks done for each WP.

Two meetings have been held with SE and University of Strathclyde to discuss about Open Innovation. The first one is considered the kick-off meeting, and the first ideas about the strategy to be followed by SPEN were discussed and help from the academic partner was offered for further collaboration. The meeting was in January 2016.

A second meeting with the same actors has been held in the middle of May 2016, for further discussion about the progress done and what was the definitive strategy chosen. Also the challenges discovered inside the company were shared, to compare with the rest of companies. University of Strathclyde representatives asked about the innovation process follows in SPEN, as has been disclosed in former sections. The meeting was held on May 2016.

Ofgem asks for the dissemination of the projects under NIA, requesting a report every six months with updates about the project. This report would be submitted at the end of June. Another is required every year for all the projects under NIA funding, so a two pages short summary was held with the main I point of the strategy.

Up to this moment, three cohort meetings have taken place. The first one was in November 2015, second one in January 2016 and last one in June 2016.

The pool of companies developing the Open Innovation initiative have been divided by comparable sectors, and SPEN has been allocated to a group of companies related to heavy industries and petrol and energy related. The rest of the members of the pools are Babcock Doosan, Subsea 7, Stena Line and Weir.

Several meetings have been held among the 5 companies to discuss a joint approach to engage SMES. The common position is to prepare an Open Innovation day for SMES at the end of October or beginning of November. Other dates were banned as there is a similar event prepared in Glasgow, and they ask for separate ours to allow people for showing to both.

The day-event hopes to show the common aims to open research and business to Scottish SMES, share the common challenges that have been identified. As the industries of the companies are similar, it is thought that companies and solutions working for one company could be reused by the others to solve their challenges. This implies SMES are interested to know the rest of the companies to share knowledge and business.

The idea is highly attractive as the common placement of the name of the 5 companies in one unique event, where specific topics are going to be shared, means that SMES expectations are going to be greater, but also the chances to cohort companies to get in touch with companies that have already solutions ready for deployment.

The third task of this work package, the website improvement is already in process. After several meetings between Future Networks team and the Communication team, a common framework for all the projects has agreed. It is only necessary to collect the information that each project wants to have online and send it to the final team.

Also a faster updating process has agreed with Future Networks team having access to the change platform, reducing the intervention of Communication team to check and confirm the correctness of the changes.

Chapter 7. - Analysis of results

The analysis of results of this project faces many disadvantages in the moment of transcription of this report, as it is a long-term project and currently only the draft of the strategy and the first steps have been done.

The following analysis would take into account the current cost of the challenges proposed, and then make estimation about the savings that can be achieved through the implementation of Open Innovation.

This is one of the main problems that the implementation of Open Innovation faces, to estimate or guess the real value of the savings of OI projects.

7.1. Results from the basic model

The current implementation for Open Innovation initiative is in the first steps. Due to the duration of the funded trial, 4 years, and the need of defining a strategy, the results up to the moment of the draft of this report are limited.

The definition set to Open Innovation, involving the use of the resources and characteristics of the projects to spread innovation across the company has proved valid and interesting for the company.

Employees of the companies need to get aware of the solutions that Open Innovation provides, and moreover support the initiative with further engagement. Employees turning to Future Networks team have not highly increased since the beginning of the Trial, as little actions has been taken during the first months of activities.

The choice of a partner is seeing as a success, with the Energy Innovation Centre (EIC) already accepting challenges in our behalf. *Tower Foundation Monitoring* is the first challenge awarded since the kick-off of the project.

The high knowledge that EIC has of energy networks and the technologies, environments and specifications required facilitates the intermediation with the Solvers, and can guide them about the requirements, avoiding the biases that SPEN has.

However, EIC uses has had little impact in the internal development of innovation, as it is totally focus on find providers outside the boundaries of the company.

As EIC provides its own platform, via its website (<http://energyinnovationcentre.com/>), there is not plan to launch any SPEN platform for Open Innovation. Anyway, in a medium-term future a special designed page for Open Innovation could be expected.

About the challenges, the process to acquire the problems from the employees and the districts members is not updated or prepared on this moment. Several propositions have been studied with external partners, but until the moment a study of the engagement of SPEN employees is not done, not further partnership would be studied.

The process in place implied the search for people with ideas, via direct contact or communication tools as electronic mail or Yammer, with are highly inefficient for the storage and management of the information provided by the employees. Also it does not allow sharing the information with the rest of the companies to help define the specifications for a solution, or the solution itself if it has already found in other parts of the business.

Challenges, as it has been already mentioned, have been launched via Energy Innovation Centre with high success. *Metal Tower Foundation Monitoring* has been awarded and several other are waiting for people to submit. Any solution is reviewed together with EIC to allow the best understanding of the solution and to maximize the gain of knowledge about new technologies or ideas.

SMES engagement has been started via the EIC challenges, as they contact new individuals or firms to help solving the problems proposed by SPEN. A proposal to arrange a public dissemination meeting with the rest of the members of the cohort has been approved, for a date in late October, early November.

The first topic of the SMES event, Industry 4.0., contains the major advancements the network will have in the future, as sensors for distribution networks, where most of the faults appear and less information SPEN has in this moment. Remote monitoring would help to increase reliability to customers, and Big Data analytics will affect the work done with the new sensors, and possibly have to face the amount of data collected by the smart meters.

As said before, the 1st Learning Lunch has been already held, the 20th May with a high participation by SPEN employees.

