# IET
The Institution of
Engineering and Technology

# CATAPULT
Energy Systems

# Future Power System Architecture Project 2

## Work Package 5 - Methodology Report

A report commissioned by Innovate UK and delivered through a collaboration between the Institution of Engineering and Technology and the Energy Systems Catapult.

**FUTURE POWER SYSTEM ARCHITECTURE**

MEETING BRITAIN'S FUTURE POWER SYSTEM CHALLENGES

# Future Power System Architecture Project 2

Final Report

**Work Package 5: Methodology Report**

**Future Power System Architecture** – A report commissioned by Innovate UK

**The Future Power System Architecture (FPSA) project 2 was commissioned by Innovate UK and delivered through a collaboration between the Institution of Engineering and Technology (IET) and the Energy Systems Catapult.**

The collaboration built upon the shared commitment to responding effectively to the challenges presented by the energy trilemma: decarbonisation, security of supply and affordability. The Energy Systems Catapult and the IET drew upon their respective strengths and engaged with a broad community of stakeholders and other experts to deliver the project.

The collaboration brought extensive expertise and experience to the project, combining technical, commercial and customer perspectives, and included the significant contribution of senior thought leaders from the IET membership. The unique combination of complementary skills enabled innovation in approach, deep analysis and strong evidence building. The collaboration worked closely on project governance, delivery and commercial management and applied best practice in all aspects of its work. The position of the IET and the Energy Systems Catapult in the energy sector assured independence of the outcomes.

## About the Institution of Engineering and Technology

The Institution of Engineering and Technology is one of the world's largest engineering institutions with over 167,000 members in 127 countries. It is also the most multidisciplinary – to reflect the increasingly diverse nature of engineering in the 21st century.

The IET is working to engineer a better world by inspiring, informing and influencing its members, engineers and technicians, and all those who are touched by, or touch, the work of engineers. The Institution of Engineering and Technology is registered as a Charity in England and Wales (No. 211014) and Scotland (No. SCO38698).

## About the Energy Systems Catapult

The Energy Systems Catapult is the UK's technology and innovation centre set up to support companies and Government for the development of new products and services to address the new commercial opportunities created by the transformation of UK and global energy systems (covering electricity, heat and combustible gases).

The Catapult's mission is to bring the worlds of industry, academia and Government together to encourage and support the development of new technology-based products and services in the energy sector. It is a non-profit, non-partisan company limited by guarantee.

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# 1. Executive Summary

The purpose of the second stage of the Future Power System Architecture Programme (FPSA2) was to deepen the analysis of requirements carried out in FPSA1 which reported in July 2016, understand barriers to implementation, and to consider innovative frameworks for delivering new functionality.

This report describes the approach to, and learning from, the agile and iterative project methodology used by FPSA2 to enable integration of project activity as an ongoing process, and synthesis of findings into an integrated whole. It also summarises the specific methods used within each Work Package. It provides a link between the main final report and the individual Work Package reports.

The guiding approach for the project methodology was to demonstrate an interactive system of innovation and learning which enabled multiple actors to work collaboratively to develop and pursue a common direction of travel to meet collective objectives. This entailed drawing on agile principles to maintain a focus on the interactions between Work Package activity, and the interactions of the project activity with the world beyond the project, rather than just on the business of ensuring the completion of tasks within each Work Package.

The motivating vision for the project methodology was to enable exploration of potential parallels between the processes and organisation for the project, and the processes and organisation likely to be required for the transformation of the whole multi-stakeholder power system, for consideration in support of future FPSA activity.

FPSA2 should be seen as a latest component of the FPSA initiative. An overview of both FPSA1 and FPSA2 are set out in this report. FPSA2 was structured into a series of delivery Work Packages (WPs), as follows:

- Stakeholder Engagement (WP1A) sought to understand current and future requirements and their implications for the whole-system, through engagement with a range of stakeholders.

- Future Stakeholders' Needs (WP1B) sought to understand requirements of future stakeholders and potential implications for the power system, including cultural, societal and behavioural issues.
- Functional Analysis (WP2) checked the validity and completeness of functions identified in FPSA1, and identified areas of potential Research, Development and Demonstration (RD&D) and Innovation to assist delivery.
- Impact Analysis (WP3) identified the barriers to developing and implementing the functions within current sector processes and assessed the impact of late or non-delivery.
- *Enabling Framework* Identification (WP4) explored how future system functionality could be enabled to meet various and changing needs in a changing landscape. FPSA1 concluded that new functionality will require new frameworks to enable delivery because of the whole-system nature of the challenge. These *Enabling Frameworks* will combine governance, stakeholder engagement, planning and implementation capabilities.

In addition, WP6 ensured the project's purpose and findings are expressed clearly and are accessible to diverse audiences and appropriate for different groups of stakeholders.

Delivery of the project methodology was the responsibility of WP5 to ensure that the work developed as a whole, seeking to enable each party to understand their role within the whole-system of activity, facilitating the integration of the parts. Within this framework of interaction, each Work Package used its own specific methodology tailored to its own objectives, while adopting common themes of ensuring an evidence-based approach to the work, and embracing iterative development of both content and method in line with the overall project methodology.

The interactive nature of the work drove the need to take an agile approach. This included structuring the project into three time-bound phases. Within each phase, delivery teams were encouraged to consider, to some extent, all aspects of their scope of work to give early

sight of issues that might be of importance to others and the project as a whole. Interactions and communications were enabled by regular weekly "heartbeat" Synthesis Team meetings, supported by a number of plenary sessions, facilitated and self-organised meetings, practical tools to support interaction and exchange of content, and the development of an overall project narrative to focus the work in the final stages on clear contributions to the overall project conclusions.

Synthesis Team meetings ran in sync with Steering Group meetings to ensure ongoing project level communication.

Experience of developing and applying the project methodology in FPSA2 has led to a number of learning points.

In terms of project design and governance, learning included the need to ensure time and organisation for ongoing project strategy development as well as delivery, to keep pace with the agile nature of the project.

Various learning points related to interaction management, including the observation that, as hoped, the quality of interactions between Work Packages matured over the lifetime of the project, from establishing relationships for information exchange, to increasingly collaborative working in phase 2, and a deeper sense of collective purpose in phase 3. There are a number of points to note concerning the management of interactions, including the importance of developing relationships of trust which, in general, worked relatively well in FPSA2, to providing support for formal interface specifications for information exchange between work groups.

The underlying agile principles adopted by the project, to enable synthesis and integration of the activity of the multiple parties involved, have parallels with the principles proposed by FPSA2 for *Enabling Framework* processes. Further development of processes to support multi-stakeholder iterative learning is likely to be a key element of taking FPSA work forwards.

# 2. Future Power System Architecture Programme and FPSA2

The parallel challenges of deep decarbonisation, maintaining energy security and stability, and ensuring cost-effectiveness will require a major transformation of the electricity system in many countries by 2030.

The Future Power System Architecture (FPSA) programme seeks to create a dynamic environment in which to develop the GB power system architecture taking a holistic and whole-system perspective. Working across the electricity industry, involving the full range of stakeholders, is key to this approach, creating a shared view of a future in which electricity customers are at the heart of the overall system.

The first stage of the project, FPSA1, which reported in

July 2016, identified a clear need to take a "whole-system view" of the power system including the implications of developments behind the customer meter such as smart appliances and electric vehicles. It identified *thirty-five* new or enhanced functional requirements for 2030 and called on the power industry and government to focus urgently on further defining and delivering these new capabilities.

The purpose of the next stage, FPSA2, was to deepen the analysis of requirements, understand barriers to implementation, and to consider innovative frameworks for delivering new functionality. FPSA2 proposes an agile approach, enabling inclusive and diverse stakeholder collaboration and a framework for ensuring timely delivery of functionality at a whole-system level.

# 3.  Purpose and Structure of this Report

## 3.1  Purpose of the report

This report describes the methodology used by the FPSA2 project to enable synthesis of the project findings into an integrated whole, including an overview of the wider management and organisation of the project. The project was structured into a set of Work Packages, each with its own purposes, interlinked and interdependent with others within a shared common purpose, and organised to co-ordinate interactions between Work Package activities throughout the project lifecycle.

Work Package 5 was charged with the delivery of the project methodology, managing the project and ensuring integration of the work streams and synthesis into a final report and other deliverables. It also managed the development, and peer challenge, of the project through its Steering Group and Project Delivery Board.

The report also provides an overview of the methods used within each Work Package by which each has delivered meaningful results in its own right.

The report thus provides a link between the main final report and the individual Work Package reports by explaining how the project as a whole, and each of its elements, was conducted to meet individual and collective purposes.

## 3.2  Structure of the report

The report starts by providing an overview of the project methodology. It then describes the purpose and structure of the FPSA programme at multiple levels, expanding on the introduction. The FPSA2 project is presented as a system of interacting activities, and the agile approach to the project described including the timeline with iterative phases. This is followed by the practicalities of achieving synthesis as an ongoing process, and lessons learnt for future developments.

# 4. Project Methodology

In the broadest sense, establishing the purpose, and associated structure, of any purposeful activity such as a project can be seen as an aspect of the overall methodology. For this reason, the purpose and structure of the project are presented after, rather than before, this introduction to the project methodology.

## 4.1 Objectives of the project methodology

The main objective of the FPSA2 project methodology was to ensure effective integration and synthesis between project activities as an *ongoing process* to deliver the purpose of the project. The methodology was designed to deal with the complexity, uncertainty and rapid pace of change inherent in the project, whilst ensuring a robust evidence base and audit trail.

## 4.2 Approach

The guiding approach for the project methodology as a whole was to demonstrate an interactive system of innovation and learning which enabled multiple actors to work collaboratively to develop and pursue a common direction of travel to meet collective objectives.

More specifically, this meant ensuring that the project maintained a focus on the interactions between Work Package activity, and the interactions of the project activity with the world beyond the project, rather than just on the business of ensuring the completion of tasks within each Work Package. The methodology comprised:

- Structuring the project as a system of activity, with as much focus on *interactions* as on individual *actions*, encouraging participants and teams to be aware of the roles they play in the whole project system.
- Adopting an agile project approach to support iterative learning, with regular "heartbeat" meetings of both the Steering Group and Synthesis Team.
- Ensuring robust methodologies and approach to evidence within each Work Package.
- Providing project co-ordination mechanisms, including facilitation where required, and ensuring consistent documentation of project activities and outputs.

