ESB Networks,

Preparation for EV’s On The Distribution System

Pilot Project Implementation Document

27/5/2013
1.1 Introduction........................................................................................................................................3
1.2 Overall Project Objectives and Project Scope..............................................................................7
1.3 Project Deliverables..........................................................................................................................11
1.4 Project Benefits...............................................................................................................................12
1.5 Key Assumptions.............................................................................................................................12
1.6 Risk Assessment.............................................................................................................................12
1.7 Timescales / Key Milestone Dates.................................................................................................13
1.9 Project Structure (Governance and Accountabilities)....................................................................14
1.10 Project Financials..........................................................................................................................17
WP 1 – Demonstrate technology passively deployed and resultant physical system impact...19
WP 2 – Optimise the charging infrastructure, connections, metering and safety standards....25
WP 3 – Smart Charging and Network Operation ..............................................................................29
WP 4 – Network Planning ..................................................................................................................35
WP 5 – Establish the potential impact on EVs on the DUoS average unit price.........................39
WP 6 – Facilitating a competitive market structure.................................................................42
WP 7 – EU Projects and collaboration outside Ireland..................................................................46
WP 0 – Project Management .............................................................................................................48
Appendix 1 EU Directives...............................................................................................................54
Appendix 2 Project Management Documentation and Processes..............................................55
Appendix 3 – Summary of Project Deliverables .............................................................................63
1.1 Introduction
Integration of the energy and transport sectors is expected to accelerate over the coming decades through the integration of electric vehicles into global transport fleets. This move is expected to be particularly strong in Europe due to the leading role the EU has taken in relation to areas such as energy efficiency, promotion of renewable energy and climate change. Transport is a recognised contributing sector to global climate change. There are currently over 750m cars in the world and this figure is predicted to double within 20 years. In order to mitigate the impact of such an increase on climate change, alternate technologies such as electric vehicles (EV) are being pursued globally. It is generally accepted that EV technology and developments in batteries have now reached the stage whereby electrification of transport (from renewable sources) is an achievable goal. If this materialises, it would be a seismic change for distribution system loading. The network and data collection systems were not designed for EVs and, without careful planning and innovative management, will struggle to accommodate this load increase without considerable network reinforcement. This trial looks to investigate the impact of EVs on the Irish distribution network and meter management systems and, if needed what initiatives can be put in place to integrate EVs in the most efficient and economical manor so as to minimise the effect on the wider DUoS customer.

Europe, through the EU, has adopted aggressive targets in the area of climate change control. EU policy objectives have been translated into Irish Government targets in the areas of greenhouse gas emissions, energy efficiency, and the promotion of renewable energy sources in transport. Specifically, the National Energy Efficiency Action Plan 2009-2020 sets out the Government’s ambition that 10% of passenger cars and light commercial fleet be electrically powered by 2020.

Existing Policy drivers for facilitation of EVs
The primary drivers for rollout of EVs across Europe are EU Directives and National Government level policy decisions. The more significant of these are set out below

EU Directives (see Appendix 1 for details)

- **Clean Package for Transport** (EU Directive Proposal January 2013)

Irish Government Policy Statements

High level implications of EVs for the Distribution Network

Based on the political policy directions and the automation industry’s investment in this technology, there are substantive reasons to expect that EVs will be a very significant element of future transportation. There is the expectation that by 2018, that even without policy incentives, EVs will be the car of choice for new car owners. Therefore ESB Networks need to be ready for this development. Unfortunately the timescale of take-up is beyond the control of ESB Networks and for that reason, it is prudent to do this research now and ensure policies in terms of connection standards, metering standards, load management standards and safety standards are developed now.

Preliminary trials have already been carried out by ESB Networks on urban networks. As Shown in Figure 1 below, the result from the existing trials, which were carried out in the absence of time-of-use pricing, have shown that, if not induced to do otherwise, customers will plug in the vehicle immediately on returning home.

Figure 1 Home Charging Connection times recorded during ESB Networks field trials to date.

(Source: SEAI EV Roadmap May 2012)
These charging patterns would add significant load to the existing network load as shown in the resultant distribution of the EV load shape shown in Figure 2. This could in the first instance drive the need for reinforcement of LV networks once penetrations levels on a local network rise to 15-20% and could possibly also drive reinforcement at medium voltage levels. Further tests must be carried out on different network arrangements to establish the potential level of required reinforcement.

![Figure 2: Home EV Charging load distribution recorded during ESB Networks field trials to date](image)

Overload caused by public charging is also a potential risk, particularly in inner city areas where network upgrades would also be expensive and disruptive. Some of this can be avoided by ensuring that network considerations are given significant attention in the planning phase of charging infrastructure.

In addition to urban LV networks, trials will also need to be carried out on LV rural networks to assess the impact of home charging, particularly on single phase networks. Co-incident charging of two or more electric vehicles in a low voltage group, particularly at peak loading time, could have a significant impact on service quality, fault rates and required network reinforcement. In the past, charging and usage policies had to be applied to electrical equipment, such as welders and electric showers, when they became prevalent, and similar policies need to be developed for EV charging, following appropriate trials.

Additional to the above concerns, in its MRSO function ESB Networks have responsibility for end user consumption measurement, change of supplier processes, aggregation of customer load to their chosen supplier, and provision of meter reading information to suppliers in order for them to bill their customers. As Electric Cars will effectively be a mobile load, the challenges of metering this load, its aggregation for
settlement while facilitating maximum flexibility to enable a competitive market for this load need to be investigated.

**Proposed Pilot Programme**

The purpose of the pilot programme is to support learning about EV technology, expected interaction with the Distribution network in terms of safety, connection standards, mobile load measurement, controllability and ICT and user behaviour. The learning from the pilot will inform DSO planning in relation to distribution network design and management and will also help inform if and when any policy changes are required.

The pilot ESB Networks EV programme will comprise a nationwide sample rollout of a national smart charging infrastructure, which will enable the trial to leverage the fact that there are 400 EVs currently in Ireland, with increasing numbers coming into the country, and assess their charging behaviour and consequent impact on the distribution network.

The trial proposes to roll out a skeleton level of charging Infrastructure as follows:

- 700 public locations – with a combination of 2 AC charge point per location (which come as standard on some of the on-street chargers selected for the trial) and 1 AC charge point per location, giving a total of 1,000+ charge points in total, distributed nationally but concentrated in urban areas.
- 70+ DC Fast chargers (urban areas and inter city routes)
- Up to 2,000 Home charge points (subject to private EV ownership take up)

The above public charge points will be supported by trial IT systems to support the research. The trial IT systems will comprise of a Charge Point Control and Management System, including an electricity market interface system and associated ICT to facilitate monitoring and metering of the mobile load and maximum flexibility in settlement in order to examine the possible options.

This level of infrastructure nationally is necessary to support adequate research enabling access to the unimpeded behaviour of private car owners as part of the research and will allow for a review of the likely usage for both short and long journeys. (e.g. though there may be no private EV’s in Donegal, we need to examine what is the likely usage of public charge points by the EV owners outside the obvious expected catchment area). In addition, by having a national distribution it facilitates a wider spread of EV ownership as part of the trial.

In order to avoid excessive costs for the pilot and to minimize the risk of stranded investment, ESB Networks intends to maximise the usage of existing market systems and processes. The pilot rollout will involve net up-front spend in the region of €30.7M. External funding sources will be accessed to reduce costs required from regulatory sources such as EU grants, motor company contributions in kind and where possible financial contributions will be sought from relevant stakeholders.
1.2 Overall Project Objectives and Project Scope
The objectives of this project are to evaluate from a technical, environmental and economic viewpoint, the impact that the potential large scale rollout of EVs will have on the electricity networks and load metering and settlement with a view to maximising the benefits and minimising the negative impact of same. The specific objectives of each work package are set out below:

**WP1: Demonstrate technology passively deployed and resultant physical system impact**
- To identify suitable charging equipment for the trial of Home, On-Street, Commercial and Fast Charging solutions.
- To develop a suitable method of electrical connection for the trial infrastructure to ensure safety and minimal system impact.

Figure 3: Research Project Structure - Hosting of EVs on the Distribution Network.

**WP 1 Demonstrate technology passively deployed and resultant physical system impact**
- To identify suitable charging equipment for the trial of Home, On-Street, Commercial and Fast Charging solutions.
- To develop a suitable method of electrical connection for the trial infrastructure to ensure safety and minimal system impact.
• To review the options for meter system operator functions at the on-street charge point – Metering equipment installation and meter reading.

• To prepare guidelines for physical installation of the trial charging infrastructure to ensure a uniform and safe installation of the chargers, to adhere to safety standards and ensure an aesthetically pleasing end product as far as possible.

• Install the on-street public and home trail charge points.

• Identify the charging characteristics of the various cars on the market with a view to disturbing effects, load pattern, etc

• Observe and study customer behaviour with regard to all types of charging

WP 2 Optimise the charging infrastructure connections, metering and safety standards

• Determine the physical and electric characteristics and load measurement of charging equipment that suit the Irish Distribution infrastructure, to ensure public safety and facilitate metering and settlement

• Determine the best installation and connection arrangements (civil and electrical) that are best suited to Ireland and based on information collected in WP1, develop draft location guidelines for on-street Charge Point installation from a physical viewpoint

• Understand the developing standards and interoperability requirements that are under consideration on an international basis and ensure that the safety, metering and installation standards imposed for Ireland are future-proofed to new charge points that may be installed on full take up of EVs.

• Draw conclusions on the optimum charging infrastructure connections, metering and safety standards for mass deployment which will be supplied to WP4 to design the overall connection standard

WP 3 Smart Charging and Network Operation

• Quantify the likely problems of uncontrolled charging for local distribution networks, based on the results of WP1

• Consider simple technical solutions to charging issues that can be integrated on electricity networks which will minimise the need, (if any) for network reinforcement to host EVs.
• Demonstrate improved methods for management of home charging, network operations or network devices that can increase hosting capacity on the network.
  • With third party suppliers, investigate advanced smart charging solutions that can:
    • satisfy customer charging needs
    • Minimise the need for network reinforcement through ensuring that ev charging, in so far as is possible, will not contribute to local peaks,
    • Facilitate flexible charging which may be leveraged by other market players (e.g. EirGrid, supply companies, service providers) to increase the amount of renewable generation on the system.
    • Facilitate flexible charging which may be leveraged by the customer and their supplier to minimise the cost of charging by availing of low wholesale market prices.
  • Investigate the potential cost and benefit of “Dumb” Charging vs Simplistic “Smart Charging” vs “Advanced Smart Charging” and consider what obligations should be imposed on EV owners in terms of home EV charge management.
  • Establish technology protection and control for managing EV charging in system emergencies

**WP 4 Network Planning**
  • To determine rules for the number of charge points allowable on any network sector
  • To ensure that in future new LV networks built for new housing schemes and single houses can accommodate the extra electricity demand that will arise from electric vehicles
  • To understand the capital cost implications of building networks than can accommodate a foreseeable level of EV penetration
  • To design connection standards in term so allowed charging level, flexibility and control for home charging.

**WP 5 Establish the potential impact of EVs on the DUoS average unit price**

This will account for factors including :
  • Current EV charging patterns and characteristics
  • EV driver charging behaviour
  • Increased energy demand based on projected annual driving rate
  • Projected operational costs of IT systems to facilitate settlement of EV charging
• Projected operational costs for implementation and management of EV Charging infrastructure

• Projected development of EV battery capacity and consequential impact of energy demand

WP 6 Facilitating a competitive market structure

• Home charging is expected to be the pre-dominant method of charging EVs. It is anticipated that the existing standard domestic meter will be sufficient to accommodate the load of the EV, however this will be guided by WP4, in any case – it should fit in to existing meter and settlement processes.

