The Institution of Engineering and Technology

CATAPULT Energy Systems

Future Power System Architecture Project 2

Work Package 4 Final Report - Enabling Framework Identification

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

The Institution of Engineering and Technology

Catapult Energy Systems

Future Power System Architecture Project 2

Final Report

Work Package 4:

Enabling Framework Identification

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.

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Executive Summary

Analysys Mason and WSP|PB delivered Work Package 4 (WP4) of the FPSA2 project funded by Innovate UK via the Energy Systems Catapult, and working jointly with the Institution of Engineering and Technology (IET) and the Energy Systems Catapult. The objective of WP4 was to develop *Enabling Frameworks* (*EFs*) that will facilitate the transformational change to the GB electricity system that is required as it moves towards decarbonisation and incorporates new technologies whilst maintaining a customer centric, secure and reliable supply. The below is the proposed approach and process, that has been developed, using best practices from across industries, and is considered on this basis the most efficient and effective way to enable the change to the future power system.

The process that was developed for both the creation and operation of *EFs*, took the whole range of system, market and social needs into consideration. Among these, of primary importance was active inclusion of all stakeholders and awareness of the dynamic and ongoing change in the sector and the implications of this for customers. For these reasons a bottom up approach was adopted, that was iterative, agile and informed through engagement with a range of stakeholders. This means that *EFs* will not prescribe the future energy solution, rather they will be the mechanism that will allow the future power system solution to be developed and improved on an ongoing basis.

The need for *EFs* in FPSA2 was partly identified from the outcomes of the FPSA1 project. Whilst further evidence for the need for *EFs* came from the work of FPSA2's WP2 and WP3 on the needs and barriers respectively, of the *thirty-five* new or enhanced power system functions. Their findings were that the current sector institutional frameworks and in particular those around change, would be severely challenged by the scale of change, and would almost certainly not be able to accommodate the rate of change needed. This is not surprising as today's institutional change arrangements are designed to accommodate incremental change within the current power system and were not envisaged to need to support transformational change.

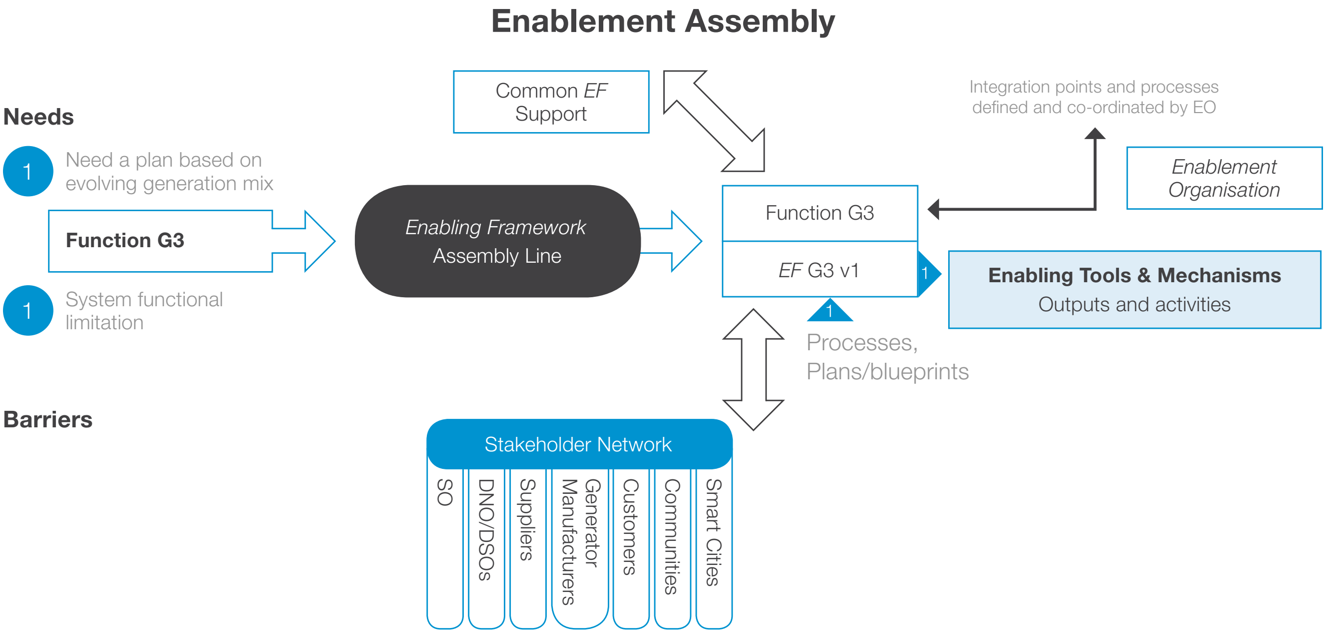
The need for *EFs* was further confirmed from the findings of a literature survey that WP4 completed to identify views from academia, industry players, new market participants, the media and other institutions. The arising conclusions were aligned with the findings coming from WP1 which clearly identified that current arrangements present barriers to market entry, lack engagement with new stakeholders and do not offer a 'level playing field'. In summary, insufficient enablers and mechanisms are in place to overcome the lock-in to the current energy system paradigm.

All of these views and insights were utilised in the development of *EFs*, with a number of foundational and guiding principles being established to steer the development of *EFs* to provide a process for future change that is fit for purpose. They required the *EFs* to be flexible, enable ongoing and iterative change, and meet a range of market and social needs, from carbon reduction to championing customer interests, to accelerating the process of change and making it transparent (to name a few). The needed inputs and outputs from *EFs* were also clearly stated, and provided an understanding for developing *EFs*.