## 4.3 Motivation

The methodological approach to the FPSA2 project was stimulated by the insight from FPSA1 that the implementation of new and enhanced functionality at the level of the whole power system will require an intensity of collaborative engagement across organisational boundaries that presents a highly complex challenge, and a recognition that fully aligning the various elements of the FPSA2

project being developed and delivered by different contracted parties shared, albeit in a relatively limited way, aspects of this kind of challenge.

The motivating vision for the project methodology, then, was to enable exploration of potential parallels between the processes and organisation for the project, and the processes and organisation likely to be required for the transformation of the whole multi-stakeholder power system, for consideration in support of future FPSA activity.

## 4.4 Agile methods, interaction and iterative learning

Agile methods are used extensively for software development in the private sector, and must also be used to build and run government digital services[1]. Agile methods emphasise rapid delivery of valuable outputs with iterative development based on feedback through interaction. The principles of agile extend beyond software development, and have also found application to general management.[2]

The FPSA2 project methodology adopted agile principles to harness learning throughout the project while ensuring development of the various project activities in alignment with one another.

It is notable that the importance of learning through interaction is a common theme in methods to address complex problems and transformative change. For example, the International Futures Forum (IFF) was established in 2001 to address the question of "how do we take effective action in a world we don't understand and can't control?" thus setting out to tackle the challenges of transformative innovation in the widest sense, for an increasingly complex and uncertain future. IFF summarises its method as offering "a process of iterative learning" through interaction between disciplinary silos and across short, medium and long-term perspectives[3]. Such approaches add to the wide range of codified methods available that encourage and harness social learning for tackling complex situations, such as Soft Systems Methodology[4], World Café[5], Action Learning[6] and others. It is likely to be appropriate to consider specific techniques such as these in the methodological approach to future stages of FPSA, within an agile project approach, to complement "harder" system engineering disciplines.

[1]www.gov.uk/service-manual/agile-delivery/agile-government-services-introduction
[2]Moran, Alan (2015). Managing Agile: Strategy, Implementation, Organisation and People. Springer Verlag. ISBN 978-3-319-16262-1
[3]www.internationalfuturesforum.com/iff-method
[4]Checkland, Peter and Poulter, John, Learning for Acton, A Short Definitive Account of Soft Systems Methodology and its use for Practitioners, Teachers and Students. Wiley, ISBN 0-470-02554-9.
[5]www.theworldcafe.com
[6]https://en.wikipedia.org/wiki/Action_learning

# 5. Purpose and Structure of the Project

The purpose and structure of the project is presented here at three interrelated levels:

1. The FPSA programme as a whole, made up of an evolving series of activities.
2. The FPSA2 project, as the latest component of FPSA activity.
3. Work Packages within the FPSA2 project.

## 5.1 Future Power System Architecture programme

### 5.1.1 Purpose of FPSA

The Future Power System Architecture (FPSA) programme seeks to create a dynamic environment in which to develop the GB power system architecture taking a holistic and whole-system perspective. Working across the electricity industry, involving the full range of stakeholders, is key to this approach, creating a shared view of a future in which electricity customers are at the heart of the overall system.

Customers will have the opportunity to benefit from smart equipment including smart meters, home energy automation, electric vehicles, their own solar generation, heat pumps for warmth, and local storage. They may also be part of community energy developments and smart cities, with the ability to buy and sell energy locally.

The aim of FPSA is to streamline the introduction of these developments at scale across the country, in ways that will meet national low-carbon goals at the lowest cost and maintain security of supply.

In more detail, the FPSA vision is to enable transition pathways towards an efficient, co-ordinated and economic GB electricity power system and overall power sector structure that:

- Provides a full range of informed choices in how electricity is produced, stored, transported and consumed.
- Facilitates achievements of the greenhouse gas (GHG) emissions reduction goals enshrined in the Climate Change Act.
- Delivers a level of supply security, reliability and resilience acceptable to all consumers and system users.
- Delivers energy at an appropriate affordable cost for current consumers, and future consumers.
- Is agile and responsive to much more dynamic external change drivers than the industry has hitherto accommodated or can necessarily foresee.
- Facilitates an effective market in energy and energy services.
- Supports and exploits innovation by consumers and communities with rapid scale-up where successful.

- Is an effective pathfinder for a whole-systems approach across the wider energy sector.
- Helps the shaping of energy policy in a whole-system context.
- Facilitates constructive change for existing parties, facilitating new means of value creation.
- Incorporates sustainable and equitable mechanisms supporting full stakeholder participation.

The overall FPSA objective is to:

- Consider the required future functionality of the whole of the electricity power system including supply, transmission, distribution and the customer's side of the meter.
- Enable and facilitate consumer and community-led, grid edge and grid-embedded innovation and demonstration, including its rapid scale-up where successful.
- Enable the potential of the traditional power system assets to be fully exploited to deliver the future required electricity power system functionality.
- Be a pathfinder for, and to integrate with, whole-systems thinking across the energy sector as a whole and where appropriate to integrate with other infrastructures (smart cities, transport, telecommunications, water and wastewater, etc.).
- Inform future energy policy so that future policy options (e.g. decisions on major projects, or new market arrangements) are considered in a whole-system context.
- To inform future institutional arrangements that will enable the above to be achieved sustainably and equitably, with a responsive capability that includes full participation of stakeholders across the whole system from supply-side to demand-side.
- Enable a transition to these new arrangements that, as far as practicable, creates opportunities for existing industry players to find new means of value creation, and to minimise the risk of stranded investments.
- Do all of this in an open and inclusive way for all traditional and new stakeholders, and to the ultimate benefit of electricity consumers and wider society.

### 5.1.2 Structure of FPSA
The following activities are considered as components of the evolving FPSA programme:

- A series of reports produced by the Power Networks Joint Vision (PNJV) expert group of the Institution of Engineering and Technology (IET) set the background and created the foundations for FPSA. This included classing the challenges facing the GB power system as a major transformative change, and exploring the potential value of system architecture and governance.
- FPSA1, which reported in July 2016, assessed the significance of the transformative change, and called on the power industry and government to focus urgently on delivering new capabilities to transform Great Britain's power system architecture by 2030, making it fit to respond to the challenges presented by the energy trilemma. FPSA1 was commissioned by the former Department of Energy and Climate Change (DECC) whose portfolio is now part of the Department for Business, Energy and Industrial Strategy (BEIS).
- FPSA2 has taken forwards the recommendations of FPSA1. The work has been conducted by the team which collaborated to deliver FPSA1 – the Energy Systems Catapult and the IET – with contracted expert support, and funding from Innovate UK via the Catapult.
- Activities to take the FPSA agenda forwards are recommended in the FPSA2 report, subject to funding and authorisation.

## 5.2 FPSA2 project purpose and structure

### 5.2.1 FPSA2 project purpose
The purpose of FPSA2 was to deepen the analysis of requirements, understand barriers to implementation, and to consider innovative frameworks for delivering new functionality. FPSA2 proposes an agile approach enabling inclusive and diverse stakeholder collaboration and a framework for ensuring timely delivery of functionality at a whole system level.

In more detail, the project objectives were to deliver:

- A comprehensive exploration of the current and future requirements of both existing and emerging stakeholders.

- A review of the *thirty-five* FPSA1 functions to identify possible gaps or new insights into required functionality.
- An assessment of the feasibility of delivering the functions under the current power sector structure.
- Identification of possible areas of RD&D and Innovation.
- A methodology for assessing the probability and consequence of late or non-delivery of the functions.
- A methodology for determining the relative impact of the identified barriers to functions under the current structure, and hence the priorities for establishing *Enabling Frameworks* to address those barriers.
- The identification of a number of *Enabling Frameworks* for development under FPSA3 to deliver the functions.
- An overall systematic approach to FPSA2 that will ensure development of practical methods for dealing with the complexity and uncertainty of innovative transformation in the electricity sector.
- Full documentation of both the methodology and outputs to provide the necessary audit trail and overall process assurance.
- A clear explanation of the complex messages delivered to relevant audiences throughout FPSA2.

### 5.2.2 FPSA2 project structure

Project delivery is structured into a set of seven Work Packages, each with its own purposes, expertise, methods and management. The structure was designed to meet both specific objectives and overall purposes of the project.

Figure 5-1 below shows the project as a system of concurrent, purposeful activity. This model of the project is further developed and discussed in section 6.2.

This model draws distinctions between the following three domains of activity:

1. The environment of the project **which is setting the context for FPSA2** (shown at the top of the figure).
2. **Delivering FPSA2** though a set of operational activities which are shown, in this figure, in terms of the defined Work Packages (WP1A, 1B, 2, 3, 4, 5 and 6).
3. The activities of **organising and steering FPSA2** to ensure the project is managed as a coherent whole and remains (at the level of the whole project) adaptive to changing circumstances.

The structure and approach to delivering the FPSA2 project, based on Figure 5-1, is an inherent aspect of the FPSA2 project methodology.