A survey was given before the start of the presentation to know the degree of knowledge of particular projects on Innovation, and their thought about the company they are working for as an innovative actor. The survey was repeated after to see the different in response with the answer in Figure 24. Answer to "SP Energy Networks is an innovative company"

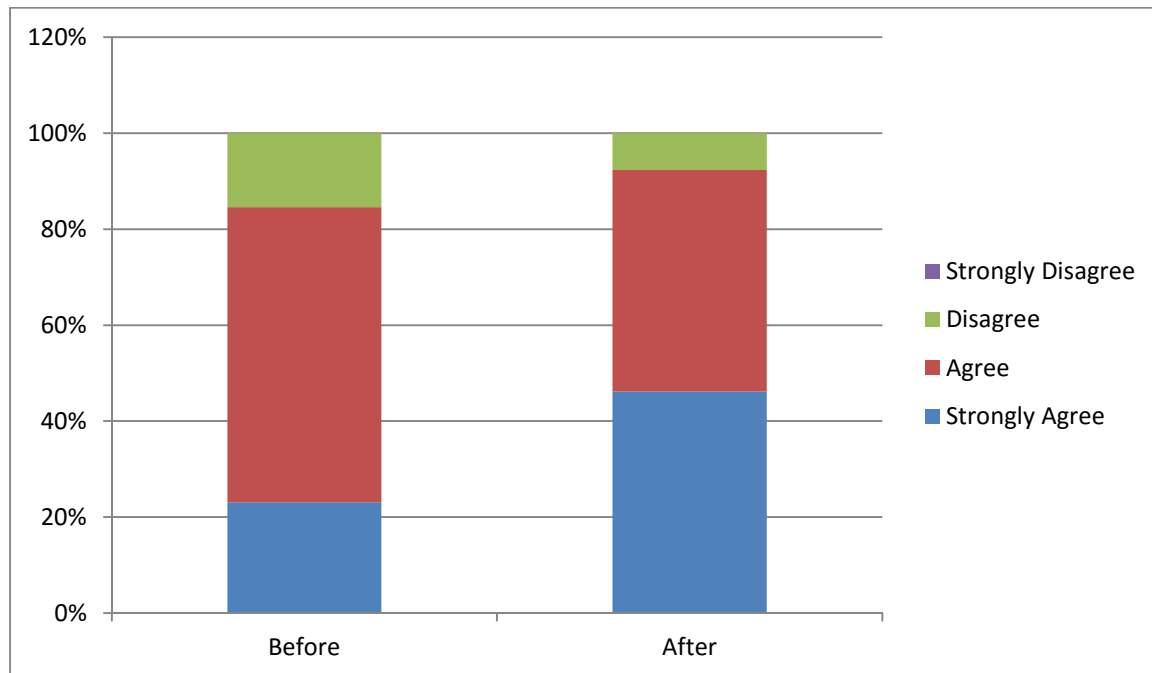


Figure 24. Answer to "SP Energy Networks is an innovative company"

Also a question regarding the interest of taking part and support Open Innovation initiative was given, with an astonishing 95% positive return. Although the team also asked for possible challenges, it is understood the little time of reflexion given did not allow to people for think about it. We expect further contact during the following weeks.

Being critics with the numbers obtained, it is important to take into account the group of attendees was mainly form of graduates and people who have entered the firm during the last 3 years, having rotated around different teams. In later Learning Lunches the survey will be repeated to increase the pool of answers and also to have more variety in the attendees.

About the internal Innovation website, no change has been done in this moment because of the interest and focus is mainly in the external website. Further discussion with Communication team would lead to a better understanding of the idea and the kind of material that can be posted.

In external dissemination, the new Innovation pages are under development. During the following weeks the new design will be launched online, and we could know more about the response of the customers and stakeholders to the change.

For the cohort meeting, the first one was in November when the initiative started, before the student started the project. The second one was little time after the kick-off meeting of the project, in late January, and the advance done by the rest of companies was small.

The 3rd Cohort meeting allows showing the evolution of the rest of the companies, being some of them in advance in the implementation, although most of them are still defining the team to be in charge of the implementation. Also an interesting course about IP rights treatment were given by experts to show the risks and advantages of the control of IP and how Open Innovation model has to be take care also of patents, trademark and trade secrets.

7.2. Economic Analysis

As the project is its first steps, the quantity of economic information is limited, and most of them cannot be disclosed to not affect the normal development of the project. The only challenge that has been awarded would be studied with the information up to this moment, remaining in secret the name of the company working on it. **All the numbers are estimations done by the student.**

i. Tower Foundation Monitoring challenge

The first challenge to be talked about is *Metal Tower Foundation Monitoring*. This project aims to reduce the time and cost of the revision, check and state statement of the foundations in the legs of the metal towers that are in the transmission and distribution networks.

Currently the process makes use of invasive process, a small digger is used to create hole to have direct access to the surface of the foundations, and then a visual and mechanic inspection is done. The use of a digger and the fact to take out soil materials has a visual and noise impact, together with the need of special tools, as the digger, and work permission for the authorities. The time taken to dig the soil is not used for the inspection, so the cost, based on the salary of the contractors or district employees is high.

The average cost for the inspection, talking about the whole process of digging, inspection and the return of the land to its original state, costs ranges from £6,000 to £12,000 per tower. The variability in the price is explained by the fact that the foundation size, form and total weight varies in accordance to the type of tower (traction or suspension), the voltage of the line (132kV, 250kV or 400kV), the kind of cable used and the angle forms by the spans wires.

The information provided by SPEN informs that around one to two hundreds (100-200) poles have to be evaluated per year to comply with the current legislation and asset management policy.

The current total cost, taking average value of all the quantities is showed in Table 20. Metal Tower Foundation Monitoring budget.

Table 20. Metal Tower Foundation Monitoring budget

Metal Tower Foundation Monitoring			
Concept	Unit cost (£)	Quantity	Total
Foundation Tower Monitoring	£9.000	150	£1.350.000

The company that has been awarded the prize in the EIC Innovation call has prepared a submission giving non-detailed information about the proposed solution, only indicating its capability to improve the current solution using proven technology that would have to be updated to work under Network Operator conditions and reduce the cost to make it affordable for any district team.

The challenge has been updated to a NIA trial, where the hardware would be developed to adapt to the required specifications and tested under real operation conditions. Moreover, in accordance with the information given by the contractor, the current device is too complex and expensive for being the final product. A simpler version would be developed to lead to better understanding by the foundation monitoring team.

Moreover, a tool to control the ageing of the foundations would be provided by the contractor, in the form of a Macro table or a SAP add-on, improving the control on the foundations and giving the possibility to predict and actively control the foundations that are expected to be in worse conditions.

All these activities and possibilities were not available before the Open Innovation initiative started, allowing for a better understanding of the foundation ageing process, a better and more robust process of monitoring and the reduction in cost and time.