After consideration, it was decided to design a process that would align and customise an *EF* for individual or groups of the *thirty-five* functions. This level of granularity would be the easiest to work with and to communicate and would also provide the most flexibility regarding grouping and would best allow for ongoing optimisation and efficiency improvement. This led to the understanding that one needed to distinguish between the *EF* and the process around the creation of *EFs*. In turn the concept of developing an *EF* 'assembly line process' that a function would go through to be equipped with a suitable *EF* was formulated.

This *EF* creation process would require some structure and definition and so an *EF* architecture was defined which illustrates and informs how the *EFs* would be assembled.

Figure 4-8: Full *Enabling Framework* Assembly Process - Example G3



A basic overview of the *EF* architecture needed for the assembly process is illustrated in Figure 4-8 above (and elsewhere in the body of this report). The key components of the *EF* assembly process are:

- Pre-structuring activities.
- The *Enablement Organisation*.
- The stakeholder network.
- *Common EFs*.

The pre-structuring activities are standard and often repeatable actions that can be taken to accelerate an *EF* readiness to start being productive. They could include things such as literature surveys for current option assessment, setting up of collaboration environments, and establishing document and project management norms. None of these activities predicate solutions, as *EFs* are able and are expected to iterate and improve themselves.

The pre-structuring activities are implemented by the *Enablement Organisation*, whose role and purpose is to act as a facilitation and co-ordination entity at the centre of the system transformation. The *Enablement Organisation* will assist with the collation and provision of knowledge and tracking of the delivery and outcomes, and will also be utilised for conflict resolution and arbitration should this be needed. Its role in the development and delivery of the *EFs* and related functions will be a supportive one that seeks the smooth and efficient operation of the *EFs* and the creation process when new *EFs* are required.

The actual design and operation of the *EFs*, and the responsibility for the delivery of the function will lie with the stakeholder network, under the broad oversight of the *Enablement Organisation*. The stakeholder network is the grouping of all relevant stakeholder roles and representatives for any particular function (or group of functions) including existing industry and new participants. A comprehensive grouping of all the necessary stakeholders is important, along with the linkages and interactions between these stakeholders. All of these aspects will be actively facilitated and managed by the *Enablement Organisation*, using modern digital collaboration tools. To ensure inclusive participation, not only will stakeholders who are already identified be directly engaged, but there will also be a process of awareness creation to ensure that active steps are taken to recruit the broadest range of possible new participants.

Common EFs were developed based on the realisation that many of the *EFs* would require related and similar activities to be performed within certain specific domains e.g. legislation or regulation. It would therefore be efficient to group the activities of these particular domains into common programmes of work, and the *EFs* would then interact with these programmes for delivery of their requirements. There would also be interaction between the common *EF* domains from the most influential to the least influential (legislation drives regulation, regulation drives standards, etc.) and this would allow for insights and interdependencies (and hence optimisation) to be drawn by comparing their delivery roadmaps.

The process around creation starts with the *Enablement Organisation* briefly assessing the function and undertaking pre-structuring activities. This then leads to the establishment of the active stakeholder network. With the aid of the *Enablement Organisation*, the stakeholder network then activates the *EF* and proceeds to specify requirements of the *Common EF* and establish linkages with other *EFs* and functions. It will continue to develop and implement plans and undertake other activities that it sees as fit and undergo iterative improvement of its activities and its own operation.

The methodology that was employed in the WP4 project working was in itself iterative, with the focus on each of the phases of work being on design, development and validation respectively. The validation component of this was implemented through a testing of the *EFs* and *EF* creation process by assessing their operation for three selected test case functions. These functions were selected based on them representing different extremes of what may need to be enabled. Also, two of the test case functions that could potentially be grouped together were included to enable testing and investigation of whether this is viable and how it would manifest. The functions that were tested were:

Function G3 – "Plan for the timely restoration of supplies following a total or partial shutdown (Black Start)."
Function H5 – "Provide a market structure that enables customers to have choices within the power system."
Function H6 – "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."

The outcomes of the testing were that *EFs* and the *EF* creation process are robust and would be able to support functions in terms of their technical, commercial and governance enablement requirements. *EFs* would be effective in supporting the development and design of options, their selection, trialling and implementation. They highlighted the importance of specifying needs and barriers in a non-solution orientated manner, and the importance of ongoing horizon scanning and agility in the process.

The testing confirmed that each of the key components of the *EF* architecture: pre-structuring activities, stakeholder network, *Enablement Organisation* and *Common EFs* all played a positive contributing part in the process. It also highlighted that some effort would be required in communicating and explaining how the new change process would work.

To enable the full operational implementation of *EFs*, further work and broader engagement would be required. This is a conscious decision to ensure that wider stakeholder participation and agreement is undertaken, increasing the legitimacy and ownership of the new process. As part of this, next steps were identified, to be considered in relation to the emerging transformation facilitated by technical and commercial innovations, including:

- Maintaining the importance and centrality of iterative learning within the process.
- The further work needed on accountability and decision making.
- An assessment of modern digital collaboration tools.
- Confirming and securing the mandate needed by *EFs*, including stakeholders.
- Maintaining urgency and momentum of the topic.
- Further investigation on the process of change management within and around *EFs*.