Figure 5-1: The FPSA2 project as a system of activity, in context
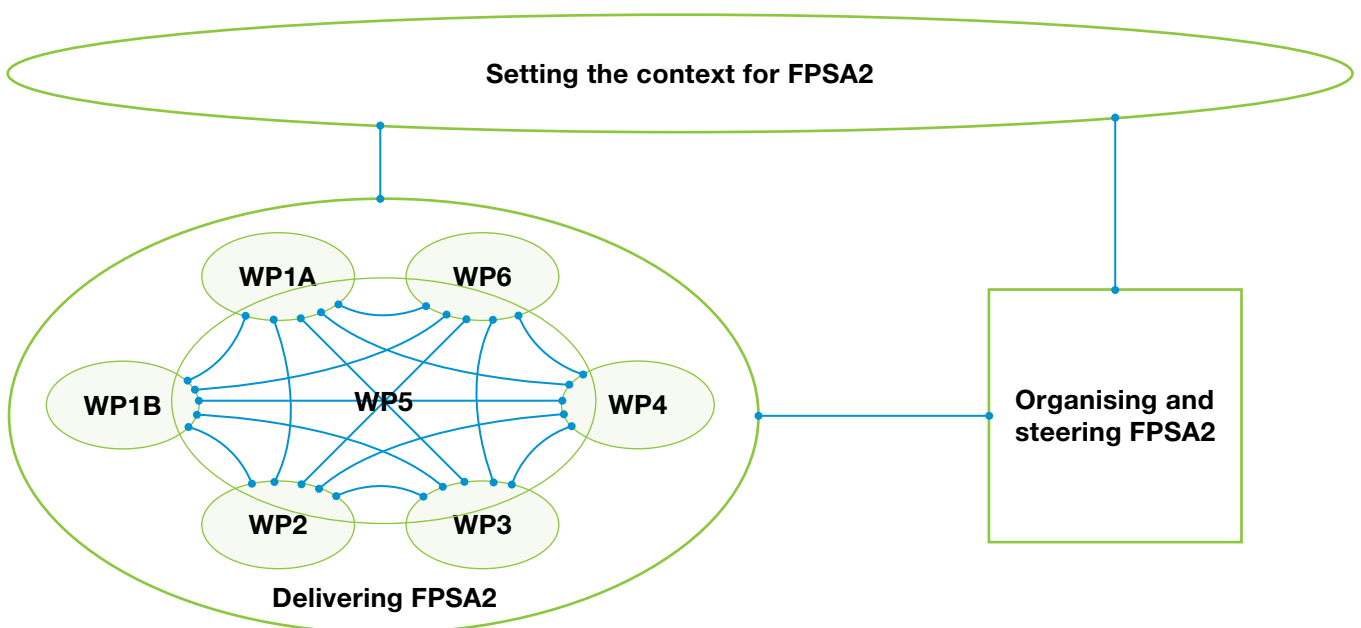
The blue lines in Figure 5-1 indicate interactions between the various different activity sub-systems shown. In general, these stand for complex interactions which could be decomposed at a less abstract level to show more detail. Thus, for example, the interaction between project delivery and the project context will be made up of interactions between each Work Package and different aspects of the wider environment. This level of detail is discussed further in section 6.2.

Any given interaction, in the most general sense, may include not only transactions (one-way or two-way exchange of, for example, information) but also collaboration, dialogue, learning and co-creation. As a general principle, the people involved in the activities at "either end" will determine the details of what is required in any given interaction, but an appropriate framework is required to encourage and facilitate effective interaction where this is in the interests of the functioning of the whole. Establishing conditions for effective interaction was a key part of the project methodology, including encouraging relationships of trust to be built, and establishing both formal and informal information exchange and agreements between Work Packages.

## 5.3 Project governance

The processes of organising and steering the FPSA2 project, indicated on the right hand side of Figure 5-1, were provided by governance and management arrangements through the Joint Sponsors Board (JSB), Project Delivery Board (PDB) and the Steering Group, supported by the IET and ESC staff providing Project Management Office functions, and the Synthesis Team providing synthesis and integration of project delivery activity.

The approach to delivering the project was built on collaborative engagement between the Energy Systems Catapult (ESC), the Institution of Engineering and Technology (IET) and Innovate UK as the funder.

The activity and operation of the boards were defined and conditioned by agreed Terms of Reference. The project risk register was a key document shared between the various project groups to enable ongoing risk management at various levels of decision-making.

Figure 5-2: FPSA2 governance bodies
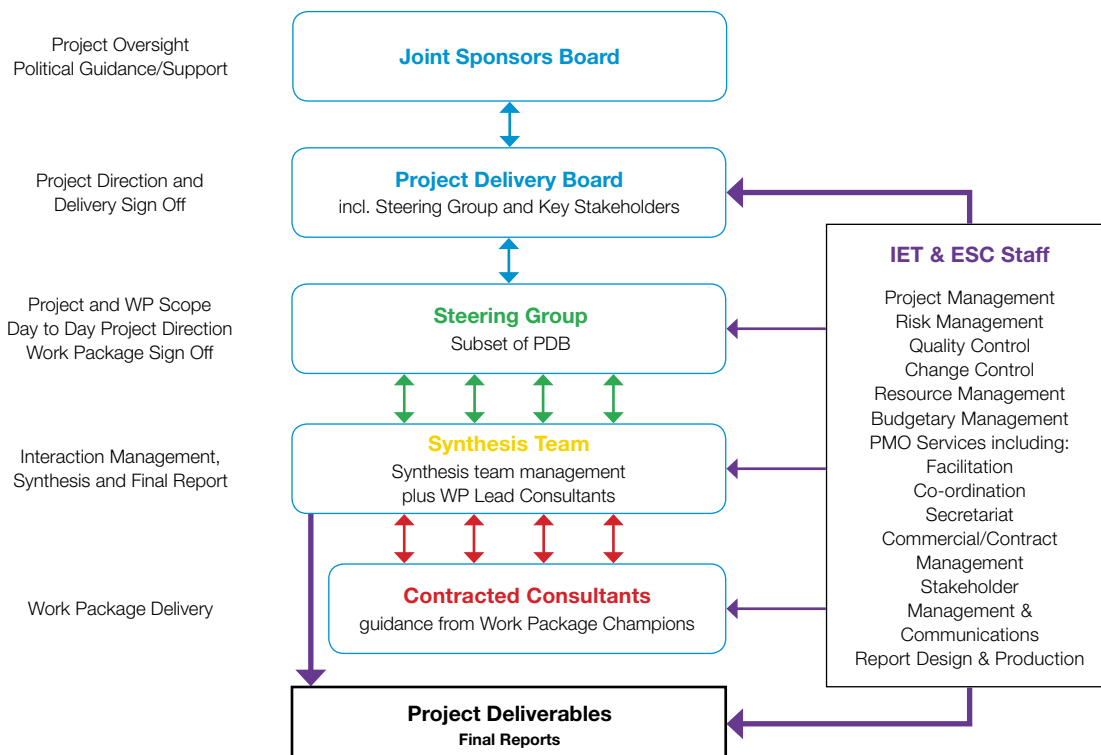
### 5.3.1 Joint Sponsors Board

The Joint Sponsors Board (JSB) comprised representation from the project sponsor organisations (Innovate UK, the ESC and the IET), with observation from BEIS.

The function of the JSB was to provide and assure project strategy, and to support key stakeholder engagement and management, taking a leading role in dialogue with government, regulatory bodies and industry. It worked with the Project Delivery Board (PDB) to assure successful delivery of the project. The JSB was convened by the ESC.

### 5.3.2 Project Delivery Board

The Project Delivery Board (PDB) comprised membership that is sufficiently inclusive to represent key stakeholder communities. The PDB provided oversight and direction of the work, and were responsible for definition, preparation and delivery. The PDB worked with the JSB regarding key stakeholder engagement. It was convened by the IET.

### 5.3.3 Steering Group

The Steering Group, made up of selected members of the PDB, provided day-to-day direction of the work on behalf of the PDB. The Steering Group kept in close contact throughout the project, in line with the agile project methodology, with regular conference calls twice weekly to review and steer progress.

Champions for each of the delivery Work Packages and the Synthesis Work Package (WP5) were drawn from the Steering Group.

## 5.4 Work Package purposes

Each FPSA2 Work Package had its own purposes.

### 5.4.1 Stakeholder Engagement (WP1A)

WP1A sought to understand current and future requirements and their implications for the whole system, through engagement with a range of stakeholders.

### 5.4.2 Future Stakeholders' Needs (WP1B)

WP1B sought to understand requirements of future stakeholders and potential implications for the power system, including cultural, societal and behavioural issues.

### 5.4.3 Functional Analysis (WP2)

WP2 checked the validity and completeness of functions identified in FPSA1, and identified areas of potential RD&D and Innovation to assist delivery.

### 5.4.4 Impact Analysis (WP3)

WP3 identified the barriers to developing and implementing the functions within current sector processes and assessed the impact of late or non-delivery.

### 5.4.5 Enabling Framework Identification (WP4)

WP4 explored how future system functionality could be enabled to meet various and changing needs in a changing landscape. FPSA1 concluded that new functionality will require new frameworks to enable delivery because of the whole system nature of the challenge. These *Enabling Frameworks* will combine governance, stakeholder engagement, planning and implementation capabilities.

### 5.4.6 Synthesis and Integration (WP5)

WP5 managed the project, ensuring integration of the work streams and synthesis into a final report and other deliverables. It also managed the development, and peer challenge, of the project through its Steering Group and Project Delivery Board.

### 5.4.7 Dissemination (WP6)

WP6 ensured the project's purpose and findings are expressed clearly and are accessible to diverse audiences and appropriate for different groups of stakeholders.

# 6. The Project as an Agile System of Concurrent Activity and Interaction

## 6.1 Overview

One of the aspects of the project methodology was to explicitly structure the project as a system of activity (see section 4.2).

In designing FPSA2 as a project, it was recognised that there would be significant interdependencies between Work Packages and, furthermore, that the details both of these interactions, as well as work to be done within each Work Package, would develop through emergent thinking throughout the process, and should be enabled to do so within the constraints of delivering overall project objectives.

In systems thinking, a system is a set of parts which is interconnected to produce the functioning of the whole, in context. The "parts" might in general be thought of as things, but it can be more helpful to think of the parts in terms of what they do. This is the approach taken here. In this way of considering a system, the parts are described in terms of their activity, such that the relationships between them can be naturally thought of as dynamic interactions.

The interactions between activities are critical to the functioning of the whole, and were therefore subject to significant focus to achieve project synthesis.

As with any system that involves human activity,

each group and individual will have their own purposes. Viewing the project as a whole system of activity can help to encourage participants and teams to be aware of the roles they play in the whole project system, while also keeping sight of individual responsibilities and level of autonomy.

Ongoing iterative learning can be seen, when considering a set of concurrent, interacting activities, as a natural aspect of the way in which the system develops and delivers, if enabled to do so. Iterative learning is important for any activity characterised by complexity, uncertainty and innovation.