• Review the options of simplistic meter operation function for on-street charge point locations (for example allocating each meter point as an MPRN, with a single entity responsible for all the charging that takes place at that charge station and following standard MRSO processes. Note WP1 will dove-tail with this also as location of such metering equipment will be an influential issue.)

• Review a more flexible/advanced system which can track the usage of a car or customer and allow aggregation of this load to their chosen supplier for settlement, and provision of this information back to the supplier to facilitate the supplier billing of EV customers.

• In conjunction with a third party, implement a flexible/advanced system which will interface with existing MRSO systems to demonstrate a possible mechanism by which this could be implemented for the full market in the future.

WP7 EU Projects

• To gauge and participate in the creation of standards necessary to operate a safe, open, efficient and interoperable EV charging system

• Ensure the voice of the Irish DSO is heard and that the specific situations that exist on the home network are addressed in the context of charging standards being developed internationally

• To harvest knowledge essential to the efficient and safe facilitation of infrastructure on the Distribution system

• To reasonably ensure future proofing of infrastructure installed for the trial so that it can be used to serve the ongoing need into the future, thereby maximising the value of the trial investment
• To mitigate against any negative effects of EV charging through knowledge gained and network planning.

• To derive EU funding to support this research.

**WP 8 Project Management**

• The organisational structure, roles and responsibilities that will allow ESB to manage the project

• The flow of information regarding the project to all stakeholders

• The processes and procedures used to establish and manage the project

**1.3 Project Deliverables**

**Periodic Deliverables**

The project will be required to provide periodic reports to share with CER and other key stakeholders such as DCENR and licensed suppliers:

⇒ Six Monthly progress report for CER

⇒ Quarterly or more frequent report for cross industry groupings

**Bi-annual Deliverables**

Present to the project board

⇒ The project progress versus the project plan

⇒ The results emerging trial

⇒ Report to the CER

**Final Deliverables**

The project will deliver a full report detailing the results of the project across each work package. (See Appendix 3 for summary of deliverables)
1.4 Project Benefits

The significant benefits of these projects are that if they are successful they will deliver long-term savings in the infrastructure costs involved in connecting and operating the distribution network, give insight into likely load management issues and requirements, help to anticipate and mitigate any negative grid impacts that might result from large scale adoption of EVs. The project will confirm the ability of the low and medium voltage network to accommodate a large scale electric vehicle roll out as is anticipated into the future and identify any steps that may be necessary to increase this capacity if required.

1.5 Key Assumptions

The key assumptions that span all of the project streams are as follows:

⇒ Availability of ESB Funding for the project and Regulatory recovery of same
⇒ Availability of adequate technical resources for the project
⇒ Availability of equipment to ESB specifications for the trial
⇒ Ability to engage and secure hosting sites at suitable locations and Local Authority and Commercial hosting support for same
⇒ Availability of EVs from manufacturers for trial
⇒ Availability and engagement of private EV drivers to participate in trial
⇒ Purchase of EVs by private individual and commercial organisations
⇒ The Support of key stakeholders for the project
  o CER
  o Industry energy suppliers
  o EV Owners
  o DCENR (to incentivise private EV ownership take-up)
  o Dept Environment/ Local Authorities
  o OEMs
  o Equipment Manufacturers
  o Commercial Hosts
  o EU bodies

1.6 Risk Assessment

*The main project risks include:*

International
  • Absence of international reference sites
  • Absence of defined international standards for charging

Product
  • Lack of suitable product availability


- Leading edge technology

Stakeholder
- Absence of key stakeholder support for trial
- Lack of suitable hosting locations
- Absence of private EV driver participation

Safety
- Absence of connection and wiring rules in EV charging space

Finance/Funding
- Non-approval of Funding by CER
- Increased cost scope due to complexity of the project

This project has been classed as having a class A risk rating. Please see below:

1.7 Timescales / Key Milestone Dates
The detailed project plan has been compiled on a Microsoft project Gantt chart. The project is expected to take 3 years to complete. The high level deliverable timelines are also listed in Appendix 3.
1.9 Project Structure (Governance and Accountabilities)

Project Board Meeting Frequency: Six Monthly
Project Meetings: Fortnightly

<table>
<thead>
<tr>
<th>Role</th>
<th>Responsibility</th>
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</thead>
<tbody>
<tr>
<td>Project Board</td>
<td>• Represent the business interests of the project</td>
</tr>
<tr>
<td></td>
<td>• Confirmation of project tolerances at start of project</td>
</tr>
<tr>
<td></td>
<td>• Escalate outside project boundaries as appropriate</td>
</tr>
<tr>
<td></td>
<td>• Articulate the vision of the project and represent the respective business/functional areas</td>
</tr>
<tr>
<td></td>
<td>• Provide authority to change</td>
</tr>
<tr>
<td></td>
<td>• To attend all Project Board Meetings</td>
</tr>
<tr>
<td><strong>ESB Networks Electric Vehicles</strong></td>
<td><strong>Project Brief</strong></td>
</tr>
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</tbody>
</table>

| **To ensure appropriate Business and IT support to the Project is fully available as required** |
| **To resolve issues escalated to Board Level** |
| **To ensure Project is fully informed of emerging issues that impact project deliverables** |
| **To assist Project Executive in approving or rejecting project managers’ recommendations and sign-off on deliverables** |
| **To ensure as a Group that the key objectives of the project take precedence over individual needs of any single business area** |

<table>
<thead>
<tr>
<th><strong>Project Manager</strong></th>
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<tbody>
<tr>
<td><strong>The primary interface and escalation point to senior ESB Networks management for the project</strong></td>
</tr>
<tr>
<td><strong>Managing the project deliverables to budget, time and quality</strong></td>
</tr>
<tr>
<td><strong>Informing, directing and managing changes of scope to the overall project</strong></td>
</tr>
<tr>
<td><strong>Managing the project processes and deliverables – attending formal reviews, management reviews</strong></td>
</tr>
<tr>
<td><strong>Timely escalation of issues and risks to Project Board that cannot be resolved at project level.</strong></td>
</tr>
<tr>
<td><strong>Timely escalation of any deviations from agreed tolerances to the Project Board</strong></td>
</tr>
<tr>
<td><strong>Taking responsibility for change control and any required configuration management</strong></td>
</tr>
<tr>
<td><strong>Reporting to Project Board through status reports</strong></td>
</tr>
<tr>
<td><strong>Identifying and obtaining any support and advice required for the planning, management and control of the project</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Project Support Office</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set up Project Management processes and structures including roles and responsibilities for managing the IT project in the e-cars programme</strong></td>
</tr>
<tr>
<td><strong>Support the Project Manager in the creation of project plans, Project Implementation Document (PID) and Governance documents</strong></td>
</tr>
<tr>
<td><strong>Creation of a high level plan and identification of interdependencies across the project both internal and external.</strong></td>
</tr>
<tr>
<td><strong>Provide Project Support to the Project manager</strong></td>
</tr>
<tr>
<td><strong>Provide progress reports to the MD and Project Board on the research</strong></td>
</tr>
<tr>
<td><strong>Manage Risks (development of contingency plans), Issues, actions and Changes across the programme</strong></td>
</tr>
<tr>
<td><strong>Facilitate Project status meetings and manage the project reporting process</strong></td>
</tr>
</tbody>
</table>
- Ensure quality is managed and maintained for the project
- Support the Programme Manager with Resource Planning
- Liaison with external groups to track dependencies and support stakeholder management
- Preparing the Lessons Learned and Project Closure Report
- Ensure compliance to and consistency with ESB Networks processes and procedures
- Responsible for maintaining the project governance framework
- Monitoring the Project mailbox (if required)
- Ensuring project documentation is stored on SPS
- Management of project SPS

**Project Team**

- Ensuring agreed milestones and deliverables are achieved
- Attending scheduled project team meetings when necessary
- Keeping the Project Support Office updated/informed of project status
- Escalating issues to the Project Support Office in a timely manner
- Highlight resource needs to the Project Support Office
- Maintaining excellent communication with project team members and key project stakeholders.
- Providing continuous input and feedback to the Project Support Office on lessons learned
- Adding value where possible
1.10 Project Financials

Reporting framework for Cost Estimates to Date and to Completion

The assumptions detailed below represent ESB Networks’ best current estimate of the resources and materials required to deliver the EV Trials Project per the terms of the project (subject to agreement with CER). The total budgeted project costs are detailed in the table below.

The main financial components of the EV trial project are:

1. Infrastructure costs
2. ICT
3. Resource staff costs
4. Information Dissemination
5. EU Grants received and income received

The costs to be incurred during the EV trial project are mainly infrastructural in nature; please refer to the table below for details.

Glossary of cost components:

1. ICT costs refer to necessary supporting IT infrastructure such as charge point management systems, settlement engines, customer relationship management systems, web interfaces and all necessary B2C and B2B interfaces.
2. Infrastructure costs are equipment, contractors’ and direct ESB Networks’ installation costs
3. Dissemination refers to costs associated with public awareness initiatives including launches of charge points, and the safety associated with them, agreements with partners, social media and advertising campaigns in both print and other media. Additionally it refers to the wider sharing of results and management of the website for same.
4. EU Grants are received for research, studies and installations work. Income is also to be sought from host locations where installations may take place or are planned

Whilst acknowledging CER’s view that the maximum allowable recovery of costs will be €25m, our estimates suggest a gross outlay of €30.7m is required to complete the trials and the breakdown of costs shown below reflects this. We will continue to seek best value in our initiatives that are currently underway in the business to maintain spend within €25m but some modification of scope may also be required.

The forecast figures are provisional best estimates available at this time. ESB Networks proposes to provide CER with a formal project update on a half yearly basis, one month after the end of each calendar half year.
Note; ESB Networks estimate the cost of the project would be of the order of €30.7M. This figure is already reduced from the level that would have been required as, significant efficiencies have already been achieved, for example, through collaboration IT element of the project. We expect further such savings and therefore the resultant reduction means that a final figure of €25M is sought. More detailed breakdown of this cost is not included due to it being commercially sensitive information.
WP 1 – Demonstrate technology passively deployed and resultant physical system impact

Description
It is imperative that the infrastructure that we install in this pilot project, meets the needs of current and initial EV drivers throughout Ireland whose charging behaviour, will be used to inform our research. We must ensure that a cost effective but technologically suitable solution is used. Some diversity will be required to ensure different types of charging in different locations are accommodated. This new infrastructure must be safe and reliable, and should not impede or hamper current road and footpath users. EV usage must also be monitored and studied to ensure that we can identify growth, clustering patterns and areas of demand.