An estimation, totally arbitrary and given by the student own understand of the topic for the investment needed in case of success on the development of the portable device is showed in Table 21. Foundation Development estimated budget.

Table 21. Foundation Development estimated budget

Metal Tower Foundation Monitoring via Open Innovation			
Concept	Unit cost (£)	Quantity	Total
Monitoring Device	£50,000	10	£500,000
Development	£150,000	1	£150,000
Real Conditions testing	£150,000	1	£150,000
Macro Table Maintenance	£20,000	1	£20,000
Training (per person)	£2,000	30	£60,000
SAP Add-on	£50,000	1	£50,000
Total Investment			£930,000

With an investment in case of success of around £1 million, a quantity totally estimated by the student with the use of his own understanding of the project because more accurate information would break IP rights in the information disclosed by the contractor.

With the estimation of the investment need by SPEN to have the new hardware in the teams, Open Innovation team has to look to the reduction of cost per tower related to the used of not invasive techniques, that avoid the use of a digger and the work permit.

In a very conservative estimation, the cost of monitoring a tower would be reduced to the lowest band of prices given in the cost by SPEN, £6,000. The new per year budget, the savings per year and the investment recovering time is showed in Table 22. Economic Case Study for Metal Tower Monitoring

Table 22. Economic Case Study for Metal Tower Monitoring

Metal Tower Foundation Monitoring			
Concept	Unit cost (£)	Quantity	Total
Foundation Tower Monitoring	£6.000	150	£900.000
Old cost per year	£1.350.000		
New cost per year	£900.000		
Savings per year	£450.000		
Investment Recovering Time	2,07 years		

The student estimated budget savings is close to £0.5 million in per year basis, in the conservative approach, where the lowest band of current cost per legs is taken. The expected steps in the quality of the information would also mean more detailed reports would be received, improving the understanding of the towers and their foundations and affecting the refurbishment program.

First estimation values the recovery time for the investment in two years with the savings produced with the new methodology. It is a very affordable investment for the company, as the savings would quickly recuperate the investment done for the project. Moreover, the investment recovery time only takes into account the savings produced by the new methodology in comparison with the current methodology, without adding to the equation the better knowledge of the assets, their state and their ageing.

The knowledge of the state of the assets could help to manage investment, reducing the uncertainty of how the assets would be.

The fast time to recover the investment together with the fact that the solutions already exists for application in other industries, shows the benefits of the use of Open Innovation in SP Energy Networks, validating the model. An external company that was already working with some of the biggest companies in Scotland presented a product that would be applied, with small time to market (6 months is the expected duration of the works) and that would improve service to clients with a better quality of the transmission lines.

Chapter 8. - Conclusions

8.1. Conclusions about the methodology

Open Innovation in the Regulated Business can be considered an approach to a correct and right path to implement Open Innovation in a company, aiming to transform and shift the culture of the company to introduce the new developments in term of technology and ideas.

The model proposed by the student looks at all the important topics for the implementation of Open Innovation, as it is the definition of the specific meaning for the company, the selection of a partner with experience to guide in the implementation and the preparation or launch of several challenges.

However, these are only the main points to implement Open Innovation. To get a successful implementation, it is necessary to look at the environment of the company, and the human capital to identify, target and solve or reduce the problems that appear around a cultural shift in an organization. As it has been stated during all the project, Open Innovation model is going to last if it fully embraces by the organization, and the organization is composed of the employees working for him.

The only point in the strategy that has not been contemplated is the search of an innovation champion who takes ownership of the project and the cultural shift from a higher position in the hierarchy of the company. This need has been highlighted as vital for all the experts the student has got access to since the beginning of the project.

The division of all the tasks in different work packages has helped to better allocate resources to each of the needs, and it also has the advantage to haul the progress of the project working in different tasks in parallel.

The Work Breakdown Structure used in the project has been taken from the Project Management subject in the Master in Industrial Engineering, due to the fact that allows a better understanding of the tasks to follow, and make the planner think in advance about the needs of the project.

It has been showed that some of the tasks were similar in different work packages. The explanation is the need to understand the different parallel paths to get to the crowd Open

Innovation needs to be implemented and successfully used by insiders and outsiders to the company.

The preparation of dissemination activities, as the Learning Lunches, aims to spread the knowledge about the project, introducing the initiative and the implementation little by little in the main of the employees, and trying to sell the idea to the management to get a wider support.

From the experience and knowledge of the student in Change Management subject of the Master in Industrial Engineering, there are always people reluctant to change, and in a company whose methodologies and processes are based on the work done in the late 50s and 60s, where most of the network was built, this process can be traumatic. Things are done the way they were done years ago, although they may be inefficient, or new methods have appeared. The own inertia of the company and the constant updates of the resources to add spare capacity means there is not hurries or stress time if things are doing right in the old way.

To control the negative feelings about the project, and gain the support from the intermediate management, who controls most of the people and set the processes and update processes, change management techniques are expected to be applied to push the implementation and need for change further. Lot of time has been invested in this part of the proposal to get a success in the implementation.

About the challenges, it is encouraging to see that the first challenge that was launched via Energy Innovation Centre has already found a Scottish solver, with would use proven technologies use in the renewable industry to monitor and check the foundations. The challenge provides the confirmation to the hypothesis that Open Innovation can work in the utility sector.

However, EIC processes are not robust enough, as there is not a platform where the companies looking for challenges could upload the information about the challenges and allows EIC to modify it. Moreover the process is quite obscure, as SPEN cannot have direct access to the submissions, and all the information about the challenge is only given to the interested companies after a first review by EIC.

If Open Innovation is to be fully implemented, the process of submission and selection of the awarded winner has to be transparent. Trust on SP Energy Networks is the major driver of SMES willing to cooperate, and an obscured and not well documented process could raise mistrusts and doubts.

Utility sector has the main problem of being an industry that needs to be error 0, meaning an error would disrupt the supply to the customers, being fined by the regulator for each Customer Minutes Lost (CML) and losing trust from the customers. This could lead to excessive protectionism of the old processes that have been proven by many years of correct operation.

The approach that Open Innovation trial has proven, with challenges leading to solutions that could be applied to business-as-usual to open a second path for innovation projects to be developed, in a faster way and with results from different industries.