As noted in section 4.3, the complexity of the transformational change facing the electricity system as a whole provided additional motivation to learn about methods of structuring activity to deal with complexity, uncertainty and innovation.

## 6.2 A model of the project as a system

In Figure 6-1 below, the delivery and synthesis activities of the project are shown as a set of activities which interact with one another, and which may in general operate concurrently, to form a whole system of activity that collectively delivers outcomes over time. The top of the figure acts as a reminder that the project only exists in context. Selected key interactions are identified.

Figure 6-1: The FPSA2 project as system of interacting concurrent activities, showing selected interactions and a level of detail within Work Packages

**Setting the context for FPSA2**

Future needs and trends　　　Stakeholder insights　　　Dissemination

**Stakeholder Engagement (WP1A): Exploring current and future needs of existing and new parties, and their contributions to the whole system**

- Reporting
- Defining and refining the WP2 methodology
- Cross checking findings
- Analysing findings
- Reporting

**Communications and Dissemination (WP6): Ensuring the project's purpose and findings are expressed clearly and are accessible to diverse audiences and appropriate for all stakeholders**

- Understanding the stakeholder landscape
- Developing messaging and materials for diverse audiences
- Understanding FPSA2 project and findings
- Selecting communication techniques

Selected questions　　　Research alignment　　　Project overview (from all)

**Future Stakeholders' Needs (WP1B): Exploring future needs of future stakeholders, and their contributions to the whole system**

- Gathering evidence
- Defining and refining the WP2 methodology
- Identifying gaps
- Deriving implications for the power system
- Reporting

***Enabling Framework* Identification (WP4): Defining how the future system functionality could be enabled to meet various and changing needs in a changing landscape**

- Discovering
- Designing and developing
- Validating
- Reporting

Stakeholder evidence　　　　　　Function needs　　　Pre-structuring *Enabling Frameworks*

**Functional Analysis (WP2): Checking the validity and completeness of functions identified in FPSA1 and examining options for further R&D to assist delivery, especially of no-regrets measures**

- Reporting
- Defining and refining the WP2 methodology
- Investigating delivery solution options and implementation challenges
- Reviewing and developing definitions of functions, including their "needs"
- Developing RD&D and innovation opportunities

Mutual understanding

Informing RD&D

**Impact Analysis (WP3): Identifying the barriers to developing and implementing the functions within current sector processes and assessing the impact of late or non-delivery**

- Reviewing and categorising barriers and consequences
- Defining and refining the WP3 methodology
- Assessing difficulty, consequences and immediacy
- Analysing and interpreting results
- Developing RD&D and innovation opportunities
- Reviewing and verifying

**Synthesis and Methodology (WP5): managing the project, ensuring the proper integration of the work streams and successful synthesis into a final report and other deliverables**

- Defining and refining overall project methodology
- Managing synthesis and integration of work streams
- Reporting and reviewing outputs

The main activities within each Work Package are indicated in Figure 6-1. Before getting into this detail of individual Work Packages in the next section, this section considers interactions between the project and the outside world, and interactions between Work Packages, treating each Work Package as a "black box" with its own purposes.

The nature and depth of interaction varied, depending on both the perceived need for interaction, and the specifics of the human relationships and processes established between the actors.

At the top of the model, evidence of future needs and trends flowed into the project via WP1B, and stakeholder insights via WP1A. Dissemination of project findings back out of the project (top right) was conducted by WP6. These interactions are shown.

For simplicity, interactions between the other Work Packages and the project context are not shown. These include research using public domain documentation, and bringing in contracted consultants' experience and knowledge, to support the review of power system functionality (WP2), the assessment of implementation barriers and consequences for non-delivery (WP3), and to inform the development of *Enabling Framework* concepts (WP4).

There was a range of interactions between Work Packages. Working down the left hand side of the model, and back up the right hand side, these included:

- WP1A-WP1B: Aligning the approaches to stakeholder research and engagement activities, where relevant, assisted by two of the same consultancy organisations being involved in both Work Packages.
- WP1A-WP2: Early discussion to enable WP2 to provide input into interview questions, with stakeholder evidence being returned to WP2 to support the function review process, including via direct involvement of WP2 consultants in selected interviews. Similar exchanges occurred between

WP1A with WP3 and WP4, although for simplicity these interactions are not shown on the model.

- WP1B-WP2: Evidence on future stakeholder needs and the relevance for power system functionality was provided by WP1B to WP2, including through face-to-face discussions of the approach and findings.
- WP2-WP3: The same team of consultants delivered both Work Packages, so close interworking was built in. This helped to build mutual understanding of the functions, implementation barriers and consequences for non-delivery. In addition, implementation barrier analysis by WP3 provided an input to the assessment of RD&D and Innovation opportunities by WP2.
- WP2-WP4: Early work by WP4 identified the value of defining the "needs" of the functions, including processes and technology enablers, to provide clarity on the requirements of the *Enabling Framework* for each function. This led to a modification to the method within WP2 to include the definition of needs against each function as part of the functional review process.
- WP3-WP4: There was an early recognition, through interaction enabled by the synthesis activity, of the need for close alignment and co-development of the structure of WP3's analysis of implementation barriers to enable alignment with the *Enabling Framework* pre-structuring process. Further discussion of this work is provided in section 8.2.5.
- WP6 interactions: Gathering information about Work Package activities and outputs from across the project informed the development of project communication and messaging.
- WP5 interactions: WP5 was a project-level management function. In one sense, the co-ordinating function of WP5 can be viewed as being made up of the aggregate of all the interactions between Work Packages discussed above. Regular (weekly) Synthesis Team meetings between Work Package consultant leads and the Synthesis Team management provided the framework for ongoing management of synthesis activity. These interactions are not shown, for simplicity.

Figure 6-2: Project plan showing the three iterative phases of the project which involved contracted consultants
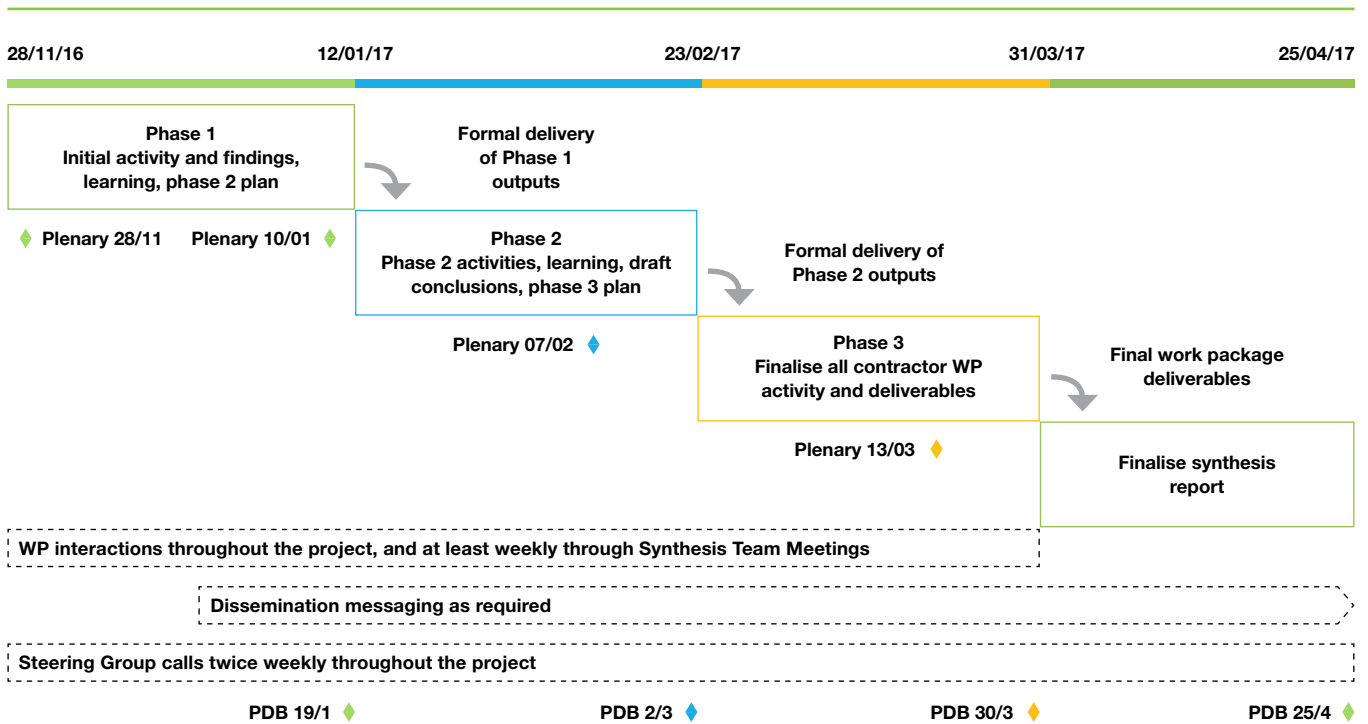


## 6.3 Agile approach and iterative phases

The interactive nature of the work in FPSA2 drove a need for an agile approach to the project, with information exchanging regularly and smoothly between the Work Packages, and requirements for collaborative working between Work Packages identified and acted upon as required. In order to facilitate this, the FPSA2 timeline was organised into three phases for the main bulk of the work, as illustrated above.

Each of the Work Packages had the same phases, with the same dates. These were considered to be "passes" of the project, where each Work Package should consider, to some level, the whole scope of the project in each phase. There was a formal deliverable from each Work Package at the end of each phase, which was used by the other Work Packages in the next phase. This phased working was supported by four plenary sessions, where the project teams and Steering Group met to discuss content and raise issues.

Interaction, discussion and joint work was enabled throughout the project, not simply at the end of phases. This was supported and facilitated by weekly Synthesis Team calls, which encouraged

informal content exchange and discussion. The Work Packages were then encouraged to identify areas of synergy between them and other Work Packages, and useful interaction which they can pursue beyond the organised calls. This included additional calls, and meetings between key individuals. It is noted that "stand-up" meetings every day, which are common feature of agile project methodologies in the context of software development, were not directly applicable to this project given the geographic dispersion of teams and the fact that consultant teams were not employed full-time on this project.