Objectives
• To identify suitable charging equipment for the trial of Home, On-Street, Commercial and Fast Charging solutions.
• To develop a suitable method of electrical connection for the trial infrastructure to ensure safety and minimal system impact
• To review the options for meter system operator functions at the on-street charge point – Metering equipment installation and meter reading.
• To prepare guidelines for physical installation of the trial charging infrastructure ensuring a uniform and safe installation of the chargers which adheres to safety standards and ensures an aesthetically pleasing end product as far as possible
• Install the On-street public and home trial charge points.
• Identify the charging characteristics of the various cars on the market with a view to disturbing effects, load patterns, etc
• Observe and study customer behaviour with regard to all types of charging

Scope

System Impact
As part of this project, the resultant physical system impact will be monitored and studied to gain practical, informed experience on the MV and LV networks. The 18 ESB electric cars, along with approximately 40 “yellow” truck ESB Vehicles will be used in the trial. In addition to this, up to 350 private car owners will be asked to take part in the trial. Using a range of different cars and at least 6 different types of DC fast charger (off-board), representative charging profiles for standard and fast charging will be delivered. The parameters measured will include power, energy, current, power factor and harmonic levels. These will help ESB Networks to develop different connection and charging models and assist with input inform planning models.

Charge Point Installation
The types of charger that ESB Networks intends to install will include

- AC Public Chargers
- AC and DC Public Fast Chargers
- Home Chargers

Small quantities of other chargers will be demonstrated based on their likelihood of penetration or other value drivers. These may include induction charging, special chargers for two-wheeled vehicles and fast chargers with battery storage.

<table>
<thead>
<tr>
<th>Charger Types</th>
<th>Plug Types</th>
<th>Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AC Public Chargers</strong></td>
<td>3 Pin</td>
<td>Expected limited use for electric bikes, Riva, etc</td>
</tr>
<tr>
<td></td>
<td>AC Type 1</td>
<td>Expected limited use for public charging</td>
</tr>
<tr>
<td></td>
<td>AC Type 2</td>
<td>Expected widespread use</td>
</tr>
<tr>
<td></td>
<td>AC Type 3</td>
<td>Not used in Ireland</td>
</tr>
<tr>
<td><strong>DC Fast Chargers</strong></td>
<td>Cha-De-Mo</td>
<td>DC Fast Charging</td>
</tr>
<tr>
<td><strong>Home Charging</strong></td>
<td>3 Pin</td>
<td>3 pin cables using the existing home circuit (small number only as this will not be the future solution)</td>
</tr>
<tr>
<td></td>
<td>AC Type 1</td>
<td>Currently used on some home chargers with tethered cables</td>
</tr>
<tr>
<td></td>
<td>AC Type 2</td>
<td>Widespread use for home charging</td>
</tr>
</tbody>
</table>

**AC Public Chargers**
The Trial AC Public charging infrastructure will be installed nationwide in locations such as on-street, shopping centres, car parks, train stations, supermarkets, etc which are the most likely sites suitable for on-street chargers in the trial period and in the future. The majority of the public charge points installed will be rated at 22kW (3-phase, 32A). Some AC chargers will be located alongside DC Fast Chargers in service stations to cater for vehicles without fast charging capabilities. AC chargers will be connected to the ESB Networks LV system in cooperation with ESB Networks Engineering Officers (EO). An interface pillar or vault will be designed and used as a connection point to the network. This will also house an RCD and point of disconnection. The location for a meter will be reviewed. The EO will ensure that there is suitable capacity available at the substation.

**DC Public Chargers**
The location of Fast Charge DC Points will be at intervals along inter-urban routes at service stations and roadside services. These sites will be strategically located on major routes to allow for regular charging within an acceptable vehicle mileage range. The selected fast chargers will have a single 50kW DC outlet or a 43kW (3 phase 63A) AC
outlet. Following usage and demand studies, additional fast charging points may be required on these sites as EV usage grows. These units will be connected to the ESB Networks LV system in a similar manner to the AC Chargers, subject to network specific technical acceptability assessment as are undertaken for all new load connections, and any reinforcements deemed necessary.

**Home Chargers**

It is envisaged that AC Home Charging will make up the majority of daily charging as EV owners will do a full 100% slow charge overnight at their home. This home charger will be connected to the domestic electricity supply by a qualified electrician. The charger used for the trial will be mounted in a suitable outdoor or indoor garage location to allow charging. The charger will be connected on its own electrical circuit and connected to an RCBO (a protection device which will trip the appliance if it becomes overloaded) on a dedicated circuit off the consumer unit. EV drivers may choose to charge at home overnight at a lower night rate tariff. Most houses in Ireland have a single phase supply and the charger is typically rated at 3.7kW (16A), but others may also be reviewed.

**Charging Modes**

Part 1 of IEC 62196 is applicable to plugs, socket-outlets, connectors, inlets and cable assemblies for electric vehicles, intended for use in conductive charging systems which incorporate control means, with a rated operating voltage not exceeding:

- 690 V a.c., 50 – 60 Hz, at a rated current not exceeding 250 A;
- 600 V d.c., at a rated current not exceeding 400 A.

The standard references the charging modes defined in IEC61851-1 which includes:

<table>
<thead>
<tr>
<th>Mode</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode 1</td>
<td>Slow charging from a household-type socket-outlet</td>
</tr>
<tr>
<td>Mode 2</td>
<td>Slow charging from a household-type socket-outlet with an in-cable protection device</td>
</tr>
<tr>
<td>Mode 3</td>
<td>Slow or fast charging using specific EV socket-outlet with control &amp; protection</td>
</tr>
<tr>
<td>Mode 4</td>
<td>Fast charging using an external charger</td>
</tr>
</tbody>
</table>

The IEC 61851-1 standard documents the pilot signal flagging the charging requirements by using pulse width modulation. The pilot signal is integrated in the plugs of IEC 62196 electric vehicle charging equipment as a requirement for higher currents.

**Plug Types**

The list of IEC 62196-2 plug types includes;

- IEC 62196-2 "Type 1" - single phase vehicle coupler
• IEC 62196-2 "Type 2" - single and three phase vehicle coupler
• IEC 62196-2 "Type 3" - single and three phase vehicle coupler with shutters

Other Charging Technologies
A number of alternative charging solutions will be identified and tested for suitability. These include:

Static Inductive Charging – Where the EV is equipped with a plate under the car and a similar plate is located in the ground. This will allow for wireless inductive charging. A suitable location might be in a driveway or garage or it could also be used in taxi ranks.

Dynamic Inductive Charging – This technology will allow for the EV to be charged while it is moving. It will require a significant infrastructure to be laid with a continuous plate being fitted to the roadway.

Public Charge Point Locations
The locations of EV charge-points for the trial are determined by selecting locations of greatest potential public benefit for the trial, and achieving a reasonable spread of charge-points to counteract range anxiety. As EV penetration increases this rollout must be informed by emerging trends in their distribution to leverage the benefits of early EV ownership for the trial. Detailed monitoring of EV usage will be required to develop a view of how EV owners use and charge their cars. In-depth analysis will be required to highlight areas of high usage, low usage, evidence of queuing and delays, etc. Usage data will also highlight the use patterns of of EVs including for for short local journeys, daily commuting or long distance journeys. Knowledge of EV sales growth and demographics will also assist in generating a profile of use of on-street and home charging.

The location of charge points will be selected using criteria which will ensure the charge point is in an easily accessible and safe location. A number of criteria will have to be adhered to, to ensure a high level of usability:

<table>
<thead>
<tr>
<th>Location Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobile Phone Signal</td>
<td>The charge points will require a GPRS signal to allow communications. The location will be required to have a strong mobile phone signal to operate the charge point.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Accessibility to public points to be assessed both for public ease and safety of use and to facilitate suitable interior access for maintenance and repair.</td>
</tr>
<tr>
<td>Parking</td>
<td>The possibility of a dedicated parking bay will need to be investigated.</td>
</tr>
<tr>
<td>Location on footpath</td>
<td>The physical location on the footpath must be studied to develop a standard approach.</td>
</tr>
<tr>
<td>Location relative to ESBN network</td>
<td>Locate ESB mains of adequate capacity</td>
</tr>
</tbody>
</table>
Location relative to parking space

<table>
<thead>
<tr>
<th>Location relative to parking space</th>
<th>Location relative to parking spaces, Side by Side parking/ Parallel Parking, etc.</th>
</tr>
</thead>
</table>

**Mechanical Protection**

Bollards or fenders may be required to provide mechanical protection of the charge point. Earthing of associated protection must also be investigated.

**Interface Pillar Location**

Location, physical design, earthing, access, etc.

---

**Customer Behaviour**

The knowledge gained through these project elements will inform an analysis of the impact of charging patterns on electricity networks, resulting in the identification of suitable solutions where risks are identified.

The collection of soft data will also be required in order to gain a better understanding of EV owners’ intentions and attitudes in the area of charging behaviour. Customer surveys will help to complete the overall picture of charging behaviours and will feed into the EV charging models.

**Home Charging vs. Public Charging**

Indications from the limited trials done to date indicate that the level of home charging is higher than was anticipated would be the case. It is not clear as yet whether this is a customer preference, or a necessity due to the lack of public charge points. Further trials need to be done on this aspect of customer behaviour to establish potential changes in home wiring policy, and in the DSOs domestic connection policies. These will also inform the level of use of various means of charging at public charge-points and the associated network reinforcement which may be necessary. It may also be necessary to establish the demand for other technology types that may also leverage electrical charging infrastructure, for example electric scooters or bicycles.

**WP1 Deliverables and timeline**

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Identify the most appropriate connection types for use with EV chargers for the trial (This work is already complete)</td>
<td>Complete</td>
</tr>
<tr>
<td>1.2</td>
<td>Identify the most suitable charge points for home, on-street, commercial and fast charger locations for the trial (This work is already complete)</td>
<td>Complete</td>
</tr>
<tr>
<td>1.3</td>
<td>Determine the likely distribution of existing EVs during the trial period and required number of charge point installations to enable their use across the country. Install the charge</td>
<td>Q4 2013</td>
</tr>
</tbody>
</table>
1.4 Determine the effect on voltage & load of the connection of EVs to both tailed and interconnected networks in urban & rural areas  
Q2 2014

1.5 Determine the effect that No1.2 will have with the incremental addition of EVs to the various networks  
Q2 2014

1.6 Measure the electrical characteristics for different EV models and how they perform with the various charge points. Metrics to be monitored include harmonics, load, current, and others.  
Q2 2014

1.7 Measure the degree of co-incident charging of multiple vehicles on urban LV network  
Q2 2014

1.8 Determine relative use of public charging versus home charging to establish likely future impact on network.  
Q2 2014

1.9 Establish demand for other technology types (e.g. electric scooters / bikes) for public charging, accounting for the charging mechanisms associated with these technologies.  
Q4 2014
WP 2 – Optimise the charging infrastructure, connections, metering and safety standards

Description
In order to develop a reliable and safe electricity we must develop an in-depth knowledge of new electrical equipment which interacts with the electrical network and is not covered by existing standards. We must ensure that the equipment is suitable for the Irish market and environmental conditions and that it can provide functionality to allow for metering, settlement and interoperability.

We must ensure that good standards are developed around safety, installation and civil works for future installations. It is hoped that the charging infrastructure rolled out for this trial will be representative of what can be expected in the future and therefore any standards developed will be future proofed.

Objectives
From information collected in the infrastructure design and installation stage of WP 1, optimise the charging infrastructure, connections, metering and safety standards for mass roll out.

- Determine the physical and electric characteristics of charging equipment that suit the Irish market and technical infrastructure, to ensure public safety & facilitate metering and settlement
- Determine the installation and connection arrangements (civil and electrical) that are best suited to Ireland, and based on information collected in WP1 develop draft location guidelines for on-street Charge Point installation from a physical viewpoint.
- consider the ability of existing domestic metering systems to accommodate the additional load.
- review how on-street charge points could be metered to fit in with existing MRSO processes, including MPRN responsibility and metering mechanisms-(installing a meter to measure the load of the charge point will be carried out in conjunction with WP6).
- Understand the developing standards and interoperability requirements that are under consideration internationally and ensure that the safety, metering and installation standards imposed in Ireland are future-proofed to new charge points that may be installed on full take up of EVs.