It must be taken into account that the project is still in the first steps of its operation, and all the results have been based on really limited information. The continuation of this project, together with the mechanisms that have been installed to provide an enduring Open Innovation initiative in SP Energy Networks, would provide more results and data to check the viability on the long-term for Open Innovation in the utility sector.

The methodology has proved to work but there are changes that have to be done for other companies, and not take assumption about the expected time of completion, because the resources at the beginning are not most of the time aligned with the delivery of Open Innovation. Changes to the strategy would be:

- Get early support from at least one person of the management of the firm. The usual path for the implementation is top-down, as one person in the high hierarchy supports Open Innovation and prepares a team for working on it.
- Multinationals are not a start-up. Things would take time to complete, and most of the people will have to spend extra time to fulfil your requirements, so they may not be as supportive as you expect.
- The need to prepare a strong business case. At the beginning it would look like as Open Innovation would sell alone to the business, but it is not the case. A

business case has to be prepared, trying to use real cases from the company, and pushing for the completion of a challenge before start selling the change.

- Communication inside the company has to be individual at the beginning. People get inbox full of message, and they get in mail changes they are not interested in. If you want a good response to your activities, try to ask for people willing to help and send them individual messages to catch their attention.
- An Innovation champion has to take ownership of the process to lead from the high hierarchy the process and the cultural shift to an innovative culture. The champion has to own a wide knowledge of the company, the processes in placed, and the employees. The champion knows who can help to the implementation and what it should ask for each department and area.

8.2. Conclusions about the results

The results in the current state of the project have to be looked carefully and taking into account the little information that it is available. In the future, possibly after the summer, more information would be available as the challenges start to be awarded and the current project finish would be near.

If the estimations done by the student are relevant, the unique challenge that has been awarded in this moment is highly interesting for the company. The time to pay the investment done in the project is two years, and small time for a utility time scope.

The calculation of the savings for the *Tower Foundation Monitoring* challenge is very conservative, and only look at the savings on the cost of monitoring the foundations. The possible benefits for having a more advance tool that allows a wider control of the state of the foundations has not been taking into account.

The benefits for having a better control of the assets it is very important for a utility, as the revenue coming from the use of the assets is the main source of revenue. The most efficient and effective way of using them, better allocating the maintenance costs and actively monitoring the current state to adapt investment are the best way to improve cash flows, the profitability of the company and get a long-term vision of the state of the assets to program their refurbishment.

The challenge has been a success at the moment a Scottish SMES is working on a project that would have application not only for SP Energy Networks, but all the Network Operators in UK, leading to a chance of improve the cash flows coming to Scotland and achieving one of the main objectives of the Scottish Enterprise initiative.

Following challenges would learn from the steps given to complete *Tower Foundation Monitoring* challenge, as feedback would be requested for all the stakeholders.

It has been observed that the approach used for EIC lacks some of the specifications or processes Open Innovation team wants to implement in SP Energy Networks, but also opens the chances to work together with them to expand the scope of its work.

About work with EIC, currently the link is directed by a unique person, and this is expected to be changed to provide with more challenges without saturates the current link. Moreover, there is a lack of information flows among the different stakeholders one time that the challenge is awarded, and the IP rights agreement has to be cleared to avoid rejection by some possible partners.

8.3. Recommendations for future studies

Future studies that aim to follow the strategy raised in this report should take into account that the strategy is based in the special need for a very specific sector, electricity network industry, a utility that has been changed the way it manages the assets in the last decade, with the irruption of renewable energy, and more climate-change concerned customers.

Future implementers of Open Innovation may try to gain experience and knowledge about the normal operation of the company, together with knowledge of the teams before starting the project of implementation of Open Innovation. The idea behind this point is the high quantity of communication required by the implementation of an initiative that tries to produce an enduring shift in the culture of a whole organization.

At the beginning of the study, the student was completely new to the company, lacking the knowledge about the specific features and characteristics of the company, the culture by the management and the expectations about the initiative. The kick-off meeting did not solve this lack of information and delays have appeared as a consequence.

Therefore, it is recommended that the project to implement Open Innovation inside a company has to start with a person familiar with the company as innovation champion, in the basis of full or part-time work time in the program. It would help to manage the starting lack of confidence or support to the initiative, with knowledge of the particulars that would be interested at the idea.

However, it has also been observed that the people inside the company can be “corrupted” by the company culture, and some of the best ideas may come from people with internal knowledge but not very long experience, as graduates or recent employees. It is important to recruit a team that is happy to go out of the usual ideas and comfort area to try to disrupt the general policy.

To end, the time expected for each task has to overestimate, as Open Innovation relies on the work of people out of the team that has to take part of the time from their usual tasks to solve Open Innovation tasks. This is not always easy, and, overall at the beginning, Open Innovation may be in the bottom of the priorities.

A complete list of additional activities and tasks that could be done in the strategy could be found in 5.7. Update to the Strategy.