In addition to the weekly "heartbeat" calls of the Synthesis Team, the project Steering Group held regular conference calls twice a week, including all Work Package Champions along with synthesis team management by invitation, to ensure close day-to-day direction of the work.

Ongoing iterative learning within and between Work Packages was complemented at the end of phases 1 and 2 by reflection and reviews of learning, both in terms of outputs as well as project process. These insights were captured in the interim Work Package reports, and used to inform planning for subsequent phases.

# 7. Work Package Methodologies

In general, the consultant delivery teams for each Work Package proposed, developed and delivered their work based on their methodologies. FPSA2 included additional methodological oversight through the contracted role of Methodology Manager, operating through the Synthesis Team of WP5.

This section summarises the methodologies used within each Work Package. This demonstrates that each Work Package followed a defined, robust methodology and that, in each case, various details were refined during project execution in response to learning. The Work Package reports contain additional detail.

## 7.1 Common features of Work Package methodologies

All Work Packages included the following features in their methods, encouraged through structure and guidance provided by the Synthesis Team in line with the overall project methodology:

- Defined and structured Work Package methods designed to meet objectives.
- Evidence-based approach, drawing on a range of types of evidence as appropriate for the specifics of the work.
- Iterative development, both with respect to findings and, in general, to the detail of the methods used, through ongoing learning within the Work Package, guidance and challenge from the Work Package Champion, ongoing interactions with other Work Packages through the Synthesis Team, reflection as part of end-of-phase reporting processes, and peer review by the wider Steering Group and PDB.

## 7.2 Stakeholder Engagement (WP1A)

WP1A engaged with a range of stakeholders to provide evidence on the requirements of existing and new parties.

Methods were defined and refined:

- Fourteen groups of stakeholders were defined, and representatives of each group were successfully engaged. This included established power sector players, market players operating non-traditional business models, local authorities,

community energy schemes, smart city developers, electricity consumers and a range of others.
- Three methods of primary research were used: telephone interviews and a stakeholder workshop (for commercial and public sector stakeholders), and an on-line survey for domestic consumers.
- Interview and survey questions were developed with input from all Work Packages, and the interview questions refined, to reduce complexity, as a result of learning from initial interviews early in the project.
- A distinction was created, during the project, between Discovery Interviews to gather a wide range of views and insights, and Focused Interviews conducted with representatives from other FPSA2 Work Packages to allow more targeted questioning around specific issues of importance.

Stakeholders were engaged for their views via:

- An online consumer survey with a pre-existing panel of 1,000 domestic consumers, resulting in a 48% return rate.
- 32 telephone interviews, made up of 25 discovery and seven focused interviews
- A stakeholder workshop towards the end of the project, with 11 of the stakeholders, to review consolidated findings.

Stakeholder issues identified by the interviews were analysed to determine their root causes, and the extent to which these root causes are expected to be addressed by the FPSA functions, drawing on interview findings, consultant expertise, additional desk-based research and discussion with other Work Packages. This analysis was guided by a process of generating a set of hypotheses from initial interviews in phase 1, which were further explored and refined in subsequent phases to become WP1A findings in phase 3.

A level of cross-checking of findings was carried out, especially in cases where views were suspected or known to be incorrect by the interviewers, or where different stakeholders provided conflicting opinions.

This was done by:

- Checking during weekly phone calls for clarification, sources etc.
- Checking after the call with members of the wider project team and secondary sources of information to verify statements.
- Seeking examples in published research, policy or regulatory documents.
- Recognising that there may be legitimate reasons for different points of view.

In phase 1, the questionnaire and interview approach was developed and tested with seven interviewees, and initial hypotheses generated. In phase 2, questions were refined and a further 23 interviews completed, the online survey was prepared and conducted, along with ongoing cross-checking and analysis. Final interviews and analysis were completed in phase 3, contributing to and in alignment with the emerging project narrative, and culminating in the stakeholder workshop towards the end of the project.

Interactions through project synthesis activity enabled WP1A findings to be developed and considered as supporting evidence across the evolving project narrative, in particular in support of FPSA functions reviewed by WP2, as well as the changing needs and wants of society, implementation barriers considered by WP3, and governance issues included in WP4.

## 7.3 Future Stakeholders' Needs (WP1B)

WP1B explored requirements of future stakeholders, including domestic customers, SMEs, communities and cities, seeking to understand potential implications for the power system including cultural, societal and behavioural issues.

A research and evaluation model was developed to provide structure to the synthesis of evidence:

- Focusing on the aspirations, attitudes, behaviours and motivations of stakeholders.
- Based around cross-cutting "horizontal" themes such as mobility.
- Enabling step changes to be envisioned, beyond the more incremental changes which may be inherent in current innovation and business models.

- Drawing on existing research and insights through desk-based research coupled with targeted interviews.
- With refinements being made to the model in response to experience of use.

Three horizontal themes were chosen – **mobility, heating and cooling, and connected and distributed energy** – and evidence gathered for each from:

- Existing literature.
- Interviews with key research bodies and institutes.
- Insights from the project team.

Implications for the power system were derived from the evidence by mapping it onto the model to draw out key findings in order to identify future stakeholders and their power system requirements.

Gaps in research were identified and filled as an iterative part of the analysis process.

The phasing of the project enabled the first theme (mobility) to be addressed in full by the end of the first phase, providing an end-to-end test of the Work Package methodology and early sight of the structure and content of the analysis and findings across the project. Details were refined in phase 2 based on feedback, while completing the majority of work on the heating and cooling theme, and commencing research into the third theme of connected and distributed energy. Phase 3 enabled alignment with the overall project narrative and completion of the research and analysis.

Interactions enabled by project synthesis activity allowed WP1B findings to be developed and considered as supporting evidence for drivers and future power system functionality, highlighting the range of potential future power system stakeholders, and their changing and uncertain demands, that may require a more agile and inclusive approach to change.

### 7.4 Functional Analysis (WP2)

WP2 checked the validity and completeness of the new and enhanced power system functions identified by FPSA1, and also examined options for RD&D and Innovation.

A review methodology was defined to enable independent assessment of the validity and completeness of the functions through a structured scoring mechanism, coupled with additional evidence gathering to supplement work carried out in FPSA1.

The definitions of functions were reviewed and developed in accordance with the methodology, resulting in:

- Adjusting the definition in response to research findings, or modifying the wording where required to clarify the meaning, formally approved via the Steering Group as proposals arose.
- A definition of the "needs" of the functions in terms of their process components and interdependencies, which emerged as a project requirement through the development of *Enabling Framework* proposals by WP4.

The work also involved investigating delivery solution options and implementation challenges, and proposing RD&D and Innovation opportunities.

In broad terms, phase 1 focused on an initial appraisal of all *thirty-five* FPSA functions, phase 2 developed a deeper understanding including development of the needs of the functions and test cases in response to *Enabling Framework* requirements from WP4, and phase 3 focused on RD&D and Innovation opportunities.

### 7.5 Impact Analysis (WP3)

WP3 identified barriers to developing and implementing the functions in the context of current sector arrangements, and assessed the consequences of late or non-delivery of the functions.

The WP3 methodology was designed to define a measure of the risk to the delivery of energy policy with respect to each of the functions. The methodology was broadly consistent with that of a risk assessment. The number and materiality of the barriers for each function was assumed to correlate with the probability of the function not being delivered (due to the inability of the sector to overcome these barriers). Together with the consequences of delivering the function late, or

of non-delivery (the impact of not delivering the function), the risk to delivery of energy policy could be quantified. This quantitative approach allowed for the identification of functions with relatively higher difficulty and consequences and the prevalence of different types of barriers. The methodology therefore quantified risk in relative rather than absolute terms.

The methodology was refined in the early stages of the project, building from an original outline approach developed in advance by the Steering Group. The relative risk to delivery of energy policy combined assessments of difficulty, consequence and immediacy, as follows:

- Difficulty - identified the barriers to implementation of each function, and related to the probability of the function not being delivered due to the inability of the sector to overcome these barriers with current sector arrangements.
- Consequence - considered the extent to which the decarbonisation, security and affordability objectives of energy policy would be impacted by late or non-delivery of the function.
- Immediacy - provided a way of indicating the order in which functions need to be delivered, considering interdependencies and the FPSA1 Evolutionary Pathway. The inclusion of the immediacy parameter enabled consideration of function sequencing in prioritising the removal of function barriers.

Barriers and consequences that apply to the functions were reviewed and categorised. Barrier categories were defined as Technical, Commercial, Governance and Societal. Consequence categories were defined, according to the trilemma, as Decarbonisation, Security and Affordability.

Difficulty (based on the barriers), consequence and immediacy were then assessed for each function. The three test case functions selected to validate the *Enabling Frameworks* in WP4 were subject to more detailed barrier analysis.

Analysis and interpretation included results visualisation, function prioritisation and barrier prioritisation. Visualisation of results used a range

of different graphical techniques including radar plots. Function prioritisation helped to inform work by WP2 on identifying potential RD&D and Innovation activities, by focusing on functions with high consequence and high immediacy. Barrier prioritisation identified barriers that are most prevalent across all functions, analysis which can be used going forwards to inform the development and focus of *Enabling Frameworks*.

A review and verification process was developed in phase 2 to ensure that the final results are robust, defensible and not significantly influenced by individual or group biases. This included peer review within the WP3 team and with the WP3 champion, and peer review with the wider FPSA2 team including detailed review of the three test case functions.

WP3 delivered a full first pass assessment of the barriers and consequences related to each of the *thirty-five* functions in phase 1 of the project to refine and test the Work Package methodology and provide early sight of the shape of the results to others. Phase 2 deepened the analysis, including responding to feedback, and built on initial collaborative work with WP4 around barrier specifications and test cases for *Enabling Frameworks*. Phase 3 completed the analysis, responding to further peer review, and developed and refined the presentation of results.

### 7.6 *Enabling Frameworks* Identification (WP4)

WP4 explored how future system functionality could be enabled in order to meet various and changing needs in a changing landscape. FPSA1 concluded that new functionality will require new frameworks to enable delivery because of the whole-system nature of the challenge. These *Enabling Frameworks* will combine governance, stakeholder engagement, planning and implementation capabilities.