Scope

Equipment Suitability
Safety of the public and any technicians or other associated workers at public charge points will be of paramount importance in this process. This project element will inform
further assessment of any public safety issues in relation to all charging infrastructure to be installed and connected to the Irish electricity system, including both domestic and public street charging infrastructure.

EV charging infrastructure provides a new electrical interface for customers for which there is not at present a specification. It is a core duty of ESB Networks to obtain a thorough understanding of the technology available and work with the regulatory bodies to ensure adequate procedures are in place for its safe installation, maintenance and utilisation. The initial roll out of charge points, in the home and on-street as identified in WP1 will ensure that these standards can be developed and knowledge gained on the safety performance for wider deployment of the technology. It is also of importance that these initial installations are undertaken by technicians who have dedicated training and experience in electrical safety and a high level of safety and hazard awareness. This is assured by their being undertaken by ESB Networks staff or approved personnel.

All chargers will be fully inspected and assessed by our engineers to ensure safe

- Structural integrity
- Electrical testing and commissioning
- Preventive maintenance inspections
- Security from interference
- Environmental impact
- Reliability and recording of faults

From the various models of charge points installed and the knowledge attained from the initial carefully managed roll out, the generic safety measures and standards required of future public and home charge points will be developed. The charge point infrastructure may need to have embedded equipment standards relating to metering and charge event management. This requirement will be dependent on the outcome of WP6, identification of any Interoperability issues, and input from CER and the Electricity industry on possible market structures. The capability of charge points to serve the possible requirements will be considered in this work package.

**Connection Methods**
The physical connection method for public charging infrastructure will be investigated to identify all suitable methods and location requirements. It is envisaged that public chargers will be connected to the LV network via an interface pillar. Other possible connection methods include;

- Direct connection to LV
- Connection via the public lighting infrastructure
- Connection via the MV network using a transformer. (overhead or cabled)
- Other connections via renewable energy equipment coupled to a transformer.
The civil installation of on-street chargers will involve the installation of the unit on a public footpath or in a public car park. Possible installations will include concrete plinth mounted chargers or some units bolted to the existing footpath or concrete base. A number of options may arise due to the various charge units available on the market. Some manufacturers may use bolted solutions, concrete set solutions or a hybrid version. The units should be replaceable so that if a unit fails, it can be easily removed from the field and replaced with another unit. This will prevent the need to repair in situ allowing the unit to be repaired in a more suitable or controlled environment.

All these issues need to be considered when developing the physical connection standards for charge points. It is hoped that these can be generic and applicable to all future types. In addition to this, the location of metering requirements will be identified, which may influence or form part of the standard connection procedure.

**System Interoperability**

In conjunction with WP 6, it is intended to develop a metering methodology by which an EV owner / operator will be free to purchase from a multitude of suppliers. The DSO, acting to serve the customer:

- Must not preclude choice by virtue of the limitations of physical/ electrical design or proprietary Charge Point Management. This would introduce an element of supplier “lock-in”. This is best ensured by pursuing the sub-items below

- Ensure interoperability between charge points deployed as part of the trial including in with technology prevalent in other jurisdictions (notably Northern Ireland)

- Ensure that any system installed as part of this trial will conform to any European interoperability standards emerging from ongoing standardisation body agreements or by law.

- Minimise costs to DUoS Customer through ensuring electrical and market Interoperability of trial EV Charging infrastructure and in doing so, set the direction for future EV charge point deployment

Interoperability must be a key feature of charge points and the supporting IT systems to enable choice and unrestricted competition. This will ensure that the charge point will be able to interface with multiple car /electric bicycle /scooter models and manufacturers and that energy can be procured from multiple suppliers. The scale and complexity of this challenge, which has not yet been addressed by any other country, is significant and needs to be addressed by the electricity sector if deregulation is to be respected. ESB Networks, as the Meter Registration System operator, will scope and test how this can be delivered. Therefore this trial includes the implementation of IT and electrical systems piloting the delivery of this market
interoperability to establish the full range of practical challenges and associated incremental costs. To deliver this, the trial will include a full review all pertinent standards and make recommendations on their appropriate application in Ireland for any subsequent national roll out so as to minimise the cost to DUoS customers.

**WP 2 Deliverables and timeline**

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due By</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Measured impact of environmental factors and public behaviour on integrity of safety standards for charging infrastructure in controlled trial.</td>
<td>Q3 2014</td>
</tr>
<tr>
<td>2.2</td>
<td>Monitoring of physical integrity of cabinets</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>2.3</td>
<td>Assessment of safety of physical location, protection systems and vehicle interface</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>2.4</td>
<td>In Conjunction with WP 6 Development of standard EV Charting/Billing/Metering system for the trial which still facilitates choice of supplier, but minimises costs through standardisation.</td>
<td>Q3 2014</td>
</tr>
<tr>
<td>2.5</td>
<td>Technology Acceptance Report – This report will assess the current state of technology acceptance across Europe. The report will review the position of the European Commission, the OEMs and other significant stakeholders. Following from the assessment, recommendations will be made for infrastructure standardisation in Ireland, so as to ensure interoperability of connection</td>
<td>Q3 2014</td>
</tr>
<tr>
<td>2.6</td>
<td>EV Charging Electrical Protection Report – This report will review the relevant standards relating to Electrical protection. Furthermore it will review the current recommendations of the OEMs regarding protection in relation to the vehicle, including cost implications of requirements of the applicable IEC standards. The report will recommend protection implementation for future installation reflecting best practices</td>
<td>Q2 2014</td>
</tr>
</tbody>
</table>
| 2.7 | Develop policies and standards for Ireland:  
→ Physical connection of Public and home charging  
→ Requirements of charging infrastructure  
→ Metering requirements for public charging infrastructure | Q2 2015 |
WP 3 – Smart Charging and Network Operation

Description
As outlined above, limited trials to date have shown that uncontrolled EV charging would result in significant increased load on the distribution network that would be coincident with existing peak load and therefore could potentially drive the need for costly network reinforcement.

The distribution network is designed to carry electricity to customers at the time of local peak loading. Therefore, electrical network installation and reinforcement costs are driven by local peak loading conditions. Avoiding unnecessary increments to this peak is essential to minimise the impact of EVs on the distribution network.

In addition, the EV load will have the potential to be flexible, enabling users and energy companies to use this as ballast for variable renewable generation or to avail of low wholesale market prices. It is essential from both the public and a network operator viewpoint that this can not be done to the detriment of the DUoS customer.

This work package will assess for the potential for smart charging. It will also work with third party providers to investigate the technical possibility of smart charging and how it may be possible to manage the EV charging so as to minimise the need for network reinforcement while delivering the needs of the EV user. In addition smart charging will need to facilitate this load being used as a flexible demand which could be used by other market players to deliver a wider set of objectives.

Objectives
The objectives of the work package are as follows:

- Consider simple technical solutions to charging issues that can be integrated on electricity networks which will minimise the need, (if any) for network reinforcement to host EVs by avoiding existing peak loading times and ensuring no new peak loading situations are created.
- Demonstrate improved network operations or network devices that can increase hosting capacity on the network.
- With a third party suppliers, investigate advanced smart charging solutions that can:
  - satisfy customer charging needs
  - Minimise the need for network reinforcement through ensuring that EV charging, in so far as is possible, will not contribute to local peaks,
  - Facilitate flexible charging which may be leveraged by other market players (e.g. EirGrid, supply companies, service providers) to increase the amount of
renewable generation on the system in a safe manner which does not disadvantage other network users

- Facilitate flexible charging which may be leveraged by the customer and their supplier to minimise the cost of charging by availing of low wholesale market prices in a safe manner which does not disadvantage other network users

- Establish technology for the protection, control and management of on-street EV charging to help in system emergencies

**Scope**

The scope of the project is to assess the potential for and impact of “Smart Charging” and “Smart Operations”, demonstrate some solutions and quantify the benefits to inform future connection and planning policies.

The project will include the following elements to examine **Smart Charging at Residential Charge Points:**

**This entails expansion of the on-going Urban demonstration Site, at Roebuck Downs in South Dublin, to demonstrate Smart Home and Smart Network to facilitate increased Charging including:**

- Installation of power quality meters and smart meters to confirm the impact of the smart charging behaviour on an interconnected urban circuit.

- Modelling of circuits in high performance simulation software to inform safe and effective trial deployments and verification that the results measured on the ground are similar to the modelled results.

- Working with partners on the EU funded Green eMotion project to develop solutions which will increase the hosting capacity of Electricity Networks – (while the site selected is the Roebuck Downs network circuit, these solutions could work on any looped LV circuit and be of benefit to increase the hosting capacity of both street chargers and home chargers).
  - Assess the physical implications of equipment in terms of size and sighting
  - Assess the performance in terms of operational management
  - Assess the safety requirements for such an installation
  - Provide multiple EVs for a suitable assessment period to demonstrate the impact of the soft open point.

- Working with partners in facilitating the trial of Smart Charging Units in homes that have an EV or potentially will be EV owners.
  - Set up appropriate legal and data sharing agreements with project partners
• Working with partners on the development of smart charging units through informing on the need for local voltage monitoring by the charge unit and considering how network capacity can be integrated in smart charging. ESBN and project partners will work with a wide range of stakeholders from across the electricity industry including suppliers/energy service providers/system operators to address smart charging from the view of facilitation of renewables/charging to avail of low wholesale market prices/Charging to facilitate system stability in terms of frequency response for home charger.

• Enlisting customers to be part of the trials in the Roebuck downs trial area:
  o engaging with regard to measuring their EV charging behaviour
  o as appropriate and consented to by the customers, facilitating 3rd party engagement in relation to installation of technologies.
  o provision of EVs to demonstrate the impact over demonstration periods

• Enlisting customers who are EV owners across the country with EVs to participate in the trials.

• Develop and test appropriate real time monitoring and analytical systems to interact with 3rd party energy management unit, to allow demand response in a fast, safe and secure manner which does not compromise rights of any network user

• manage agreements regarding the collection and treatment of information for the purpose of informing this trial

• Set up a second trial area to demonstrate home smart charging in a rural site similar to Roebuck downs with intensive metering and measurement to demonstrate the impact of EVs on LV circuits and un-earth the loading and safety issues with same.
  o Engage up to 5 customer on a typical LV overhead group
  o Lend electric cars to these customers (From the 15 cars that ESB have)
  o Install smart meters to measure the effect of the EV charging – before and after the deployment of the EVs.
  o Demonstrate the consequence of dumb charging on rural networks by deploying EVs for 8 weeks
  o Install simplified smart charging – Delayed charge or time limited charge with boost facility
  o After the above step, Install Smart Charging units, designed by the project collaborator, to define the further benefit of more advanced smart charging.

• Simulate the consequents of both simple and advanced smart charging
The project will include the following elements to examine the potential management of On-Street Charge Points.

Develop a pilot of a single management CPMS (Charge Point Management System) to control a diverse fleet of charge points from a range of manufacturers that comply with a standard protocol (The Open Charge Point Protocol or OCPP). This protocol enables a high level of control over charging events both individually and on a wider scale which may be needed in the case of wider network emergencies (38kV network fault/110kV network fault) or indeed system-wide failure.