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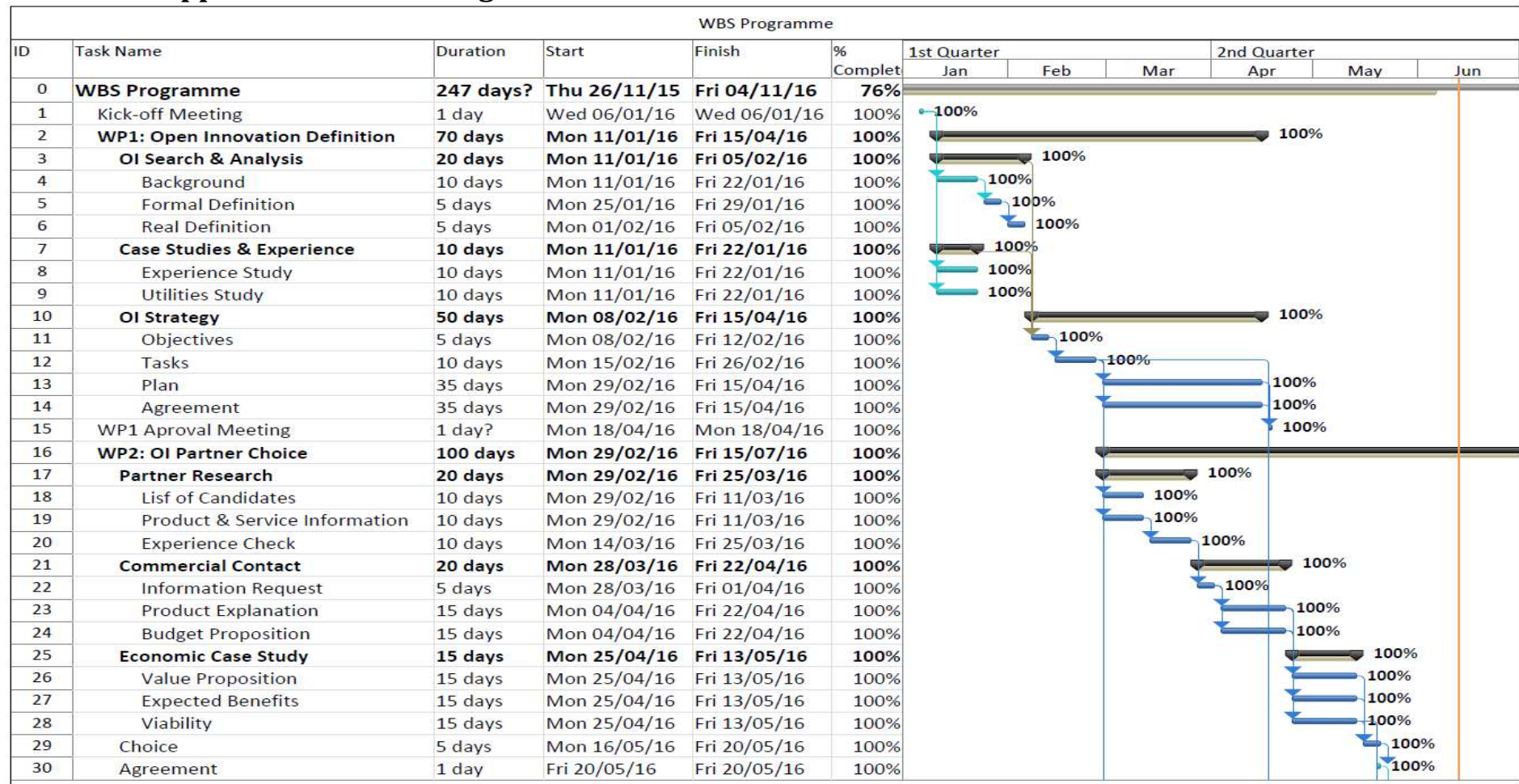
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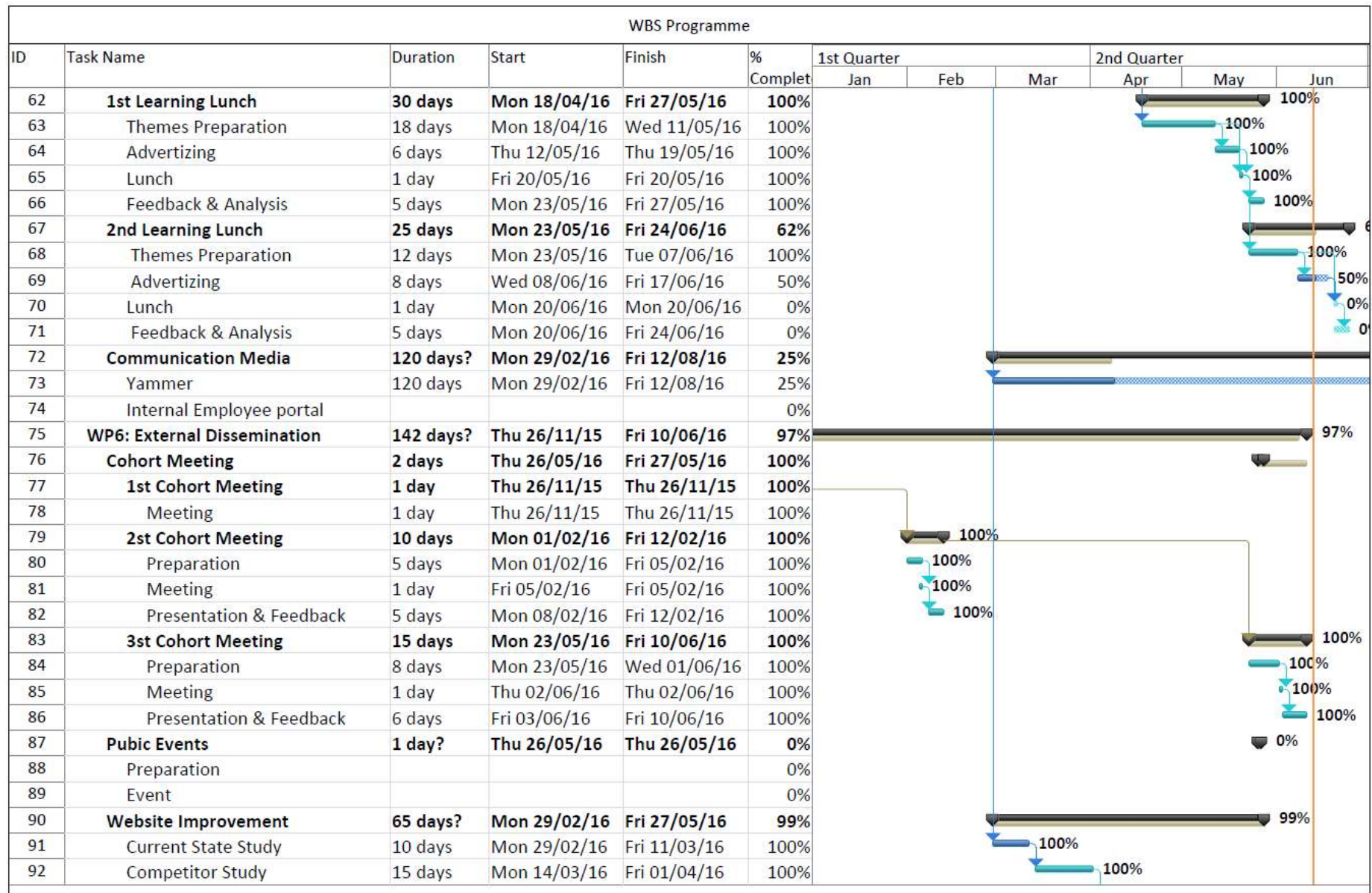
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Chapter 10. – Appendixes