The work focused on the preparation of *Enabling Frameworks*, in advance of their implementation and operation in future, subject to approval and funding. The methodology was designed to embody the approach that the frameworks themselves will apply, including agility and flexibility, and the ability to cater for multiple perspectives, drawing on existing industry realities and various stakeholder roles and needs.

The main activities of the methodology were:

- Discovering.
- Designing and developing.
- Validating.

Aspects of these activities ran concurrently throughout WP4's work, interacting with one another, as well as with other project activities, and drawing on information from stakeholders, industry and the wider world. This concurrency of activity is key to enable learning throughout the process to support the desired agility and flexibility in the approach.

In practice, the mix of activity varied across the three phases. Phase 1 dealt with discovery and initial design including early thinking about testing and validation, while phase 2 focused on design and development, and explored the approach to validation with WP2 and WP3 using test case functions, supported by additional discovery research, and phase 3 deepened the validation work on test case functions and concluded the design and development work.

Discovery activities combined research with team discussion and brainstorming. Background desk-based research focused on a number of themes, including change and transformation models, change in highly complex systems, change leadership and complex system leadership, and whole-system change. Team discussions and brainstorming sessions sought to explore definitions of, and approaches to, *Enabling Frameworks* with an open mind. This included framing discussions around key questions from within and outside the core WP4 team, drawing on the experience of the team and background research. Initial discovery activities were used to inform the drivers, requirements, input and outputs for *Enabling Frameworks*, with ongoing desk-based research, and interactions with other Work Packages, providing further evidence to support the developing approach.

The design and development activity resulted in an *Enabling Framework* model of increasing detail throughout the project, starting from an initial high-level model provided for consideration, review

and agreement across the project. It was quickly recognised at the outset that focusing *Enabling Frameworks* on the functions as defined by FPSA1 would be the most appropriate starting point, given the central role that these functions play in FPSA thinking, based on the system engineering approach adopted in FPSA1. The approach included socialising concepts and language for discussion and agreement across the project. A strawman approach was adopted to promote discussion and inform improvements to the simple *Enabling Framework* starting point. This facilitated WP4 team thinking, sharing with the wider FPSA2 team, gathering feedback and the ability to iterate quickly. Numerous iterations of the *EF* strawman were developed to further understand the questions identified through the discovery activities with each iteration helping to clarify and develop learning. Development activity focused on elaborating key elements of the *EFs* to ensure real world context relevance and effectiveness.

Validating the *EFs* in the context of FPSA2 involved the selection of three test case functions, via a set of criteria, to test the *Enabling Frameworks* with challenging and complex functionality covering both technical and market-oriented issues. These were used to validate, in desk-based tests, the extent to which the *Enabling Framework* approach is fit for purpose when applied to specific functions. Validation involved significant interaction with WP2 and WP3, building on earlier work with these Work Packages to ensure alignment between WP2 outputs on function "needs", and WP3's work on implementation barriers.

An extended presentation of the *Enabling Framework* proposals at the final plenary session mid-way through phase 3 generated a range of additional peer review comments and challenge from the Steering Group and consultant teams which were incorporated in the final WP4 report and overall FPSA findings.

### 7.7 Synthesis and Integration (WP5)
The primary function of WP5 was to ensure synthesis and integration of the work carried out by FPSA2, ensuring a robust methodology, and the delivery of the final report. Its function therefore sits as part of the project methodology itself, rather

than as a core project activity with its own research, analysis and findings.

Elements of the approach to WP5 were:

- Defining and refining the project methodology itself, as described in this report.
- Managing synthesis and integration through the application of agile principles and a framework to enable co-ordination between the various activities.
- Reporting.
- Providing oversight and peer review of the project through the Steering Group and the PDB.
- Steering Group input to project strategy development in response to external and internal developments.
- Helping to maintain project identity over time through the work of the Steering Group.

The project methodology as a whole provided a framework within which each of the individual Work Packages could operate, and effectively interwork with one another and with the world outside the project, as required.

The project took a robust approach to evidence. In the final reporting, clear linkages were drawn between the conclusions and the evidence that supports it.

### 7.8 Dissemination (WP6)

WP6 has ensured that the project's purpose and findings are expressed clearly and are accessible to diverse audiences and appropriate for different groups of stakeholders.

To assist with the process of messaging to different audiences, the diverse range of stakeholders of the power system was categorised into five broad groups. The range of topics of likely interest to each group, including drivers, opportunities, requirements and relevance of the FPSA functions, were collated to provide a knowledge base from which to develop tailored messaging, as required, for specific audiences.

Selected communication techniques included the use of blogs throughout the project, coupled with standard printed and online reporting, and dissemination events. The activity was also supported by circulating press releases to targeted media and articles were placed in Energy Systems Catapult and IET communications with registered stakeholders, through e-newsletters.

Ongoing interactions between WP6 and other Work Packages ensured that the communications team built an understanding of the project approach and findings throughout the process. These interactions also provided challenge back to the Work Package teams to ensure clarity of messaging and presentation.

The dissemination work was overseen by the Communications Steering Group which included the communications team and selected members of the Project Steering Group. The terms of reference of the Communications Steering Group included:

- To ensure consistency of messaging across the FPSA2 project.
- To review activities in the communications timeline, making sure that all milestones are being met.
- To comment on and approve out-bound communications (then circulated "for information and deal-breakers only" to the Steering Group).
- To raise and discuss wider issues in the market that could impact on FPSA2.
- To exchange ideas.
- To provide for onward communication of key developments to the wider FPSA2 project team.
- To benefit from the value of direct interactions/ information gathering from stakeholders in WP1A (audience insights).
- To work with WP4 to ensure communication around *Enabling Frameworks* is effective and consistent.

# 8. Managing Synthesis and Integration

The practicalities of achieving synthesis as an ongoing process included:

- Facilitation of interaction between Work Package teams.
- Plenary sessions and specific facilitated working sessions.
- Development of the overall project narrative as a focus for synthesis.
- Practical tools to support interaction and exchange of content.

## 8.1 Facilitation of interaction between Work Package teams

As regular interaction between Work Packages was key to the success of the project, it was important to encourage, enable, and facilitate this. The nature of these interactions were tailored to the needs of the project activities within the Work Packages at the time of the interaction, and included for example, exchanging information, inputting into each other's work, or joint discussion and decision.

A principle adopted was to maximise the ability of Work Package teams to both identify and define the characteristics of necessary interaction. It is these

parties who can best understand the requirements that they have from such an interaction, and can judge how best to use time and resource to achieve these goals.

A regular weekly call involving the lead consultant from each of the Work Packages and Synthesis Team management helped to create an ongoing awareness of the activities and outputs of other Work Packages, the relationship to the work within each Work Package, and a view of the whole project and its goals. Each of the Work Packages gave a general update on progress and outputs, with ongoing tasks, risks and issues being discussed. Each call allowed tracking of the project over time, and provided a forum for regular communication to be set up, and then continued beyond the call as required. This was a key way in which further interaction was triggered.

In some cases, opportunities for benefits from interaction between Work Packages were not immediately obvious to those in the Work Package. WP5 used its holistic view of the project and its requirements to identify these, and aimed to trigger these where appropriate.

Over and above the weekly calls, interactions between Work Package teams included information exchange, phone calls to discuss specific points and make decisions, pre-scheduled plenary meetings, and various other face-to-face working meetings which arose in a variety of ways from direct arrangement between the teams to direction and facilitation by Synthesis Team management. The use and effectiveness of different approaches are considered in section 9.

## 8.2 Plenary sessions and specific facilitated working sessions

The project included a number of plenary sessions that brought together the whole project team of contracted consultants and Steering Group members:

- Plenary session 1, Kick Off Meeting, London, 28 November 2016.
- Plenary session 2, Phase 1 End Point Review, Birmingham, 10 January 2017.
- Plenary session 3, Phase 2 Interim Review, London, 7 February 2017.
- Plenary session 4, Phase 3 Interim Review, Birmingham, 13 March 2017.

Two additional one-day working sessions, facilitated by the Synthesis Team management, were included to address the need for specific collaborative development between WP2 (Functional Analysis), WP3 (Impact Analysis) and WP4 (*Enabling Framework* Identification).

### 8.2.1 Plenary session 1, Kick Off Meeting, 28 November 2016

The FPSA2 kick off meeting brought together representatives of each of the consultancy consortia providing services into WP1A, WP1B, WP2, WP3 and WP4, and was managed by WP5. WP6 representatives were not available at that time. The one-day working session was held on the very first day of the project, with the following objectives:

- Meet one another to begin to build the project team.
- Establish the ground rules and working patterns to ensure effective interaction between Work Packages.
- Build sufficient understanding to proceed with confidence in the initial tasks.

Informal feedback was gathered at the end of the session. Participants reflected that the opportunity for everyone to meet one another at the outset of the project was helpful in establishing a collaborative environment, and encouraging all to think about, and commit to, providing one another with specific information. Some points for improving aspects of the workshop process were gathered and used to inform subsequent sessions.

### 8.2.2 Plenary session 2, Phase 1 End Point Review, 10 January 2017

The second plenary session included consultant and Steering Group representatives for all work packages. The objectives were to:

- Provide a chance for face-to-face communication and cross-thinking between WPs.
- Report and reflect on progress in Phase 1.
- Review process in Phase 1 and take learning for Phase 2.
- Plan for Phase 2 including required interactions.

The plenary session included summary findings to date presented by each of the Work Package consultancy teams, and also an account of the "learning journey" experienced by the participants in a facilitated session between WP3 and WP4, discussed further in section 8.2.5 below.

### 8.2.3 Plenary session 3, Phase 2 Interim Review, London, 7 February 2017

The Steering Group and Synthesis Team recognised that in order to maximise the robustness and credibility of the *Enabling Framework* concepts and processes, it was important for FPSA2 to dry run a number of test cases through the *Enabling Framework* process (in desk-based tests, in accordance with the scope of the project).