1. Introduction

The work presented in this report was completed by Analysys Mason and WSP|PB as part of the second Future Power System Architecture project (the 'FPSA2 project'), in particular Work Package 4, WP4. The FPSA2 project has been funded by Innovate UK via the Energy Systems Catapult working with the Institution of Engineering and Technology (IET).

1.1 Conventions

This report uses the reference convention and definitions agreed for use in FPSA2. A table mapping the FPSA2 numbering and definitions to the corresponding FPSA1 equivalents is provided in Appendix A.

1.2 Acknowledgements

In carrying out the work documented in this report, WP4 has received invaluable contributions including guidance and feedback. In particular, we would like to acknowledge the contributions of:

- Duncan Botting, Work Package 4 Champion.
- The other FPSA2 Work Package teams.
- The FPSA2 Project Steering Group.
- The FPSA2 Project Delivery Board.

1.3 Background

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. FPSA2 builds on the first FPSA project, which 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). The findings called on the power industry and government to focus urgently on delivering new capabilities to transform GB's power system architecture by 2030, making it fit to respond to the challenges presented by the energy trilemma: decarbonisation, security of supply and affordability.

The team that worked in collaboration to deliver FPSA1 – the Energy Systems Catapult and the Institution of Engineering and Technology (IET) – has now worked on FPSA2. Innovate UK provided funding via the Energy Systems Catapult.

The objectives for FPSA2 were to deliver:

- A comprehensive exploration of the current and future needs 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 Research, Development and Demonstration (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.
- 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.

The tasks for FPSA2 were split into a number of Work Packages to enable project activity to be co-ordinated and managed effectively. A Work Package Champion led each Work Package, supported by external suppliers and contractors to deliver the work. The main tasks associated with each Work Package are summarised in Figure 1-1 opposite.

Figure 1-1: Tasks within each FPSA2 Work Package

WP1A: Engage with Stakeholders
Establish a survey technique to identify the barriers being encountered, especially for communities and grid-edge technologies.
WP1B: Future Stakeholder Needs
Research future socio-political drivers on customer and stakeholder behaviours.
WP2: Review the Functional Analysis, Identify no-regrets actions, assess RD&D required to accelerate deployment
Check validity and completeness of functions and options for delivery. Progress no-regrets actions where feasible through today's sector processes, including touch points with other vectors. Identify RD&D and Innovation opportunities to accelerate delivery.
WP3: Impact Analysis
Identify the barriers to developing and implementing the functions within current sector processes and assess the impact of late or non-delivery.
WP4: *Enabling Framework* Identification
Assess architectural options to remove institutional (regulatory, market, technical, cultural, etc.) barriers to delivering functions. Identify *Enabling Frameworks* and potential trials for development under FPSA3.
WP5: Synthesis Integration and Reporting
Ensure key findings are integrated between Work Packages and deliver final reports.
WP6: Dissemination
Ensure complexities of FPSA are appropriately shared to audiences. Explore improved communication techniques.

2. Objectives and approach of the Work Package

2.1 Why – purpose

FPSA1 identified *thirty-five* functions that would be needed in a future power system in the UK. FPSA1 also concluded that there is a "need (for) a transformational mechanism for catalysing how new functionality will be progressed and co-ordinated". This transformational mechanism is needed to ensure an agile, inclusive and time-sensitive process of change from the current power system to a future power system, to deliver the *thirty-five* functions identified by FPSA1, and to accommodate the delivery of any future functions. The development of this transformational mechanism has examined a broad range of best practices and proven processes from other sectors, and has also built on existing experience in the electricity supply sector. '*Enabling Frameworks*' (*EFs*) is the concept that we have used to describe this mechanism.

The purpose of Work Package 4 (WP4) was to apply industry and cross-sector expertise to the development and assessment of *EFs* and to test the proposed process to ensure these are robust and operable. WP4 developed *EFs* both in terms of the future needs of the *thirty-five* existing functions (and any new future functions) and the barriers that exist to their implementation in current institutional or governance arrangements. These requirements of the enablement process, together with the views of the industry and stakeholders, have been used to inform the development of the *EFs* and the process around the creation of *EFs* and their structure for the creation of *EFs* (also known as the *EF* architecture). It should be noted that the purpose of WP4 was not to define the future power system solution itself; rather WP4 has focused on the creation of *EFs* and the development of the *EF* creation process. These processes will enable the delivery of the future power system solution in line with the key (foundation and guiding) principles outlined in Section 3.5 of this report.

2.2 What – deliverables

The key deliverables of WP4 were:

- Understanding the requirements of *EFs* through engagement and participation with other WPs.
- Identifying guiding and foundational principles for *EFs*.
- Defining and developing *EFs*.
- Defining the process around the creation of *EFs*.
- Testing and validating that the approach to *EFs* and the *EFs* themselves are practicable.
- Reporting of the above including description of the applied methodology and appropriate justification.

2.3 How – WP approach and methods

WP4 was primarily concerned with the preparation of *EFs*. This process includes defining and designing *EFs* and testing *EFs* for implementation to ensure the *EF* process is fit for purpose. This corresponds to the first phase of the *EF* lifecycle, as illustrated in Figure 2-1 below. Due to time and resource constraints in FPSA2, there was less focus on the roles, authority and financial flows, and more of a focus on ensuring the proposed process would be able to remove barriers discovered in other WPs, and deliver future needs in an agile, inclusive and time-sensitive manner.