Design the system to allow a range of commands to be sent to charge points, which can support load management, both as an ancillary service and potentially automatically in the case of network or system emergencies.
Virtual Spinning reserve is a service that can be provided to the TSO based on a percentage of drivers opting for lower tariffs in exchange for allowing their charge events to be suspended for a period of time. The total virtual spinning reserve provided during an ancillary service request/response cycle would be calculated by the system for payment purposes. Frequency response can be set up for demonstration either as a command based event or one triggered automatically if a system emergency is detected.

Similarly it may be the case that EV users are contracted by 3rd party aggregators offering demand response services. To enable such services while ensuring that network safety and power quality standards are not compromised, and that the needs and rights of all network users are respected, ESBN is developing an automated real time system based on local monitoring and networks analysis which will interact with 3rd party systems. Working with a range of collaborators in an EU wide project, the system will be demonstrated in operation alongside aggregation and communications systems being developed for such purposes.

**WP 3 Deliverables and timeline**

<table>
<thead>
<tr>
<th>No</th>
<th>Deliverables and timeline</th>
<th>Due by</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Report on the potential for advanced Smart Home Charging</td>
<td>June 2014</td>
</tr>
<tr>
<td>3.2</td>
<td>Report on potential benefit of Smart Network operations to increase hosting capacity of EVs</td>
<td>June 2015</td>
</tr>
<tr>
<td>3.3</td>
<td>Report on the potential contribution on-street EV charge points can make to Spinning Reserve.</td>
<td>Dec 2014</td>
</tr>
</tbody>
</table>
WP 4 – Network Planning

Description
Electric Vehicle charging will constitute a significant new type of load on the system. In order to ensue that LV networks will not be overloaded and that adequate voltage will be maintained, it will be necessary to understand the impact of a given % penetration of electric vehicles on the overall peak demand on the networks.

The traditional peak loading for demand customers is well understood at this stage, and the network is sized accordingly. These traditional network planning standards can be considered as a baseline benchmark measure. However, if peak demand for EV charging turns out to be co-incident with the traditional load peak, then significant additional network reinforcement costs could accrue.

This incremental cost will be measured and evaluated in the trial through the data and analysis gained in the trial. This will then establish whether the behaviour of the EV load or operation of the network can be adjusted to defer investment and to quantify the cost savings.

It will be necessary to anticipate the costs of network reinforcement requirements that will arise for various levels of electric vehicle penetration. This will be needed for DUoS revenue controls and is also a prerequisite for WP 5.

In addition to understanding the reinforcement requirements for existing networks for various levels of charging, it may be necessary to amend the design standard for new housing scheme developments.

The design guidance of non-scheme housing (which is generally in rural settings) will need to be reviewed taking account of the knowledge obtained in previous stages.

Objectives
The objectives of this work package are to:

- Quantify the likely challenges of uncontrolled charging for local distribution networks, based on the results of WP1.

- understand the capital cost implications of building networks to accommodate a likely level of Electric vehicle penetration

- Investigate the potential cost and benefit of “Dumb” Charging, Vs Simplistic “Smart Charging” Vs “Advanced Smart Charging” and consider what obligations should be applied in terms of charge management to ensure fairness and appropriate allocation of costs.
• Design the electrical connection standards– including smart charging requirements for domestic EV charging

• design the electrical connection requirements for home and on-street charge points

• ensure that LV networks built for new housing schemes and single houses can accommodate the extra electricity demand that will arise from electric vehicles

Scope

In conjunction with WP3 develop demand profiles for groups of domestic customers with various penetrations of EV

Study the home charging profiles of WP1 representing a range of home charging behaviours and assess the consequent load profile as seen on the electricity network.

Simulate the consequence of “dumb” home charging on typical LV circuits, urban and rural, combining the potential home charging behaviour, with the characteristics of the connection with the network circuit. Identify the range of possibilities based on EV take up within the LV circuit group, (% of households with EVs among the customers connected to the same LV circuit or group), charging behaviour, specific locations or distribution of EVs on a given LV circuit (Start/Middle/End)

Create a set of profiles for electric charging which will be related to the number of vehicles. The profiles will be such that they can be added to the profiles that are already established for conventional load to predict the profile and specifically the peak load of a group of domestic customers with a given penetration of EVs. The predicted peak load can then be modelled against a given network design to check if any elements of the network are overloaded and that voltage is within standard at all points.

The profiles of home charging and charging via public charging points will naturally be very different and separate profiles will need to be created for home and public charging points.

Initially the home EV charging profiles will be based on uncontrolled charging where customers do not have incentives for off peak charging. These will need to be kept up to date in line with observed customer behaviours as time differentiated tariffs evolve.

The outcome of WP3 will be reviewed in terms of how smart charging can reduce the need for network investment.

Evaluate Network Reinforcement Requirements for various levels of penetration of electric vehicles
In order to understand network reinforcement requirements for various levels of EV penetration it will be necessary to set up models for a statistically significant sample of LV and MV networks serving both urban and rural customers. Load flow studies will be run on the sample networks assuming various levels of penetration of EVs and based on the demand profiles determined. The extent of networks found to be overloaded for a given % EV penetration will be determined. In addition to the voltage level, the voltage quality in terms of harmonics and other effects will be modelled. The nature and cost of the required reinforcements to correct any overloading and voltage standard breeches can then be determined.

The extent of reinforcements required and the nature of those reinforcements may vary significantly by network type and location, likely seeing more numerous but lower cost reinforcements required in rural locations.

**Review and revise as necessary the design standards for new housing**
To do this it will be necessary to assume a likely maximum % penetration for EVs. The demand profile and peak loading for that particular level of EV penetration can then be used as the basis for a revised design standard for housing developments.

**Review the non-scheme house (mainly rural) connection design standards**
Rural domestic dwellings are generally connected to single phase networks supplied by single phase transformers. Typically up to 10 houses within a radius of 300m are supplied form a transformer.

The present network is designed with the assumption that an individual dwelling with a maximum electricity load requirement of 12kVA will contribute just 2KW to the peak of their local network. This assumption is based on the fact that all households do not use their electricity at the same time and therefore there is a large diversification factor applied. This method of sizing the design of the system is best international practise and the approximately 2KW level adopted in Ireland has been proved to be correct for Irish network to date. This 2 kW level is known as the After Diversity Maximum Demand (ADMD).

To future proof domestic connections for EV charging it will be necessary to assume that residents could own an EV in the future. This will mean that a higher standard supply level will be adopted. It may simply be required to revise the standard connection maximum import capacity. It will also be necessary to consider the ADMD per house. The profiles developed for electric vehicle charging and possibilities for smart charging will inform at.

Rural networks are inherently more vulnerable to harmonic pollution of the supply quality. As part of this work package, a voltage quality measurement programme will be carried out on a sample of 5 houses to ensure that the harmonic distortion is within acceptable limits.
WP 4 Deliverables and timeline

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due by</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Report on residential demand profiles and peak demands for various levels of EV penetration. Taking in the output of 3.1 and the smart charging options as developed in WP3</td>
<td>Dec 2013</td>
</tr>
<tr>
<td>4.2</td>
<td>Report on network reinforcement requirements for various levels of EV penetration and the impact of Dumb Charging on urban low voltage circuits based on existing EV trials.</td>
<td>June 2014</td>
</tr>
<tr>
<td>4.3</td>
<td>Estimate approximate reinforcement costs for widespread roll-out and how they might be minimised</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>4.4</td>
<td>Establish design rules for maximum number of on-street charge points on LV Group in order to minimise reinforcement costs for DUOS customers.</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>4.5</td>
<td>Examine the conductor and cable sizes for future networks taking account of EV demands.</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>4.6</td>
<td>Revise housing scheme design guidelines</td>
<td>June 2015</td>
</tr>
<tr>
<td>4.7</td>
<td>Review of rural non-scheme connection standards</td>
<td>June 2015</td>
</tr>
</tbody>
</table>
WP 5 – Establish the potential impact on EVs on the DUoS average unit price

Description
If the charging of electric vehicles is managed so as not to drive up the requirement for network reinforcement as outlined above, the impact on DUoS should be positive. The load factor of the network at all levels should increase and therefore asset utilisation would increase. The consequence of this would be to reduce the cost per kWh delivered as more units will be sold on the same infrastructure base. However clustering patterns, 3rd party load aggregation or other factors beyond the control of the DSO may lead to negative impacts on DUoS if they are not fully understood and appropriate rights and obligations determined.

Objectives
To estimate the likely impact of EV uptake on system demand and load patterns and to develop parameterised models to support scenario analysis

An analysis of the potential impact of varying levels of EV uptake will be completed taking into account factors such as

- Current EV charging patterns and characteristics
- EV driver charging behaviour
- Increased energy demand based on projected annual driving rate
- Projected operational costs of EV charging infrastructure
- Projected development of EV battery capacity and consequential impact of energy demand

Scope
This physical trial, supplemented by scenario modelling will determine the potential impact through the following methodology.

1. Establish base-line load factor/utilisation rate of networks

   Measure level and impact of night-time charging

   Monitor charging characteristics of selected EV models currently on market in both the domestic and commercial sectors such as

   Passenger Vehicles
   1. Nissan Leaf (1st Generation)
   2. Nissan Leaf (2nd Generation)
   3. Renault Fluence ZE
   4. Renault Zoe
   5. Mitsubishi iMiev
Commercial Vehicles

1. Renault Kangoo
2. Nissan NH200

Other models may be tested during the trial assuming availability including Plug-in-hybrids.

Determine through site testing and survey, inter alia,

- Profile of night time charge events
- Typical Rate of charge
- Time of charge events
- Duration of charge events

2. Estimate potential increase in night-units sold as a result of EVs based on trial evidence and targeted surveys for predetermined tranches of EV uptake.

Government target is to achieve 10% EV penetration of the passenger car fleet by 2020. Impact analysis will look at penetration levels below and in excess of this target.

<table>
<thead>
<tr>
<th>EV uptake by 2020</th>
<th>EV uptake by 2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>100,000</td>
<td>250,000</td>
</tr>
<tr>
<td>150,000</td>
<td>325,000</td>
</tr>
<tr>
<td>250,000</td>
<td>400,000</td>
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<tr>
<td>300,000</td>
<td>475,000</td>
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<tr>
<td>350,000</td>
<td>550,000</td>
</tr>
</tbody>
</table>

3. Develop models to estimate potential cost/kWh delivered as a result of higher load factor

Develop Excel models to project expected load increases and profiles based on predetermined tranches of EV volume uptake

Model variables to include

- Variable projected EV uptake rate data
- Variable projected battery development scenarios
- Statistical data in relation to driving behaviour and patterns for Irish motorists
- System demand projections
- Projected public charging behaviour
- Projected work location charging behaviour
4. Detail factors which could detrimentally impact network costs including the impact of “dumb charging” (where no incentive or requirement is placed on the EV user to charge at times which do not impact on the electrical network) or 3rd party controlled EV charging, particularly where clustering occurs. Based on scenarios for % uptake of aggregation services and clustering of vehicles, perform sensitivity analysis accounting for the impact on load factor decreases and potential associated reinforcements

Deliverables and timeline

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due by</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Parameterised Models to support DUoS impact analysis</td>
<td>Q4 2013</td>
</tr>
<tr>
<td>5.2</td>
<td>Real time data capture of typical charging behaviour through in commercial and domestic scenarios</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>5.3</td>
<td>Final Report on project impact of EV Rollout on DUoS charges</td>
<td>Q4 2014</td>
</tr>
</tbody>
</table>
WP 6 – Facilitating a competitive market structure

Description
In order to facilitate the early take up of EV ownership nationwide and validly examine the on-street charging requirements of EV owners, provision of an initial public charging infrastructure is required. In addition to the vital learning that will be derived from this as outlined in the work packages above, it offers the opportunity to trial an advanced charge point control system which can be used for demand management as outlined in WP3, but also will be used for flexible electricity usage measurement and flexible settlement systems as part of the MRSO function for this new type of mobile load.