Appendix A – Gantt Diagram



WBS Programme											
ID	Task Name	Duration	Start	Finish	% Complet	1st Quarter			2nd Quarter		
						Jan	Feb	Mar	Apr	May	Jun
31	Platform Development	40 days	Mon 23/05/16	Fri 15/07/16	100%						
32	Study Design	15 days	Mon 23/05/16	Fri 10/06/16	100%						
33	Prototyping & Iteration	25 days	Mon 13/06/16	Fri 15/07/16	100%						
34	Launch	1 day	Fri 15/07/16	Fri 15/07/16	100%						
35	WP2 Aproval Meeting	1 day	Fri 20/05/16	Fri 20/05/16	100%						
36	WP3: OI Challenges	75 days	Mon 29/02/16	Fri 10/06/16	100%						
37	Search	25 days	Mon 29/02/16	Fri 01/04/16	100%						
38	Background	10 days	Mon 29/02/16	Fri 11/03/16	100%						
39	Problem Statement	10 days	Mon 14/03/16	Fri 25/03/16	100%						
40	Solution Specifications	5 days	Mon 28/03/16	Fri 01/04/16	100%						
41	Economic Impact	5 days	Mon 28/03/16	Fri 01/04/16	100%						
42	Preparation	15 days	Mon 04/04/16	Fri 22/04/16	100%						
43	Scope Challenge	10 days	Mon 04/04/16	Fri 15/04/16	100%						
44	Non-biased description	5 days	Mon 18/04/16	Fri 22/04/16	100%						
45	Launch	30 days	Mon 25/04/16	Fri 03/06/16	100%						
46	Public Dissemination	30 days	Mon 25/04/16	Fri 03/06/16	100%						
47	FAQ Answer	30 days	Mon 25/04/16	Fri 03/06/16	100%						
48	Solvers Engagement	30 days	Mon 25/04/16	Fri 03/06/16	100%						
49	Results & Analysis	5 days	Mon 06/06/16	Fri 10/06/16	100%						
50	Solution Collection	5 days	Mon 06/06/16	Fri 10/06/16	100%						
51	Specifications Check	5 days	Mon 06/06/16	Fri 10/06/16	100%						
52	Analysis & Economic Viability	5 days	Mon 06/06/16	Fri 10/06/16	100%						
53	Winner Award	1 day	Fri 10/06/16	Fri 10/06/16	100%						
54	WP4: SMEs Engagement	180 days	Mon 29/02/16	Fri 04/11/16	50%						
55	Dissemination Challenges	30 days	Mon 25/04/16	Fri 03/06/16	100%						
56	Shortlisting SMEs	30 days	Mon 25/04/16	Fri 03/06/16	100%						
57	Targeting SMEs	30 days	Mon 25/04/16	Fri 03/06/16	100%						
58	SMEs Event	180 days	Mon 29/02/16	Fri 04/11/16	33%						
59	Preparation	120 days	Mon 29/02/16	Fri 12/08/16	50%						
60	Targeting SMEs	60 days	Mon 15/08/16	Fri 04/11/16	0%						
61	WP5: Internal Dissemination	120 days?	Mon 29/02/16	Fri 12/08/16	43%						



WBS Programme											
ID	Task Name	Duration	Start	Finish	% Complet	1st Quarter			2nd Quarter		
						Jan	Feb	Mar	Apr	May	Jun
93	Improvement Plant	40 days	Mon 04/04/16	Fri 27/05/16	100%					100%	
94	Launch	1 day?	Fri 27/05/16	Fri 27/05/16	50%						50%

Appendix B – GE Ecomagination Infographics

A Decade of Ecomagination

GE's Ecomagination initiative, launched in 2005, led to the development of ultra-efficient technologies that have provided resource productivity improvements across industries. Looking ahead, Ecomagination and the Industrial Internet promise to unleash accelerated resource productivity improvements.



2005 Goals

In 2005, GE launched Ecomagination, its commitment and strategy to solve the world's biggest energy and environmental challenges.

GE commits to:

1. Doubling its investment in clean research and development (R&D) from \$700 million/year to \$1.5 billion/year by 2010.
2. Growing revenues from Ecomagination products to at least \$20 billion.
3. Reducing its greenhouse gas (GHG) emissions by at least 1% by 2012.

2007 Expansion

In 2007, GE announced a new commitment in addition to the original three.

4. GE commits to reducing its global water use by 20 percent between 2006 and 2012.

2010 Progress

1. \$5 billion invested in clean R&D.
2. \$85 billion in Ecomagination product revenue.
3. 22% reduction in GE's GHG emissions from the 2004 baseline.
4. 30% reduction in water use from the 2006 baseline.

2013 Success

1. \$12 billion invested in clean R&D.
2. \$160 billion in Ecomagination product revenue.
3. 32% reduction in GE's GHG emissions from the 2004 baseline.
4. 45% reduction in GE's water use from the 2006 baseline.

2005

2005

GE creates the Ecomagination product review scorecard, which quantifies a product's or solution's environmental benefits.



2005

GE surpasses 5,000 installations for its 1.5 megawatt wind turbine.

2006

GE increases its annual investment in clean R&D from \$700 to \$900 million and expands research on renewable energy, clean coal, carbon captures, water, and energy efficiency.

2006

GE launches Ecomagination in China, nearly 100 years since GE first began working in the country.

2007

2007

GE Transportation's partner United Group Rail delivers 10 Evolution Series locomotives to Rio Tinto Iron Ore, bringing advanced locomotive technology to an energy-intensive industry.



2007

The GENx becomes the quietest, most energy-efficient and fastest-selling large engine in GE Aviation history. Emirates, an airline based in Dubai, is among those GE customers that have chosen GENx engines to power their fleets.

2007

GE Energy's Jenbacher gas engines power Japan's largest wood gas-to-energy plant.