The practical implementation and operation of *EFs* will follow in subsequent stages after the completion of the FPSA2 project. This was a conscious decision to ensure that the *EF* implementation would embrace a much broader stakeholder group and therefore benefit from ownership and practical experience in the design of the roles, responsibilities, accountabilities and financial commitments that will be needed to deliver *EFs*.

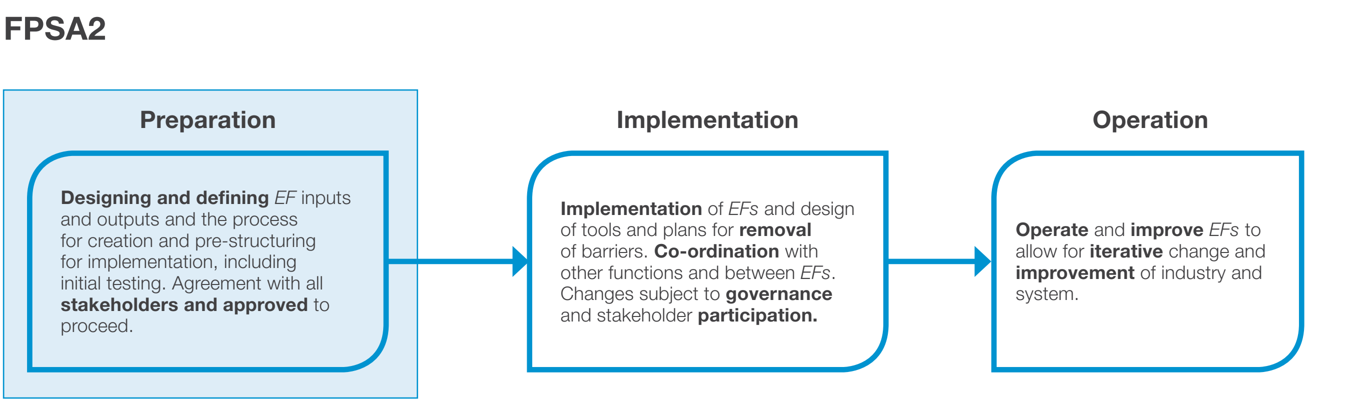
It should be noted that the phases identified in Figure 2-1 are iterative within themselves and between each other. They are depicted in a simplified manner below to convey the focus of each of these stages. Details of the methodological approach taken are covered in section 9 of this document. In summary, the main activities that we conducted as part of WP4 included research and literature reviews, brainstorming workshops, ideas development work, and engagement with FPSA2 stakeholders and other WPs gathering feedback and then revising/iterating of the outputs if necessary.

Table 2-1: Context of WP4

	Delivered to WP4	Delivered by WP4
WP1	Understanding of stakeholder views on the energy system and WP1's perceived requirements for what needs to change and what will enable change. Expectations for the future power system and how this may introduce new service providers.	Understanding of *EFs* in order to shape engagement with stakeholders and ensure their needs are understood.
WP2	Function definitions and needs (including interdependencies), understanding of solutions and research requirements.	Understanding of *EF* requirements and implications.
WP3	Function barriers and their grouping.	Understanding of *EF* requirements and implications.
WP5	Synthesis and methodology guidance.	Synthesis requirements.
WP6	Assistance with communication of *EFs* to all stakeholders.	Understanding of *EFs*.

During the implementation phase, findings from other FPSA2 WPs will form part of the inputs to *EFs*. WP1 will provide input in terms of stakeholder views and needs, WP2 in terms of function needs and WP3 in terms of function barriers. In preparation for the implementation phase, WP4 has used WP1, WP2 and WP3 inputs in the testing of *EFs* to meet stakeholder requirements and has liaised with other WPs to ensure that they understand their integral role in supporting *EFs*. WP4 has collaborated with all other WPs, and has received information from and provided information to them, as indicated in Table 2-1 above.