The third plenary session included a working session focused on the details of three selected test case FPSA functions, considering each from the perspectives of each Work Package. This was designed to inform the development of a synthesised narrative for selected functional use cases, as well as refining the methodology being used in each Work Package.

The working session was conducted in three work groups, with each group made up of one representative from each of WP1A, WP1B, WP2, WP3, WP4 and WP5, (which, in this particular meeting, was either a consultant or the Work Package champion, with groups configured to have only one Work Package champion per group) with additional presence from WP6 and wider Steering Group members.

Each work group focused on one of three selected FPSA functions to consider how a desk-based test of the *Enabling Framework* process (WP4) might work for the specifics of the function (defined by WP2) in the context of its barriers (WP3). WP1A and WP1B representatives were in attendance to consider supporting evidence from the wider stakeholder perspective, with a WP6 representative involved to be able to experience working level discussion.

The three functions were selected by WP4 on the basis of criteria designed to ensure stress testing of the *Enabling Framework* concept and process. This working session contributed to the robustness of the *Enabling Framework* concepts and processes. This session formed part of ongoing collaborative developments between WP2, WP3 and WP4, enabled by the synthesis process, reported further in section 8.2.5 opposite.

### 8.2.4  Plenary session 4, Phase 3 interim review, Birmingham, 13 March 2017
The fourth plenary session provided the opportunity for all Work Packages to present their findings in depth for peer review and scrutiny by the Steering Group and consultant teams. Significant emphasis was placed on the *Enabling Frameworks*, resulting in valuable debate and decisions around bringing this complex work to a close.

The day was structured around the evolving synthesised narrative for the whole project developed by the Synthesis Team Manager in collaboration with the Steering Group and Work Package teams, providing a framework to enable each Work Package to demonstrate the part that their work plays in the overall narrative of the project.

### 8.2.5  Facilitated working sessions between WP2, WP3 and WP4
WP4 (*Enabling Framework* Identification) and WP3 (Impact Assessment) had identified through their Phase 1 work that there would be mutual value in spending some project time in a face-to-face working session, rather than just through conference calls and information exchange.

The Synthesis Team identified value in running this as a facilitated session to enable the consultants to focus on content. The objectives and outline agenda were set in discussion between the Work Packages in order to meet their mutual needs, and then refined in discussion with the Synthesis Team Manager and Methodology Manager in the role of facilitators. The session occurred towards the end of phase 1.

The initially proposed topic for discussion related to ensuring that the outputs from WP3 (concerning barriers to the implementation of the functions) are designed to be useful for WP4. In preparatory discussions, this led to a realisation that this presenting topic was an aspect of a wider issue concerning the need to provide a level of validation of the *Enabling Frameworks* approach for selected test case functions and, further, that there is a need for clarity over the roles and responsibilities to ensure this is done.

The session was attended by the WP3 and WP4 consultancy teams, and their Work Package champions, in addition to the Work Package 1 champion to provide a link to WP1A and WP1B. There was also representation from WP2 at the event, by virtue of the fact that the consultancy team for WP2 shared many of the same personnel as WP3.

Observations from participants on the day included a recognition that the stated objectives were not all met in detail but that the facilitated dialogue had significant value in sharing knowledge, building collective understanding and terminology, and creating a space which identified a number of issues that individually and collectively "we didn't know we didn't know". The value of this learning process, through dialogue, was recognised by all participants.

This session was followed by a working session during the third plenary, as reported in section 8.2.3 earlier. By that time, the three test case functions had been selected by WP4 through a set of criteria, explained further in the *Enabling Frameworks* (WP4) report, to test the *Enabling Frameworks* with challenging and complex functionality covering both technical and market-oriented issues. The selected test case functions were:

- Plan for the timely restoration of supplies following a total or partial shutdown (Black Start) (G3[7]).
- Provide a market structure that enables customers to have choices within the power system (H5).
- Enable customers to choose from a full range of market options which determine how they interact within the power system including individual, community and smart city services (H6).

A further one-day working session was organised and facilitated by the Synthesis Team during phase 3 to further develop the thinking and detail around the three test case functions, and finalise the consistency between the outputs from WP2 concerning function needs, the outputs from WP3 on implementation barriers, and the input requirements of the *Enabling Framework* processes.

From the perspective of synthesis and integration, this experience demonstrated that:

- The strong focus in the project methodology on *interactions* between different project delivery activities initially encouraged WP4 and WP3 to consider their mutual dependencies, which led from early discussions about what each might provide to the other to a deepening of dialogue and greater appreciation of the role that each played in the wider eco-system of activity which formed the project.
- This experience provided a level of demonstration that any given interaction (in the sense meant by the lines on the model of the project as a system in Figure 5-1) may include not only transactions (one-way or two-way exchange of, for example, information) but also collaboration, dialogue, learning and co-creation.

## 8.3 Development of the overall project narrative as a focus for Synthesis

A key focus of the methodology was to ensure that the activities within the project, including those within each Work Package, fit together to produce a cohesive whole body of work which tells a consistent and compelling story for the new and enhanced needs of the future power system, and a proposed way forward to meeting them. This narrative is reported in the final Synthesis Report, developed by WP5.

The development by WP5 of an overall narrative for the whole project, which began in phase 2, enabled each Work Package to position their findings in the context of a whole picture, building on the managed interactions enabled and facilitated by the synthesis activity, and provided a means to identify gaps in Work Package activity and findings to enable these to be addressed before the finalisation of the Work Package reports.

## 8.4 Practical tools

WP5 put in place a number of practical tools to ensure that the whole team was working from a similar position, produced compatible and synergised outcomes, and could exchange information and thoughts effectively. These included:

- **SharePoint** – A file-sharing site using Microsoft SharePoint, with a simple file structure, was used to enable sharing of Work Package content for information and review, accessible by the whole team. Content also included formal meeting notes, templates, task tracking and risk log, team contact details, and other project documentation.
- **Templates** – Document templates were established at the outset of the project, helping the feeling of being part of a cohesive whole, and providing the practical advantage of enabling documents or elements from documents to be combined easily.
- **Risk register and task tracking** – WP5 maintained a task tracking sheet and risk register, which were updated prior to, and discussed during, each weekly synthesis team call.

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[7]The numbering of the *thirty-five* FPSA functions was changed between FPSA1 and FPSA2. The mapping between old and new numbering is provided in the WP2 report.

The tracker aimed to focus on tasks specifically related to interaction or synthesis, rather than detailed individual Work Package tasks which were managed by the Work Package teams. The tracking document also included a summary of weekly updates from each Work Package.

- **Work Package phase planning form** – The diagram below shows a phase planning form, a version of which was used in the plenary sessions at the outset of phase 1 and phase 2 to enable Work Packages to plan and share the detail of Work Package activities, outcomes, and interactions within the phase. This form provided a focus for discussion and agreement between each Work Package and every other Work Package on the expected interactions and information exchanges over the coming phase, forming the basis for interaction planning.

Figure 8-1: Work Package phase and interaction planning form
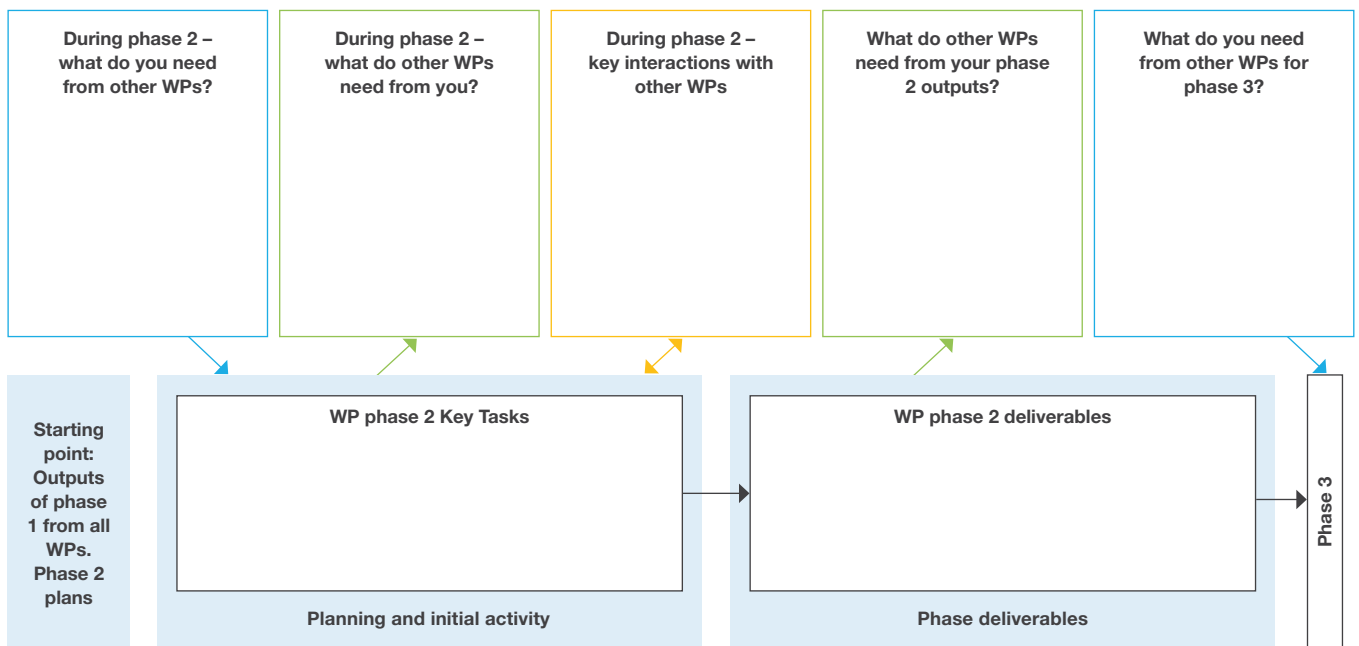
# 9. Learning

This section summarises lessons learnt from experience of the project methodology and organisation in terms of:

- Project design and governance.
- Interactions.

  - Characterising the features of interactions in terms of evolving quality from phase-to-phase, and different methods of triggering interaction.
  - Maximising the effectiveness of interaction within the project.
  - Maximising the effectiveness of interaction with external stakeholders.