2009

2007

GE's broad portfolio of Ecomagination products spans the entire range of GE businesses.



2007

GE invests more than \$1 billion on clean R&D, drawing closer to the 2005 pledge billion to invest \$1.5 billion by 2010.

2009

GE surpasses its clean tech R&D goal of \$1.5 billion one year early.

\$1.5 billion

2010

2010

GE commits to buying 25,000 alternative fuel vehicles by 2015 to use in its fleets and those of its fleet- services business in 2010:



2010

Ecomagination software solution, Movement Planner™, makes it possible for trains to move more freight faster and more efficiently on existing rail lines.

2010

GE researchers set a world record of 12.8% thin film solar panel efficiency.

2010

ProfiCity™, a software platform for measuring and managing the efficiency of manufacturing operations, is included in the Ecomagination portfolio.

2011

Ecomagination opens GE to outside innovation through the Ecomagination Challenge. Collaborating with venture capital firms, GE invests more than \$130 million in 22 companies to help bring exciting new energy technologies to the world.

2012

2012

Ecomagination Nation, a global GE Power & Water initiative designed to protect the environment by encouraging employees to take action, gains increasing momentum within GE.

2012

GE's Ecomagination portfolio expands to include CNG In A Box™, GE's fully integrated CNG fuel supply system.



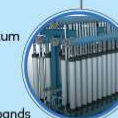
2013

Ecomagination launches Brilliant™ Wind, a renewable energy system comprised of a wind turbine, battery and software. The system harnesses the power of the Industrial Internet and reaps the benefits of energy storage without the high costs.

2014

2014

GE opens the Ecomagination center in Masdar City, United Arab Emirates.



2014

GE provides its ZeeWeed™ 1500 ultrafiltration system to the Santa Eufemia water treatment plant in Northern Portugal.

2014

San Diego becomes the first city to install LightGrid™, GE's wireless lighting control system.

2014

GE sets new Ecomagination commitments. After investing \$15 billion in clean R&D since 2005, GE commits to investing a total of \$25 billion by 2020. GE also commits to reducing GHG emissions and water use by another 20% from the 2011 baseline.

2014

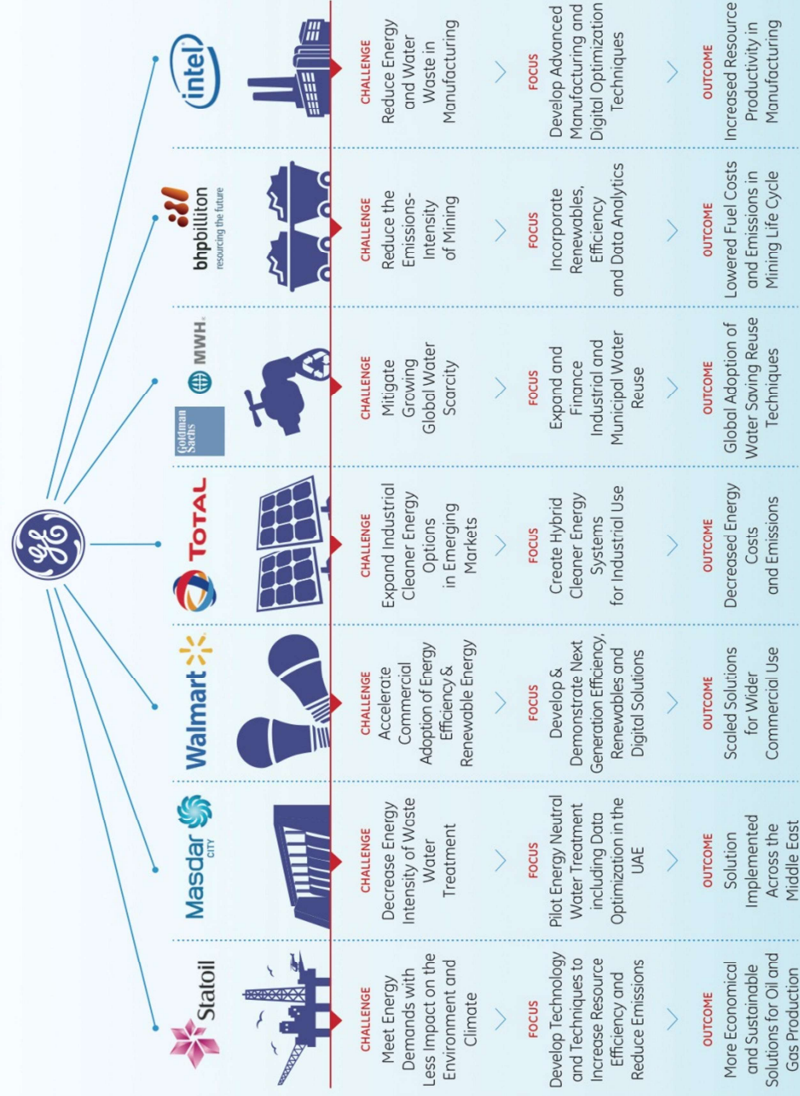
GE's Predictivity™ Industrial Internet solutions are added to the Ecomagination portfolio.

\$15 billion

GE ECOMAGINATION ANNOUNCES PARTNERSHIPS TO ACCELERATE INNOVATION IN WATER AND ENERGY EFFICIENCY

"The success of Ecomagination has proved that efficiency and economics go hand-in-hand. Global water and energy challenges require immediate action. Today we're joining forces with business partners to develop technology solutions that will improve productivity, reduce impact and increase returns."

- Jeff Immelt, Chairman & CEO, GE



BUSINESS CAN DRIVE IMMEDIATE ACTION. BY 2020 WE SEE:

The number of installed smart meters will reach 1 billion	Fuel cell installations will grow by 400%	50% of all new electric power additions will be renewables	Energy storage costs will be cut in half
Gas and solar will displace diesel in one third of all distributed power installations	The Industrial Internet will help double the rate of resource productivity	Industrial desalination and water reuse will grow by 3X	
Global LED shipments will quadruple	New coal power plants will achieve a net electrical efficiency of 50%	One quarter of all global energy industry jobs will be in clean tech	Global transportation energy efficiency will increase by 10%

Appendix C – Awards from GE Ecomagination Challenge

2010

ClimateWell, Stockholm, Sweden (Efficient Appliances). ClimateWell's energy-efficient cooling and heating systems run on solar-powered hot water rather than electricity, maximizing energy efficiency. This technology translates into a significant reduction of power consumption and carbon emissions. While initially targeting operations like hospitals or commercial buildings, GE is working with ClimateWell on deploying this technology in additional markets already served through GE's appliances business.