Figure 2-1: FPSA WP4 scope of work in relation to the whole *EF* lifecycle



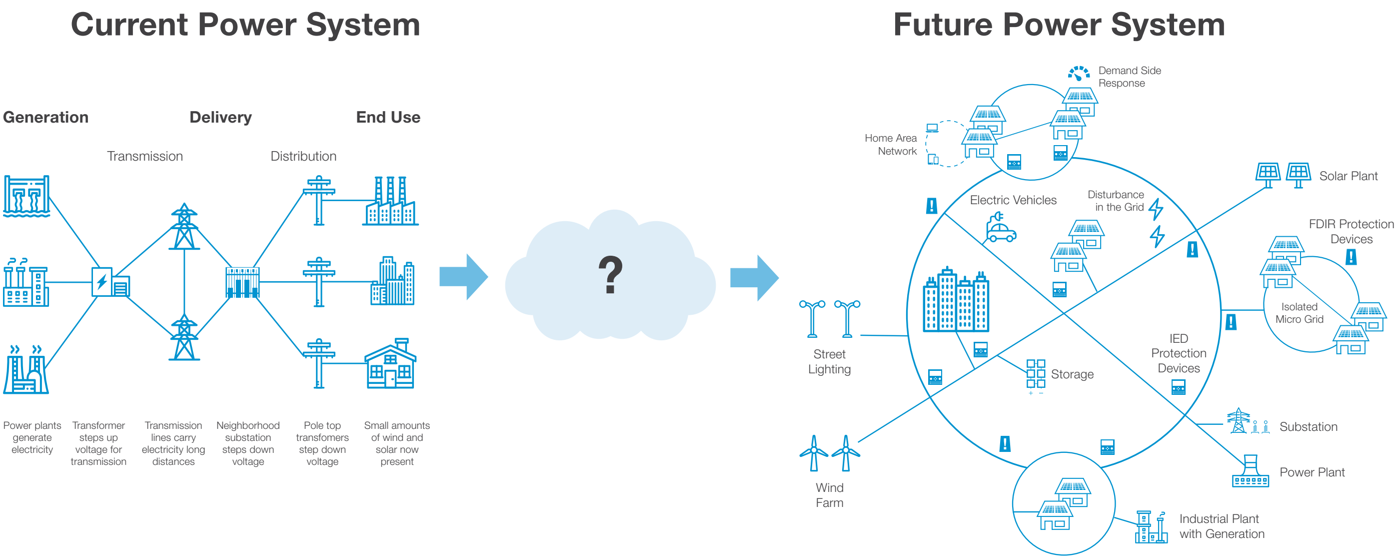
3. The Industry Change Process

FPSA1 established the need for the currently identified *thirty-five* new functions to be deployed for the future power system. This system change can be broadly illustrated by Figure 3-1. The current power system is a heavily centralised system with a few large generators where supply follows demand. The potential future power system is more distributed, with a far greater number of generation sources. In the future power system, supply and demand are matched in several ways, and the system aims to minimise carbon and cost on an ongoing basis. Currently the industry and its change process is governed and managed in a manner that was designed for the former, rather than the latter scenario. It is important to realise the impact of market structure on both technical and commercial decisions. Customers also have higher expectations of how they should be able to interact with, and play a part in, the power system. The current power system processes are already finding it challenging to meet past transformational requirements – meeting future transformational requirements would be very likely impossible. The *thirty-five* functions defined are also just a starting point in terms of functionality for the future power system and a change process is needed that accommodates changes to these functions over time. This is the consensus of the majority of stakeholders engaged by WP1.

The current industry change process is designed for incremental change within the old power system ecosystem. To achieve the transformational change needed for the future power system and its ongoing iterative operational improvement, it is important that the requirements of *EFs* be driven by the needs and barriers of the *thirty-five* functions of the future power system. To ensure legacy thinking did not limit the design of *EFs*, a 'blank slate' approach was used in the development of *EFs*, this drove the approach to research, engagement and design of the *EF*.

During the information gathering process and stakeholder engagement, we identified numerous issues and challenges related to the current industry change process

Figure 3-1: Power industry transition



Source: http://www.sciencedirect.com/science/article/pii/S1364032115008771

Source: http://psm.ucy.ac.cy/research-projects/

and a potential future power system. The feedback we received is that the current industry change process would not be able to facilitate the nature, scale and pace of change required for the implementation of a future power system. It should be noted that this does not necessarily mean that the industry change process is deemed to be unfit for changes made to the current power system, were this system to remain in a steady state.

It is also important to consider that although *EFs* are, and should be, defined by the function needs and barriers that need to be addressed for their implementation, the *EF* creation process will, where appropriate, be able to leverage and retain valuable parts of the current industry change process as modules. In some cases, this may require adaptation of the existing capabilities.

3.1 Cross-industry views of need for process change

FPSA2 undertook research to establish the high-level views of a broad range of industry and stakeholders regarding the implementation of future changes and whether they could be adequately addressed under current arrangements.

In addition to the primary and secondary research conducted by WP1A and WP1B, a literature survey was conducted by WP4 to confirm the views of a wider audience from industry, media and academia to inform the details, intricacies and interdependencies of *EF* design.

The WP desk research found that industry stakeholders supported the need for enhancements to existing change processes to enable a transformation to a future energy system. The summary findings from this desk research can be found in Appendix C. The key findings are that, in the context of altering current change processes, *EFs* need to be:

- Faster.
- More flexible.
- Iterative and ongoing.
- Co-ordinated.
- Inclusive of new participants.
- Supportive of innovation and improvement.

3.2 Need for process change - evidence from WP1

Results from the work undertaken by both WP1A and WP1B indicate a different scale of change needed to that currently supported by industry change processes. Detailed learning arising from WP1A's stakeholder interviews and customer surveys, as reported in their Phase 3 report, has confirmed that there is a desire for future change and a requirement for modification of existing systems.

Interviewed customers indicated the desire to be energy self-sufficient and showed some willingness to manage their demand. Overall, domestic customers showed an appetite for the transition to a smarter energy system in their homes. This indicates that there will be new participants in the energy system in the future as supported by the customer survey results showing that customer awareness of smart meters, PV, smart heating and EVs was high. Since existing change processes do not support new smart energy participants, we can conclude that modification of existing systems is necessary before participation and its associated benefits can be realised.

Stakeholder interviews confirmed that there are barriers within existing systems (for example charging methods and lack of strategic investment) that must be overcome to enable future functionality. Issues with existing change processes are highlighted in the stakeholder interviews, confirming the need for alternative change processes. A stakeholder commented that large incumbent market players with many resources dominate present change processes, which results in constrained, slow and biased transformation.

WP1A findings (summarised within their report), have influenced the structure of *EFs*, as summarised in Table 3-1.

Other influences on *EFs* arising from the development of the WP1A work included:

- *EFs* should facilitate market economy influence to provide the market access required so that the market can drive solutions.
- *EFs* need to address the concern that the FPSA initiative might result in the substitution of the current rigid and complex system with a new system with similar characteristics.

The WP1B report evidences the potential extent of societal change and the impacts on the electricity industry. The key learning that emerged relating to *EFs* are that:

- The system changes will be extensive and all-encompassing, reinforcing the need for *EFs*.
- Future uncertainty will require *EFs* to take an agile approach.
- Change will introduce new stakeholders that need to be incorporated within the process.