This system which will be delivered as part of a research collaboration with industrial partners can provide access to competitively priced e-mobility energy from multiple suppliers, and, facilitate the development and testing of "smart grid" functionalities such as frequency response, virtual spinning reserve "nega-watts" (Rapid load reductions), and V2G capabilities.

In addition, in order to facilitate other possible market models, the pilot IT data model will collect information on Charge Point IDs and geo location that can be used to enable EV charging events to be settled in other ways, including EV mobility operator and the Landlord model. A diagram of the proposed pilot solution design is shown below.
Objectives

- To provide the information systems associated with EV charging which will need to be intuitive and easy to use for the consumer
- To ensure that the entry cost for licensed energy suppliers to the pilot market will be minimal
- To provide transparent and open information directly to the consumer with regards to available tariffs from all licensed energy suppliers bidding into the market
- To enable the customer to choose and change supplier at any time without penalty or barrier
- To enable all licensed energy suppliers to participate in the market at a minimised cost of entry while also keeping supporting a positive cash flow via the Charge Point Payment System (CPPS) and provision of a secure tariff portal
- To collect charge point data required to settle EV charging events in a range of different ways. The pilot IT system is flexible enough to support many industry models, the selection of which could be determined by CER at the end of the pilot

Scope

In the first release of the pilot system there will be a single Charge Point Management System (CPMS) based on a new open standard being developed by ESB Networks in association with international partners with subject matter expertise, to allow for interconnectivity and control of charge points from a range of different manufacturers. This means that “smart grid” capabilities with the potential to support system operation or ancillary service provision be supported and demonstrated at an early stage. The CPMS is also designed to support V2G capabilities, once business rules and PWM and PLC technical standards for such functionality is agreed and standardised.

A national charge post infrastructure is different from the current electricity market provisioning models with different customers using different charge posts in different locations day and night. The normal market processes for mapping customers to supply points and supply points to energy suppliers are inappropriate, as they can only be executed on timescales of days. It is vital that these new dynamics are implemented carefully and in a way that attempts to minimise the impact on existing market systems. Exploring the options available for retail and wholesale market integration is a key area of scope within the pilot.

Significant changes to market systems and/or market messages are complex and can be costly to design, code, test and implement. Multi-million euro systems are not tenable in the current economic environment. It is hoped to provide the minority of EV energy supplied through the public infrastructure with most charging taking place overnight at the home or commercial premises. Therefore innovative solutions based
partially on managed services coupled with careful analysis of interfaces that are required is vital to minimise system cost both for build and operations.

**Customer Focus - combining affordability and ease of use**

The ESB Networks proposed approach to Ireland’s pilot e-Charging system is designed to facilitate ease of use and value for money for the EV consumer. The customer is not unnecessarily exposed to the complexity of the system, which will potentially allow open access to all licensed energy suppliers. For the consumer, they will be able to choose the supplier that offers the lowest tariff for energy at the time that they anticipate the need for on-street charging.

A single access card based on HF RFID will be used nationally for access and authentication, no account balances will be held on the card. Such account balances may be managed centrally and adjusted after each charge point event. The consumer will have the ability to change supplier at any stage, when more attractive tariffs are available or their pattern of charging changes, the consumer will be in control in terms of supplier choice.

Other commercial models can be examined during the course of the pilot if CER deem that that to be appropriate. The pilot IT system collects sufficient data on charging events to permit this flexibility.
Solutions evaluated will pertain to EV issues only and will not set precedents for use in other areas of the retail market.

**WP 6 Deliverables and timeline**

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Delivery Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Confirm correct implementation of OCPP 1.2 by charge point vendors during on-boarding process.</td>
<td>Q2 2013</td>
</tr>
<tr>
<td>6.2</td>
<td>Implement go-live of All-Island Charge Point Management System</td>
<td>Q2 2013</td>
</tr>
<tr>
<td>6.3</td>
<td>Complete integration with appropriate platforms</td>
<td>Q3 2013</td>
</tr>
<tr>
<td>6.4</td>
<td>Demonstrate smart grid capabilities</td>
<td>Q4 2013</td>
</tr>
<tr>
<td>6.5</td>
<td>Develop solution and business/contractual framework for virtual spinning reserve capability</td>
<td>Q1 2014</td>
</tr>
<tr>
<td>6.6</td>
<td>Support ongoing European development and adaption of OCPP.</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>6.7</td>
<td>Support the convergence of international roaming and settlement standards.</td>
<td>Q2 2014</td>
</tr>
</tbody>
</table>
WP 7 – EU Projects and collaboration outside Ireland

Description
While Ireland is an island, the importance of conformity from a standards perspective cannot be ignored. Furthermore the operation of an electric vehicle charging infrastructure will require both openness to use by visiting vehicles and the facilitation of Irish vehicles travelling outside our jurisdiction. Fundamentally, standardisation is required to ensure that Irish customers do not have additional requirements in terms of EV technology which might limit the models available for them to purchase, or the services which they can avail of. The relevance of this is brought home by the closeness of neighbouring authorities via seaports and the land border with Northern Ireland, and that the vast majority of Irish vehicles are by necessity imported. The wide ranges of topics which need to be considered include connection hardware, communication protocols, user identification and contract agreements. Engagement with the major stakeholders across Europe provides both an insight into activities which can affect the DSOs operation of a network and ensure that the concerns and wishes of the Irish energy infrastructure are addressed at this crucial stage in the development of the EV arena. These European initiatives can facilitate learning around the impact of EVs on the energy system, both through our direct participation and the lessons of other European partners.

Objectives
The projects in which we currently participate include Green eMotion, MobiEurope, Enevate, FINSENY, PlanEV, FINESCE and EPRI.
The key objectives of participation in European e-Mobility projects are:

- To gauge and participate in the creation of standards necessary to operate a safe, open, efficient and interoperable EV charging system
- Ensure the voice of the Irish DSO is heard and that the specific situations that exist on the home network are addressed
- To harvest knowledge essential to the efficient implementation of infrastructure
- To reasonably ensure future proofing of infrastructure and value of investment
- To mitigate against any negative effects of EV charging through knowledge gained and network planning.

Scope
In the Green eMotion project we will gain an understanding of charging habits of EV users. This task will consider the locations, times of charge, energy consumed as well as the durations when vehicles are connected to the charge point. The activity will facilitate access to data from partner regions where penetrations of EV are similar or higher than Ireland. The knowledge gained from the wider availability of data will strengthen the value of data gathered at home.
The programme will deliver an understanding of EV infrastructure initiatives underway in Europe, assessment of the standards and specification chosen as well as the methodology used in the installation of EV charging systems. Understanding of works in other regions including the lessons learned by the responsible authorities will assist Ireland in developing a quality system.

There will be a review of initiatives for a European e-Mobility marketplace which facilitate the provision of energy services. This task will see the implementation and testing of connections to the marketplace allowing the exchange of white-lists with external regions. This activity will ensure that Ireland is integrated into a European system for EV energy purchase.

The signing of the Treaty of Vaals and participation in the collaboration eMI3 are two initiatives to ensure integration in an interoperable system. The treaty establishes the intention and willingness of partners to share white-lists in order to facilitate interoperability. The collaboration group eMI3 has been set up to ensure that the key identifiers and data packet formats necessary to ensure integration into a common interoperable system are agreed and developed into standards. The grouping includes members of a wide range of European projects and key stakeholders across a range of industry sectors. DSOs from a number of European countries participate in the group which will in turn affiliate with an established standards body such as Eritico.

Understanding of the potential use of EVs in Fleets and the subsequent impact on grid connections to fleet parking bays is addressed in the Green eMotion Project. Through the project we will gain an understanding of the likely uptake levels, the charge patterns and the quantities of EVs in fleets. Furthermore we will address the potential issues that these penetration levels are likely to present.

Hardware solutions such as load balancing power electronics and battery support for multiple fast charge devices are being developed in the Green eMotion by appropriate technological partners. These solutions will be tested in Ireland to establish their effectiveness in addressing a wide range of network control issues including, but not limited to those presented by EV charging. Load balancing power electronics will be used to connect two network nodes together, allowing bi-directional power flow, potentially alleviating network stress conditions. The use of battery support for multiple fast charge devices is expected to reduce the need for network upgrades resulting from the parallel use of multiple fast chargers during peak periods.

In the FINSENY and subsequent projects (Future Internet for Smart ENergY), will examine the integration of EVs onto the power system. Topics which will be addressed include load management and specifically Demand Side Management, demonstrating the opportunity for use of coordinated or aggregated optimisation of EV charging by 3rd parties, and the necessary DSO systems to facilitate this.

Collaboration with industry partners demonstrate the opportunity to couple EV charging with the generation of energy through renewable sources. Essentially the technologies
being developed control the charging of vehicles to make best use of renewable energy. Charging can be started, stopped and charging rates reduced with the system, while ensuring the neither EV users nor any other network users are negatively effected.

**WP 7 Deliverables and Timelines**

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Interim Report on EV Charging Green eMotion – This report will present charging patterns across the Green eMotion project including private and commercial users</td>
<td>Q3 2013</td>
</tr>
<tr>
<td>7.2</td>
<td>Final Report on EV Charging Green eMotion – This report will present charging patterns across the Green eMotion project including private and commercial users</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>7.3</td>
<td>Green eMotion Market place Report – This report will describe the state of progress of the Green eMotion marketplace initiatives as well as considering any external forces which may be active in Europe</td>
<td>Q2, 2014</td>
</tr>
<tr>
<td>7.4</td>
<td>Report on identification and ICT initiatives – This report will consider initiatives from eMI3 and any other groupings which may impact on the standards adopted in Ireland</td>
<td>Q3, 2014</td>
</tr>
<tr>
<td>7.5</td>
<td>Technology Report green eMotion – This report will describe the technology demonstration in Ireland of Green eMotion developed solutions</td>
<td>Q3, 2014</td>
</tr>
<tr>
<td>7.6</td>
<td>Smart Charging Report – This report will address the combined activities in intelligent charging technologies and scenarios across all projects in which we will participate</td>
<td>Q4, 2014</td>
</tr>
</tbody>
</table>

**WP 0 – Project Management**

**Description**

The elements of Project Management which are Information Dissemination, Time, Cost, Quality, Procurement, Resources, Scope, Risk and Change are all being managed in this project. The PM principles and processes being used on this project are aligned with PRINCE 2 and PMI frameworks

**Objectives**

This purpose of using all the elements of project management is to provide processes and procedures in order to deliver the project on time and within agreed costs. The PM framework will deliver the following:
• The organisational structure, roles and responsibilities that will allow ESB to manage the project
• The flow of information regarding the project to all stakeholders
• The processes and procedures used to establish and manage the project

Scope

Issue Management & Review Schedule

The standard ESB Networks Governance Issue Management process should be used to manage the project issues. Please see the issues log on SharePoint.