Consert, Raleigh, NC (Energy Management Systems and Software). Consort's demand side energy management solution empowers utilities, municipalities and co-ops to manage load curtailment, increase operations efficiency and act as a virtual power plant. Consort's technology complements GE Digital Energy's existing solutions to meet the unique needs of these market segments.

FMC-Tech, Ltd., Shannon, Ireland (Intelligent Sensor Technologies). The power line monitoring system for medium voltage networks serves as a nervous system for the smart grid and has applications for GE's Smart Grid Delivery Optimization. It integrates overhead line sensing, data storage, and wireless communication to a local controller to detect and locate faults in the smart grid and manage distribution communications, providing a platform for the present and future needs of the network.

Fu Foundation School for Engineering and Applied Science, Columbia University, New York, NY (EV Charging Stations). A new collaboration with GE, Columbia Engineering, FedEx Express, and Con Edison to enable the conversion from hydrocarbon to electric delivery vehicles in New York City. ColumbiaEngineering's technology, developed by its Center for Computational Learning Systems, manages load and delivery and links electrical vehicle charging stations to the utility's electric distribution management system in real-time. FedEx is providing and operating the all-electric vehicles that the collaborative team will study. In addition to providing funding, GE will supply expertise from its Digital Energy division and GE's Global Research Center to support this program.

JouleX, Atlanta, GA (Energy Management Systems and Software). JouleX provides a single, network-based, energy-management solution. The JouleX Energy Manager monitors,

analyzes and automatically adjusts the energy usage of a network's connected devices and systems. It has the potential to reduce energy consumption by 30-60 percent. It will enhance GE's data center solutions to help customers reduce energy consumption in the data center. In addition, the technology will enhance Demand Response Management System capabilities in GE's Digital Energy business.

OPOWER, Arlington, VA (Energy Management Systems and Software). OPOWER integrates consumer demographics, energy consumption data and behavioral analytics to encourage households to make intelligent choices around power consumption in their homes. The average user reduces consumption by about 2.5 percent per month, helping to deliver savings. With GE's global work in Smart Metering and Automatic Metering Infrastructures, OPOWER can help utilities secure buy-in from consumers and public utility commissions.

Scientific Conservation, San Francisco, CA (Energy Management Systems and Software). This platform monitors and manages energy drift in commercial buildings through predictive maintenance of core energy systems: heating, ventilation, air conditioning, refrigeration, lighting, controls and renewable sources. Using its patent pending diagnostics, it typically improves efficiency covering the cost of installation in less than two years. The technology has applications for GE's Intelligent Platforms building management software business and provides conservation opportunities for GE's real estate portfolio and GE buildings.

SecureRF Corporation, Westport, CT (Utility Security). SecureRF provides security solutions that address lower-powered embedded devices that will be used throughout the Smart Grid. Its Algebraic Eraser™ is a public-key cryptography method designed for resource-constrained devices like meters and sensors. GE's Digital Energy business can draw on this security technology for the smart grid to help utility customers alleviate consumer privacy and data security concerns.

Sentient Energy, Burlingame, CA (Intelligent Sensor Technologies). Sentient develops advanced grid monitoring solutions that consist of modular intelligent monitoring devices and software applications, enabling cost-effective distribution automation. It improves fault location, cause analysis and remediation, grid capacity management, and utility workforce utilization, presenting integration and partnership opportunities for GE Energy's Digital Energy offerings.

Soladigm, Milpitas, CA (Building Efficiency). This window technology electronically switches glass from clear to tinted, enabling control of heat and glare. It can reduce energy usage for heating, ventilation and air conditioning (HVAC) systems by 25 percent and reduce the HVAC peak load by 30 percent, an important tool to level demand for the future smart grid infrastructure. With GE's green homes and green hospitals ecomagination programs, its zero energy home program and other energy efficiency initiatives, there are multiple paths for commercial relationships with the technology

SustainX, West Lebanon, NH (Energy Storage). This technology provides isothermal, compressed-air energy storage technology to enable cost effective, grid-scale energy storage. SustainX's approach has the potential to be less than half the cost of traditional compressed-air energy storage. The technology presents opportunities for collaboration with GE's Global Research Center and commercial partnership opportunities with GE Energy to commercialize energy storage applications and to enable a higher percentage of renewable power generation in markets like Europe.

SynapSense Corporation, Folsom, CA (Data Center Services). Using a robust wireless sensor network, SynapSense's solutions measure and manage the environmental conditions and power usage throughout data centers, resulting in a 10 percent reduction in overall energy consumption for typical, enterprise-class data centers. The technology offers commercial relationship opportunities with GE's Digital Energy business and its Intelligent Platforms business with its visualization and energy management offerings.

There were also five innovation winners that will each received \$100,000 to develop their ideas, and another set of companies will be given \$10,000 for being "best in show." The innovation winners are:

Capstone Metering: Intelligent Water Meters – Carrollton, Texas. A smart water meter that can generate its own power using water and help conserve water.

ElectricRoute: Secure Communications Network for the Electric Grid, Salem and Hollis, New Hampshire: Secure network infrastructure to connect substation to transmission and distribution systems.

GridON: Controlling Power Quality in Electric Grids, Givatayim, Israel. The technology involves a fault-current-limiter that increases grid reliability and enables more intermittent renewables by limiting short-circuiting and outages from overloads.

IceCode: Wind Turbine Blade Anti-Icing and De-Icing, West Lebanon, NH. High-power pulses remove ice from turbines, limiting the downtime of the turbines. The technology can also be applied in refrigeration and other applications.

WinFlex: Inflatable Wind Turbines, Kiryat Yam, Israel. Trading steel for inexpensive cloth, these wind turbines reduce the return on investment and cut installation costs.