Table 3-1: WP1A findings and their influence on *Enabling Framework* capabilities

No.	Finding	Influence
F001	**Decision-making processes** Decision-making has a disposition towards the status quo.	*EFs* should ensure that decision-making includes all interested stakeholders.
F008	**Technology neutrality** Some aspects of electricity system operation have a disposition towards a sub-set of the potential solutions.	*EFs* must not align to a particular solution, in order to deliver unbiased enablement.
F011	**Engaging public sector and local stakeholders** In moving to a low carbon energy system, local stakeholders will be more important (local authorities, smart city developers etc.).	*EFs* should involve all stakeholders.
F016	**Require a greater degree of innovation and faster application of innovation** Innovative solutions will be needed to deliver the smart flexible system, so greater levels of innovation will be needed.	*EFs* should be technology neutral, actively support innovation and be agile to accommodate new developments quickly.
F017	**Existing codes and regulations are obstacles** The electricity system has many codes and regulations, many of these do not anticipate the innovative ideas and propositions now proposed.	Dedicated capability (common *EFs*) within *EF* to deliver a co-ordinated approach to ensure that codes and regulations evolve with and at the same pace of industry transformation.
F018	**Access to information** Information on assets and system operation needed for operations of systems and markets.	*EFs* should provide a mechanism for the capture, management and creation of necessary information to facilitate developments and inform decision-making.

3.3 Need for process change - evidence from WP2 and WP3

The roles of WP2 and WP3 are to verify the details and the barriers of each of the *thirty-five* functions respectively. WP2 detailed the needs that a function has, such as development, testing or demonstration, for example. The needs and definition of the function will be critical inputs into what is needed for that function to be enabled and be implemented. In fact, any new and unknown needs will need to be catered for in any new process considered for future implementation.

WP3 defines the barriers that each function faces. In WP3, evidence of the need for a broader, deeper and more co-ordinated industry change process is even more apparent. In many cases, these function barriers are key parts of the current industry institutional arrangements, including the change process itself, or aspects thereof. The range, scale and complexity of overcoming many of these barriers is one of the central drivers for developing *EFs* and ensuring that they are aligned to the needs of the future power system functionality.

3.4 Key attributes of *EFs*

Below we list the most important attributes of *EFs*, based on the WP1 and literature review findings:

- An appropriate inter-relationship between policy, legislation, regulation, commercial models, technology, infrastructure and society.
- Level the playing field so the system can benefit from competitive and collaborative effects leading to best value and other optimal market outcomes for the consumer.
- Enablement of innovation across energy domains and paradigms covering political, economic, commercial, technical and end users.
- Freedom for new modes of operation whilst ensuring the safety, security and integrity of the system.
- Fluid changes and adaptability allowing iterative learning and evolution towards best-case solutions.
- Enhance the ability of the energy system to deal with unforeseen or unexpected change.

3.5 The principles behind *EFs*

From the research, expert opinion and engagement across the FPSA2 project, we identified the following foundational and guiding principles that were used in conjunction with all the detailed input to design and develop *EFs*.

3.5.1 EF foundation principles

EF foundational principles are informed by requirements that are mandated by UK legislation:

- Facilitating decarbonisation.
- Supporting competition and championing consumer interest.

It should be noted that affordability although discussed in workshops is specifically not included in either the foundation principles as it is not legislated. A variety of policy tools are available to address affordability issues. Incorporating these tools into the *EF* foundation principles would in effect mean offering predetermined solutions to affordability challenges. The distribution of profit and loss is also not covered in the *EF* work, as market structure changes impact commercial and technical implementation and it is not in scope for *EFs* to consider the share between investors, businesses and customers.

3.5.2 EF guiding principles

Guiding principles have been developed to focus the way in which *EFs* are developed. These guiding principles are important aspects of the *EFs*. There is strong evidence from the research conducted and specialist expertise that the identified guiding principles enable transformation of complex systems with multiple stakeholders where the public interest is key.

The guiding principles for *EFs* are as follows:

- Stakeholders integrated in the process.
- Enhanced co-ordination and facilitation.
- Maximise synergies.
- Facilitate conflict resolution.
- Transparency and visibility.
- Innovative approaches to accelerate decisions and support system change.
- Ongoing feedback from and iteration of all activities – an iterative learning and adapting ecosystem.
- Support and harmonise technical and economic evaluation.
- Strive for simplicity at the point of use.

4. The Development of *EFs*

An important decision that was made at an early stage of the *EF* development process by WP4 and agreed by the other WPs, that *EFs* should be aligned to future power system functions. This approach was compared to the alternatives of aligning *EFs* to the higher-level drivers or groupings of functions. Given the complex nature of *EFs* and that it is critical that a clear and consistent understanding of *EFs* be maintained within FPSA2, it was deemed most logical to align *EFs* with functions. This is also a level that all other WPs are familiar with. The lower-level granularity means that it is still possible to combine functions and their related *EFs* into higher-level groups, or associate them with drivers in a hierarchy at a later stage. Should functions be grouped together, then their associated *EFs* would also be grouped together. The fact that *EFs* are aligned with functions also meant that function grouping could happen before or after *EF* creation, with low impact, supporting the need to be flexible and undergo iterative change.