Risk Management & Review Schedule

The standard ESB Networks Risk Management process should be used to manage the project risks commencing with those identified as part of this process. Please see the risks log on SharePoint.

Change Control

The standard ESB Networks Change Management process should be used to changes to the project scope and base lined plan.

Information Dissemination & Research Data

ESB Networks has engaged in promoting the role the energy sector can play in developing a clean, low carbon transport system and helping to meet Ireland’s international obligations in cutting greenhouse emissions. We are trying to increase awareness and enhance the visibility of the EV charging infrastructure currently being installed by ESB Networks nationwide.

Ongoing monitoring and surveying of the public and other interested groups’ attitude to EVs and the availability of charging infrastructure and the type of infrastructure preferred by the consumer is being undertaken as part of this.

From an educational point of view ESB Networks is providing presentations and talks to schools and colleges as part of the Sustainable School Programme.

Quality Management & Review Schedule

The standard ESB Networks Quality Management process should be used and enhanced to cater for any additional requirements specific to this project.

• Complete regular QA checks to be done on:
  o Project Plan
  o Issues/Risks/Action logs
  o Adherence to ESB Processes and Procedures
  o Project Status Reports
• Produce ad hoc trend reports (Issues, Risks and Changes) where required.
• Check that Lessons Learned are captured in Lessons Learned Log and/or the Project Closure report.

Project Assurance Review Schedule
The standard ESB Networks Project Assurance process should be used to identify whether formal Project Assurance reviews are required; scope of such reviews and the schedule for the reviews for the project.

Project Reporting
The standard ESB Networks Project Reporting requirements should be adhered to.

Project Meeting Schedule
The following table of governance meetings (showing typical agenda items for each) have been agreed in order to monitor progress/status and to manage decisions and change requests through to resolution.

<table>
<thead>
<tr>
<th>Meeting</th>
<th>Agreed Schedule</th>
<th>Agenda</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal Project Team Meeting</td>
<td>Second weekly</td>
<td>• Progress in last week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Forecast for next week</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Status review (issues, actions, decisions needed etc.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Change request reviews where necessary</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Agreement and action planning for items for Project Board meetings</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Other items arising from current stage of planning or execution</td>
</tr>
<tr>
<td>Internal Project Board Meeting</td>
<td>Quarterly</td>
<td>• Progress in last month</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Status Review (RAG status, risks and escalations)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Review key milestones/critical path</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Review new/open changes requests (where necessary)</td>
</tr>
</tbody>
</table>

Project Plan Management
Project plan management is required throughout the lifecycle of a project and is the process of ensuring timely completion of the project. The Project Support Office will be responsible for compiling and tracking the project plan.

Communications Management including communications plan
The Project Manager/Project Support Office will work with the Project Team to ensure that all stakeholders and information needs have been identified and planned for.
Communications Plan

<table>
<thead>
<tr>
<th>Information</th>
<th>When</th>
<th>What Format</th>
<th>Distributed to</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status report</td>
<td>Second weekly</td>
<td>Word Document</td>
<td>Project team/MD</td>
</tr>
<tr>
<td>Project board report</td>
<td>Quarterly</td>
<td>Word Document</td>
<td>Project Board and MD</td>
</tr>
<tr>
<td>Project update</td>
<td>As Required</td>
<td>Word Document</td>
<td>Project team</td>
</tr>
<tr>
<td>Project Plan</td>
<td>Second weekly</td>
<td>MS Project Plan</td>
<td>Project team/MD</td>
</tr>
<tr>
<td>Change Requests</td>
<td>As Required</td>
<td>Word Document</td>
<td>MD</td>
</tr>
<tr>
<td>Project documentation</td>
<td>As per the plan</td>
<td>As agreed per the plan</td>
<td>As agreed per the plan/RACI</td>
</tr>
<tr>
<td>RACI Document</td>
<td>As Required</td>
<td>Excel Spreadsheet</td>
<td>Project team/MD</td>
</tr>
<tr>
<td>RAID Logs</td>
<td>Second weekly</td>
<td>From SPS</td>
<td>Project team/MD</td>
</tr>
</tbody>
</table>

**Deliverable Acceptance**

Project manager/Project Support Office is fully accountable for the completion of all deliverables in their project. Each deliverable shall be signed off by the person(s) assigned as per the RACI Matrix. Please see the RACI Matrix on the SharePoint site for further information.
Document Management

The following documents must be stored in the relevant folders on SPS:

- Contractual documentation
- Project Initiation Document
- Project Plan
- Progress and Status Reports
- Change Requests
- Approved Meeting Minutes
- RAID Logs
- Assumption log
- Project Closure Report/Lesson’s Learned Actions and outputs

Version Control

The document owner should apply version control to all documents that need to be issued for formal signoff by the customer. The ‘Check Out’ facility in SPS should be used to make changes to such documents. For further information on what should be stored in SPS or any related queries contact the Project Support Office.

Escalation Management

Escalation is needed when approval and/or resolution is needed for an issue that has not been resolved at work stream level. The escalation process should only be instigated when all other options for resolution have been exhausted.

Meeting Management

All meetings should have an agreed agenda (either casual or documented). Minutes should be produced (in whatever format deemed appropriate) and circulated to the relevant people.

Provision of tools and templates

The project support office will provide the necessary governance tools for use on the project as well as providing training on the use of the tools.

Project Closure

- The Project Manager/Project Support Office and the Project Review Board will ensure that the project is brought to a controlled end.

- Project Closure Documentation - Once the project has been completed, the Project Manager/Project Support Office should hold lessons learned sessions with the Project Team and other relevant stakeholders. This will allow the PM/Project Support Office to update the Lessons Learned Log and to produce the formal Post Project Review for consideration by the Project Board. This report will document
how well the project has performed against the project scope, the lessons learned (what went well, badly and was lacking) and follow on recommendations.
Appendix 1 EU Directives

EU proposal for a directive mandating minimum numbers of publicly accessible charging points to be installed by 2020. The proposal also mandates standards for charging connections and installation types. ESB Networks pilot programme rollout meets many of the proposed requirements for public infrastructure already. The current directive proposal outlines the need for the DSO to invest in alternative fuel infrastructure at sufficient scale prior and parallel to demand.

10% of Transport Energy to be sourced from renewable sources by 2020. The Irish Government targets seek to achieve this through biofuels and electrification of transport.

A fleet-average CO$_2$ emission target of 130 g/km must be reached by each vehicle manufacturer by 2015. It is currently proposed to reduce this to 95g/km by 2020. In order to achieve this, vehicle manufacturers will be required to sell low carbon vehicles as part of their fleet offerings.

Commitment to ensure a full rollout by ESB Networks of EV infrastructure project and implementation of cost recovery and long term regulatory framework
Appendix 2 Project Management Documentation and Processes

Please find Project Management processes and example templates:

**Project Mobilisation checklist:**

<table>
<thead>
<tr>
<th>Mobilisation Item</th>
<th>Action</th>
<th>Process/Tool Options</th>
<th>Deliverable</th>
<th>Timeframe</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Project Organisation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Organisation Structure</td>
<td>Agree Project Org Structure</td>
<td></td>
<td>Project Organisation Chart</td>
<td>Complete</td>
</tr>
<tr>
<td>Project Roles &amp; Responsibilities</td>
<td>Identify roles required for the project and list their responsibilities</td>
<td></td>
<td>Project Roles &amp; Responsibilities Document</td>
<td>Complete</td>
</tr>
<tr>
<td>Documentation Management</td>
<td>Agree tool repository for project documentation</td>
<td>Share and/or SharePoint</td>
<td>Folder Structure as per Org Chart created in chosen repository</td>
<td>Complete</td>
</tr>
<tr>
<td><strong>Planning</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Initiation Document</td>
<td>Complete PID and get signoff from Project Board</td>
<td>ITC PID Template</td>
<td>Signed Off PID</td>
<td>Complete</td>
</tr>
<tr>
<td>Project Plan</td>
<td>Hold workshops to understand and breakdown work of the project, who is going to do it and what the project critical path, milestones and interdependencies are.</td>
<td>MS Project</td>
<td>Project Plan per stream (work area). Base lined High level project plan with key milestones Interdependencies listed separately or as part of the project plan</td>
<td>Complete-to be base lined</td>
</tr>
<tr>
<td><strong>Resource Management</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Resource Estimate and Resource Plan</td>
<td>Estimate number and skill set for resources for project as well as timeframe when each resource is required.</td>
<td></td>
<td>Resource Plan</td>
<td>Complete</td>
</tr>
<tr>
<td><strong>Finance</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost Allocation</td>
<td>Identify a cost allocation number for the project</td>
<td></td>
<td>Cost Codes setup and communicated</td>
<td>Complete</td>
</tr>
<tr>
<td>Financial Controls</td>
<td>Identify what Financial controls need to be in place for the project</td>
<td></td>
<td></td>
<td>Complete</td>
</tr>
<tr>
<td>Financial Reporting</td>
<td>Identify what Financial reporting may be required.</td>
<td></td>
<td></td>
<td>Complete</td>
</tr>
</tbody>
</table>

**Draft V0.7**
<table>
<thead>
<tr>
<th>Reporting Process</th>
<th>Agree Reporting Process, Templates and schedule</th>
<th>ITC Reporting Process, ITC Checkpoint Status Report Templates, Project Reporting Process</th>
<th>Complete</th>
</tr>
</thead>
<tbody>
<tr>
<td>Issue Management</td>
<td>Agree Issue Management Process and tool for managing issues. Agree on level at which something becomes an issue and should be logged as such.</td>
<td>ITC Issue Mgt Process</td>
<td>Project Issue Management Process</td>
</tr>
<tr>
<td>Quality Assurance</td>
<td>Create A Quality Plan for the Project. Deliverables List for each area of the project should be listed with review and signoff criteria</td>
<td>ITC Quality Plan Template</td>
<td>Project Quality Plan</td>
</tr>
<tr>
<td>Naming Standards</td>
<td>Agree Project Naming Standards</td>
<td></td>
<td>Naming Standards documented and communicated to project</td>
</tr>
<tr>
<td>Stakeholder Management</td>
<td>Agree on Strategy for managing Stakeholder</td>
<td>Stakeholder Management Strategy</td>
<td>Complete</td>
</tr>
<tr>
<td>Communication Plan for Stakeholders</td>
<td>Create a Communication Plan for liaising with Stakeholders</td>
<td>Stakeholder Communication Plan</td>
<td>Complete</td>
</tr>
</tbody>
</table>
### Benefits Tracking

| Benefit Tracking/Benefits Realisation | Review Business Case and List Benefits and define method for tracking against them | To be done at half yearly review |

### Communication Management

| Contact List | Create a Project Contact List and/or use the ESB Phone Directory | All project teams contact details are available to all |

### Project Control

| Progress against baseline Project Plan | Agree on method of weekly reporting against project plan, top issues, risks, change requests | ITC Reporting Pack Template |
| Requirements/Scope Document | Create a Requirements document for the Project and method of tracking against it. | Signed off Requirements document and tracking process |
| Meetings | Agree protocol for arranging meetings and conducting meetings |
| Action Management | Agree use of Action Log for capturing Actions, Minutes, Decisions for meetings | ITC Action Log Template ITC Minutes Template |

Complete
Change Control process:

1. Request Change
2. Assess the Impact
3. Approve – Project Manager
4. Project Board Approval
5. Plan & resource
6. Implement Change

Issue Management process:

1. Identify the Issue
2. Evaluate the Issue
3. Select Resolution
4. Manage Change via Change
5. Monitor and Review
6. Close Issue
Risk Management Process:

Evaluate the Risk

Identify Mitigation actions

Complete Mitigation actions

Monitor and Review

Close Risk
# Project Close template:

<table>
<thead>
<tr>
<th>No</th>
<th>Description of Task</th>
<th>Handover By</th>
<th>Handover To</th>
<th>Completion Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Close Project Risks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reassign or close all outstanding Risks</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.</td>
<td>Close Project Issues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reassign or close all outstanding Issues</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Close Project Changes</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Reassign or close all outstanding CRs</td>
<td></td>
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<tr>
<td>4.</td>
<td>Close Project Defects</td>
<td></td>
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<tr>
<td></td>
<td>• Reassign or close all outstanding Defects</td>
<td></td>
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<tr>
<td>5.</td>
<td>Close Project Files</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Project Share – Delete unwanted files</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Project Share – Remove access rights and archive</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• SharePoint - Ensure all official Project Deliverable documentation is present on SharePoint at current published version</td>
<td></td>
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<tr>
<td></td>
<td>• SharePoint – Transfer official deliverable documentation to new owner/s repository/ies</td>
<td></td>
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</tr>
<tr>
<td>6.</td>
<td>Close Project Tasks</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Review and handover Tasks assigned to business in Quality Centre.</td>
<td></td>
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</tr>
<tr>
<td>7.</td>
<td>Transfer ownership of &lt;insert project name&gt; Support Quality Centre</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Handover &lt;insert project name&gt; Call Logging Support tool to SCC??</td>
<td></td>
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<tr>
<td>8.</td>
<td>Close Project Tools</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Remove access and archive Quality Centre Issues, Risks, Changes, Defects once all open items are closed.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Remove Project Folders from SharePoint once all documentation is transferred.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>• Remove admin rights and software no longer required from PCs</td>
<td></td>
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</tr>
</tbody>
</table>
| **9.** Close Project Web Site  
   - Review content of Project Web Site and transfer to new owners, as appropriate and close down site. |   |
| **10.** Complete End Project Report which should include:  
   - Achievement of project objectives  
   - Performance against plan  
   - Impact of changes on business case  
   - Lessons learned  
   - Follow-on action recommendations (Benefits Tracking)  
   - Post-implementation review plan  
   - Customer acceptance  
   - Project files  
   - Project closure notification |   |
| **11.** Lessons Learned  
   - Complete and include in End Project Report |   |
| **12.** Complete Handover from Consultants/Contractors |   |
| **13.** Complete Handover to Support Team |   |
| **15.** Complete Knowledge Transfer |   |
| **16.** Complete handover ownership of BIG to business  
   - Scheduling and facilitation/chairing of meetings  
   - Preparing meeting documentation  
   - Storing of meeting documentation |   |
| **17.** Complete handover of Control Group to business  
   - Scheduling and facilitation/chairing of meetings  
   - Consolidation and distribution of Control Group Reports  
   - Preparing meeting documentation  
   - Storing meeting documentation |   |
| **18.** Complete handover of Data Management Group to business  
   - Management of DMG function  
   - Scheduling and facilitation/chairing of meetings  
   - Preparing meeting documentation  
   - Storing DMG function related |   |
<table>
<thead>
<tr>
<th>SUB-PROJECT</th>
<th>RAG STATUS</th>
<th>Deliverables/Targets Within next 2 weeks</th>
<th>Key activities planned against MPP timelines</th>
<th>Priority (L/M/H)</th>
<th>RISKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project status report:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

WEEKLY STATUS REPORT
DATE:

IT PROJECT – OVERALL CURRENT RAG STATUS:

COMMENTARY ON RAG STATUS:-

ACTIVITIES:

Please find the link to updated project plan:
Appendix 3 – Summary of Project Deliverables

WP1 Demonstrate technology passively deployed and resultant physical system impact

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due By</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Identify the most appropriate connection types for use with EV chargers for the trial (This work is already complete)</td>
<td>Complete</td>
</tr>
<tr>
<td>1.2</td>
<td>Identify the most suitable charge points for home, on-street, commercial and fast charger locations for the trial (This work is already complete)</td>
<td>Complete</td>
</tr>
<tr>
<td>1.3</td>
<td>Determine the likely distribution of existing EVs during the trial period and required number of charge point installations to enable their use across the country. Install the charge points. (This work is already partially complete)</td>
<td>Q4 2013</td>
</tr>
<tr>
<td>1.4</td>
<td>Determine the effect on voltage &amp; load of the connection of EVs to both tailed and interconnected networks in urban &amp; rural areas</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>1.5</td>
<td>Determine the effect that No1.2 will have with the incremental addition of EVs to the various networks</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>1.6</td>
<td>Measure the electrical characteristics for different EV models and how they perform with the various charge points. Metrics to be monitored include harmonics, load, current, etc.</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>1.7</td>
<td>Measure the degree of co-incident charging of multiple vehicles on urban LV network</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>1.8</td>
<td>Determine relative use of public charging versus home charging to establish likely future impact on network.</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>1.9</td>
<td>Establish demand for other technology types (e.g. electric scooters / bikes) for public charging, accounting for the charging mechanisms associated with these technologies.</td>
<td>Q4 2014</td>
</tr>
</tbody>
</table>

WP2 Optimise the charging infrastructure connections, metering and safety standards

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due By</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Measured impact of environmental factors and public behaviour on integrity of safety standards for charging infrastructure in controlled trial.</td>
<td>Q3 2014</td>
</tr>
<tr>
<td>2.2</td>
<td>Monitoring of physical integrity of cabinets</td>
<td>Q2 2014</td>
</tr>
</tbody>
</table>
### 2.3 Assessment of safety of physical location, protection systems and vehicle interface

Q2 2014

### 2.4 In Conjunction with WP 6 Development of standard EV Charting/Billing/Metering system for the trial which still facilitates choice of supplier, but minimises costs through standardisation..

Q3 2014

### 2.5 Technology Acceptance Report – This report will assess the current state of technology acceptance across Europe. The report will review the position of the European Commission, the OEM’s and other significant stakeholders. Following from the assessment, recommendations will be made for infrastructure standardisation in Ireland, so as to ensure interoperability of connection

Q3 2014

### 2.6 EV Charging Electrical Protection Report – This report will review the relevant standards relating to Electrical protection, furthermore it will review the current recommendations of the OEM’s regarding protection in relation to the vehicle, including cost implications of requirements above IEC standards. The report will recommend protection implementation for future installation reflecting best practice

Q2 2014

### 2.7 Develop policies and standards for Ireland:
- Physical connection of Public and home charging
- Requirements of charging infrastructure
- Metering requirements for public charging infrastructure

Q2 2015

---

### WP3 Smart Charging and Network Operation

<table>
<thead>
<tr>
<th>No</th>
<th>Deliverables and timeline</th>
<th>Due by</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Report on the potential for advanced Smart Home Charging</td>
<td>June 2014</td>
</tr>
<tr>
<td>3.2</td>
<td>Report on potential benefit of Smart Network operations to increase hosting capacity of EVs</td>
<td>June 2015</td>
</tr>
<tr>
<td>3.3</td>
<td>Report on the potential contribution on-street EV charge points can make to Spinning Reserve.</td>
<td>Dec 2014</td>
</tr>
</tbody>
</table>
## WP4 Network Planning

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due by</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Report on residential demand profiles and peak demands for various levels of EV penetration. Taking in the output of 3.1 and the smart charging options as developed in WP3</td>
<td>Dec 2013</td>
</tr>
<tr>
<td>4.2</td>
<td>Report on network reinforcement requirements for various levels of EV penetration and the impact of Dumb Charging on urban low voltage circuits based on existing EV trials.</td>
<td>June 2014</td>
</tr>
<tr>
<td>4.3</td>
<td>Estimate approximate reinforcement costs for widespread roll-out and how they might be minimised</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>4.4</td>
<td>Establish design rules for maximum number of on-street charge points on LV Group in order to minimise reinforcement costs for DUOS customers.</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>4.5</td>
<td>Examine the conductor and cable sizes for future networks taking account of EV demands.</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>4.6</td>
<td>Revised housing scheme design guidelines</td>
<td>June 2015</td>
</tr>
<tr>
<td>4.7</td>
<td>Review of rural non-scheme connection standards</td>
<td>June 2015</td>
</tr>
</tbody>
</table>

## WP5 Establish the potential impact on EVs on the Duos average unit price

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due by</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Parameterised Models to support DUoS impact analysis</td>
<td>Q4, 2013</td>
</tr>
<tr>
<td>5.2</td>
<td>Real time data capture of typical charging behaviour through in commercial and domestic scenarios</td>
<td>Q2, 2014</td>
</tr>
<tr>
<td>5.3</td>
<td>Final Report on project impact of EV Rollout on DUoS charges</td>
<td>Q4, 2014</td>
</tr>
</tbody>
</table>

## WP 6 Facilitating a competitive market structure

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Delivery Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1</td>
<td>Confirm correct implementation of OCPP 1.2 by charge point vendors during on-boarding process.</td>
<td>Q2 2013</td>
</tr>
<tr>
<td>6.2</td>
<td>Implement go-live of All-Island Charge Point Management System</td>
<td>Q2 2013</td>
</tr>
<tr>
<td>6.3</td>
<td>Complete integration with Enablement IT Platform</td>
<td>Q3 2013</td>
</tr>
<tr>
<td>6.4</td>
<td>Demonstrate smart grid capabilities including frequency response</td>
<td>Q4 2013</td>
</tr>
<tr>
<td>6.5</td>
<td>Develop solution and business/contractual framework for virtual</td>
<td>Q1 2014</td>
</tr>
<tr>
<td>No</td>
<td>Description</td>
<td>Due</td>
</tr>
<tr>
<td>----</td>
<td>------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>6.6</td>
<td>Support ongoing European development and adaption of OCPP.</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>6.7</td>
<td>Support the convergence of international roaming and settlement standards.</td>
<td>Q2 2014</td>
</tr>
</tbody>
</table>

### WP 7 EU Projects

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Due</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.1</td>
<td>Interim Report on EV Charging Green eMotion – This report will present charging patterns across the Green eMotion project including private and commercial users</td>
<td>Q3 2013</td>
</tr>
<tr>
<td>7.2</td>
<td>Final Report on EV Charging Green eMotion – This report will present charging patterns across the Green eMotion project including private and commercial users</td>
<td>Q2 2014</td>
</tr>
<tr>
<td>7.3</td>
<td>Green eMotion Market place Report – This report will describe the state of progress of the Green eMotion marketplace initiatives as well as considering any external forces which may be active in Europe</td>
<td>Q2, 2014</td>
</tr>
<tr>
<td>7.4</td>
<td>Report on identification and ICT initiatives – This report will consider initiatives from eMI3 and any other groupings which may impact on the standards adopted in Ireland</td>
<td>Q3, 2014</td>
</tr>
<tr>
<td>7.5</td>
<td>Technology Report green eMotion – This report will describe the technology demonstration in Ireland of Green eMotion developed solutions</td>
<td>Q3, 2014</td>
</tr>
<tr>
<td>7.6</td>
<td>Smart Charging Report – This report will address the combined activities in intelligent charging technologies and scenarios across all projects in which we will participate</td>
<td>Q4, 2014</td>
</tr>
</tbody>
</table>