- Implications for *Enabling Frameworks*.

## 9.1 Project design and governance

The following learning points arose in consideration of aspects of project design, governance and decision-making that may be of value in the design of future projects.

- There is a need to ensure sufficient time and organisation for ongoing project strategy development, informed by both the conduct of the project, and monitoring of changing events and circumstances in the wider environment. Strategy development was formally the responsibility of the JSB. In the day-to-day agile development of FPSA2, members of the Steering Group found that they needed to dedicate time to engage in strategic discussions around the direction of the project. This need for ongoing strategy development is an inevitable feature of the iterative nature of projects of this type. This suggests the need to ensure dedicated time for both operational management and strategic development, while also recognising that fully effective strategic development requires the close, and often uncomfortable, interaction between development opportunities and operational realities.

- The need to ensure robust processes for resource allocation in the context of agile working, recognising that it is not possible to plan in full detail in advance the scope of work to be delivered when fully exploring the innovation opportunities that can arise through interaction.

- The anticipated complexity of interaction between project activities should be taken into account when designing the structure of the project (in terms of Work Packages). The design principle is that the project should be structured to minimise

the complexity of interaction. Assessing this requires careful thought at the project design stage as to the potential implications of the types and frequency of interaction (information flows, collaborative working, etc.) that are likely to be needed between packages of work. Such considerations can lead to alternative project designs.

- To a certain extent, the project explored the development of method as well as developing a body of new findings. In the widest sense of innovation, it is important to create space to prototype new methods as part of the necessary project activity, in addition to focusing on the development of new outputs. As a corollary to this, innovation should in general be thought of more widely than just technological innovation, considering organisational and process innovation as well, as demonstrated by the approach taken to *Enabling Frameworks* in FPSA2.

## 9.2 Interactions

### 9.2.1 Evolution of quality of interactions

It was expected that there would be a progression through the project in the quality and maturity of interaction between delivery teams in different Work Packages, and with the Synthesis Team management. The Synthesis Team management observed a broad evolution in the three project phases from:

- Establishing relationships for information exchange in phase 1, to
- Increasingly collaborative working in phase 2, to
- A deeper sense of collective purpose in phase 3.

### 9.2.2 Methods of triggering interactions

Different interactions varied in how they were initiated.

The triggers to initiate interactions were either:

- Directed by the Synthesis Team management or the Steering Group.
- Encouraged by the Synthesis Team management, through identifying opportunities for interaction to bring benefit, or gaps or inconsistencies which needed to be solved. Interactions that met these needs were then encouraged, and where necessary, facilitated.

- Arranged between the Work Package teams directly, which is an efficient approach as the teams themselves are often best placed to understand opportunities particularly if they have a sufficiently interactive relationship with the other parties. It was an aim of WP5 to support the development of this kind of relationship, in the context of wider synthesis team arrangements to ensure that the outcomes and implications of such interactions were shared with other Work Packages.

The main directed points of interaction between Work Packages, clearly established from the outset of the project, were the four plenary sessions and the weekly Synthesis Team calls. These functioned well as a means of building a sense of team between the Work Package suppliers, and a common direction, as well as supporting the practicalities of tracking tasks, managing risks and issues, sharing findings and learning, and providing peer challenge.

Over and above the plenaries and weekly calls, the Synthesis Team management adopted a principle of encouraging, rather than mandating, additional interactions. In general this worked well. At the outset of the project, significant effort was made to emphasise the expectation of collaboration between Work Package teams, in order to mitigate the risk of the Work Package suppliers seeking to deliver to a defined scope in isolation from the rest of the project. Coupled with the professionalism of the organisations involved, this helped to create a high level of willingness to engage with one another in the interests of the project as a whole. The Synthesis Team management remained alert to cases where new interactions may be of value, and intervened to encourage these where deemed necessary.

In one case, the Synthesis Team management, with agreement from the Steering Group, directed and facilitated an additional working session involving WP2, WP3 and WP4. This focused on progressing a dry run of three test case functions through the *Enabling Framework* processes to help validate the robustness of the *Enabling Framework* concepts. As with all interactions, the value of this activity to the project had to be balanced with the limitations in time and resource within which each Work Package had to be delivered.

## 9.3 Interaction management for future FPSA activity

This section summarises learning points relating to the management of interactions for FPSA activity beyond FPSA2.

### 9.3.1 Interactions within the project

Experience of the management of interactions between Work Packages in FPSA2 suggests that, for future phases of FPSA:

- The configuration of mandatory plenary sessions plus regular calls to co-ordinate activity, within defined time-bound iterative phases, works well to provide a predictable framework for project interaction, and should be retained where practicable. It should be recognised that different groups of organisations (such as, for example, market competitors, or volunteer participants) will be subject to different motivations and pressures which would need to be accommodated within the arrangements.

- In designing the project phases, opportunities should be sought to include consideration of all aspects of the anticipated work within each phase, such that each phase both delivers a tangible output and provides early visibility and understanding of issues that will need to be addressed. For example, the first iterative phase of a project to demonstrate a function implementation supported by an *Enabling Framework* could include consideration not only of inputs, outputs and other EF design issues, but also high level consideration of the full lifecycle including practical testing, implementation issues and approach to ongoing review.

- Within this defined structure, the general approach of creating a framework which encourages team working, rather than attempting to define and schedule all interactions in advance and "from above", has worked well and should be retained, recognising that directed interaction may also be essential in certain circumstances, for example if necessary interactions are actively or passively resisted due to lack of trust, conflict situations, lack of understanding of the value, etc. Terms of reference for participants should reflect the expectation, being mindful of different needs and behaviours of different types of organisation and individual, and including guidelines and consequences for non-conformity.

- Building on the point above, a number of factors support effective interaction between different parties. Enabling relationships of trust to be built is a critical element of maximising the effectiveness of interaction, and in general this worked well in FPSA2. Effective interaction then also depends on a combination of formal and informal structures, processes and interface specifications. Formal interface specifications for interaction between specific Work Packages is likely to be necessary in particular cases, and interventions to facilitate this may well be necessary. Such interventions should provide specifications to enable effective interworking, while encouraging mutual agreement between the parties on the details, rather than imposing arrangements that risk being not properly owned by those who will use them.

- A dedicated co-ordination management activity, including project support and access to facilitation expertise, is an important element of project effectiveness.

- For the purposes of diary management and budgeting, project planning should schedule, from the outset, a number of additional working days which can be drawn on as required for interworking between multiple teams, as the need arises, especially if teams are not co-located as was the case in FPSA2.

- The need for dedicated time to support ongoing strategy development at the project level is noted in section 9.1. This also applies to the management of the working groups which will, in general, each need to recognise the need for ongoing strategy development at their level to respond to changing threats, opportunities and requirements as the project develops.

- The principles of the synthesis arrangements might be applied and adapted, on a wider scale, to help enable cross-industry and inter-agency working to take the demanding FPSA agenda forwards, with clear accountability for leading and co-ordinating change.

### 9.3.2 Continuity of the FPSA programme

There are also methodological considerations in providing continuity from one phase of FPSA to the next (FPSA1 to FPSA2 to future activity). Continuity of involvement of core Steering Group members is key to ensuring continuity of understanding of both the content – such as the *thirty-five* functions, and

the needs and attitudes of core stakeholders – and of the methods used – such as the system engineering approach which has underpinned the work since FPSA1, and the agile and interactive project approach used in FPSA2 to integrate the various work streams.

### 9.3.3  Interactions with stakeholders and other parties outside the project

Regarding the management of interactions with parties beyond the project, it is convenient to segment these as:

1. Messaging to a range of stakeholders and other external parties to explain what the project is about.
2. Gathering the views of stakeholders to inform the development of the project.
3. Involving stakeholders as active participants in the project.

There was significant emphasis on messaging (type 1) in FPSA2, in particular through the communications activity of WP6 and overall project reporting managed by WP5. This is an essential element of project activity to ensure widespread dissemination of project messages. Target audiences, and methods of dissemination, should be subject to ongoing review and development. Gathering stakeholder views (type 2) could, in general, include:

- Targeted stakeholder interviews, surveys and research.
- Stakeholder reviews of project findings.

FPSA2 had a strong focus on the first of these through the work of WP1A and WP1B, as an explicit response to feedback in FPSA1. The Project Delivery Board (PDB) provides stakeholder reviews of project findings in each phase of the project. In addition, a stakeholder workshop during the latter stage of the

project enabled stakeholders engaged by the project through WP1A to review the analysis of their input. Future dissemination events will also gather feedback from event participants.

The FPSA2 Steering Group is actively engaging with communities of stakeholders around the future potential opportunities that FPSA can deliver.

Type 3 interactions would involve stakeholders becoming active participants in project activity such as design and testing of proposals, and project advocacy. This goes beyond the type of stakeholder engagement carried out in FPSA2 and was not explicitly part of the scope, although it should be noted that the PDB provides a range of stakeholder representation with opportunities, in principle, for members to become more deeply involved in aspects of the work. Processes of deeper stakeholder involvement will be an essential element of realising the concept of *Enabling Frameworks*.

### 9.4  Implications for *Enabling Frameworks*

*Enabling Frameworks* are intended to provide a process environment in which a full range of stakeholders are enabled to drive the implementation of new functionality in the power system. In the ongoing development of the *Enabling Framework* approach, it will be necessary to be clear on the point at which it is appropriate to bring stakeholders into the processes of developing, implementing and using *Enabling Frameworks*.

The underlying agile principles adopted by the project, to enable synthesis and integration of the activity of the multiple parties involved, have parallels with the principles proposed by FPSA2 for *Enabling Framework* processes. Further development of processes to support multi-stakeholder iterative learning is likely to be a key element of taking FPSA work forwards.

# Future Power System Architecture Project 2

Final Report

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# Work Package 5: Methodology Report

The full set of FPSA2 documentation including the Main Synthesis Report, Policy Briefing paper, individual Work Package Reports and project data files are available online via the Institution of Engineering and Technology and the Energy Systems Catapult.

www.**theiet**.org/fpsa        **es.catapult**.org.uk/fpsa