Black box modelling of the *EF* was used to understand *EFs* in terms of their inputs and outputs. The modelling of *EF* in this way led to the illustration in Figure 4-1 showing the most basic state of *EF* operation. It is important to note that there will be ongoing iteration of inputs and enablement as needed.

A significant consideration in assessing this high-level model is that it is imperative to ensure that the *EF* change process **significantly improves throughput from the current change process.** Some of the ways that this could be achieved include:

- Pre-structuring *EF* attributes.
- Re-use and modification of tools from other *EFs*.
- Distribution of responsibility and accountability – specialising activities and providing transparency and trust services should they be needed.
- Greater use of digital technologies and innovative development methods.
- Strict delivery focus and iterative improvement.

Inputs to the *EFs*, the needs of the various functions as well as the barriers to their implementation will allow the development of the above approaches to improve the change process. As such the management of information will be essential to enable action to be taken and hence it is likely that the provision of information or knowledge management and creation services will be centrally marshalled.

Figure 4-1: *Enabling Framework* high-level operation

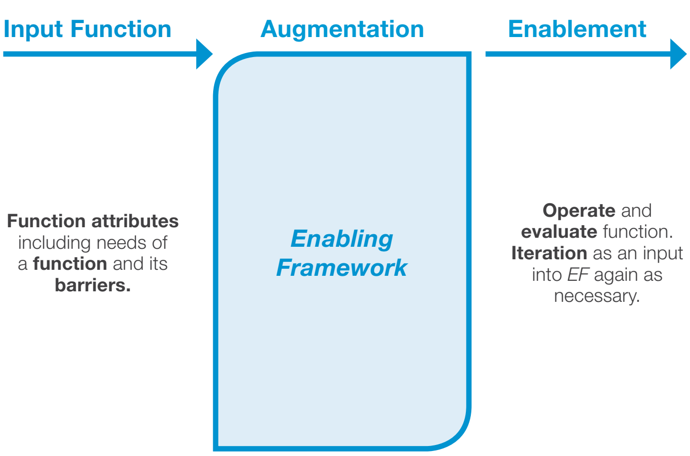
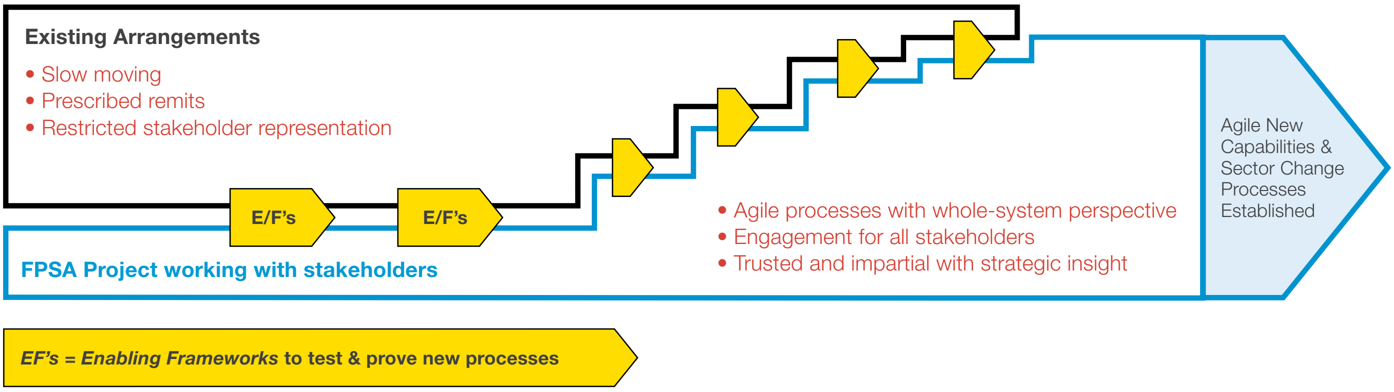


Figure 4-2: Transition from existing to future processes facilitated by *Enabling Frameworks*



4.1 *EF* starting point

The starting point for WP4 was the view that existing industry change processes and mechanisms were insufficient to enable the degree and speed of transformational change needed to deploy the functions developed in FPSA1.

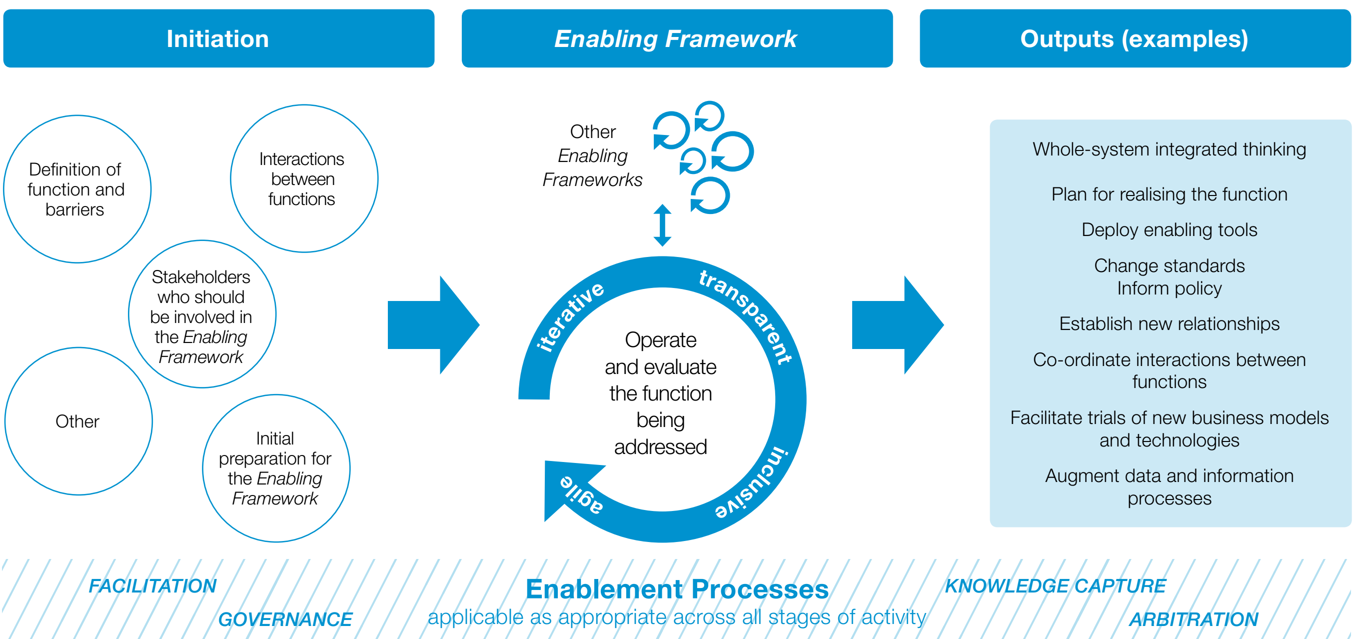
It was anticipated that an *EF* mechanism would gradually enable change from the existing processes to future processes through the sequential demonstration and implementation of functions. This process of transition in context from existing to future processes is illustrated in Figure 4-2 above and summarised in the following key points:

- New arrangements work with and adjacent to existing arrangements.
- Over time, new arrangements supersede the current arrangements.
- The *EFs* are the mechanisms for change.
- The end goal is a new set of change processes and capabilities.

4.1.1 EF inputs and outputs

Figure 4-3 shows a basic black box model that identifies the key *EF* inputs and outputs, and was constructed considering the needs of the *EF* within the identified context.

Figure 4-3: *EF* Inputs and Outputs



The *EFs* respond to and will be specifically designed to meet the requirements of their related function. The attributes that define this design and operation of the *EF* include the needs based on the functional definition, the identified barriers to implementation, range within which the function needs to operate and the complexity of change related to the barriers. Added to these, it is also critical to understand the details of the various stakeholders who will need to participate, the urgency, and information requirements, dependencies that the function has on other functions and the requisite plans and pre-structuring that would benefit function implementation.

4.2 Shaping *EFs*

EFs have to evolve with changing needs and be iterative based on current needs to improve on delivery and operational performance. This means that *EFs* cannot be precisely defined in the manner the current industry processes are. This report aims to outline the general shape of *EFs*. We also present the key operational principles that ensure they deliver as expected while remaining adaptable to specific stakeholders and contexts. These very open and flexible environments have much in common with concepts such as open innovation as discussed by authors such as Henry Chesborough[1] and the operating principles that underpin many of the most successful Silicon Valley companies.

4.2.1 A fundamental shift in thinking

Approaches that introduce very open and flexible environments with a degree of in-built ambiguity are likely to create discomfort among those used to very predictable and linear, process-orientated organisations and sectors. There are, however, significant precedents, and such approaches have been deemed to be necessary for, and used in, mission-critical operational environments with great success.

The following two examples are from outside of the energy industry, where such thinking is managing change in highly complex and uncertain environments:

I. **The US military application of CONOPS (Concept of Operations) is used to prepare for ambiguous, uncertain and volatile environments**
The goals in military CONOPS often change midway. US military training seeks to develop tools and approaches that will allow their personnel to prepare for such situations by instilling in them from early on that what is considered success in an operation may well change at some point during that operation and the team needs to be prepared to adapt.

II. **Alan Blackwell from the University of Cambridge in his research “Radical Innovation: Crossing boundaries with interdisciplinary teams” refers to “fuzzy goals”**
He highlights the importance of providing motivation for the general direction of work without placing unnecessary blinders or burdens on the innovation team as this may mean that they miss out on great opportunities that may arise during their work.

The principle of a target functionality without a specific delivery route is central and amongst the most crucial aspects to consider in the process of the energy system transformation and hence the creation of *EFs*. In such approaches and environments, distributed responsibility and control are often central to the operational logic and key to effective outcomes.

Other leading authors and scholars support many of the principles and approaches that we have applied to *EFs* in WP4. Two such examples include:

1. The distributed decision and control proposed within the creation and operation of *EFs* is aligned with Elinor Ostrom’s[2] support of ‘polycentric governance’ and her view that communities can manage common resources by defining and enforcing rules at a local level in some circumstances. In systems that are managed by communities, (such as *EFs*), Ostrom states that decision-making should be transparent and democratic.

[1]Open Innovation, Chesborough HW, Vanhaverbeke, WM, West J; Oxford University Press; (2006) – coined the term open innovation as a new imperative for innovation which rely on more flexible and non-tightly integrated innovation processes as key. These principles are central and key to the way in which many Silicon Valley companies operate
[2]http://www.nobelprize.org/nobel_prizes/economic-sciences/laureates/2009/ostrom-lecture.html

2. *EF* architecture employs principles for companies that are successful and enduring, as promoted in Arie de Geus's *The Living Company*[3]. De Gues views companies as living beings with an ability to learn, anticipate and respond to a changing environment. The creation of *EFs* is considered to be agile in that it evolves naturally, and keeps in close contact with the changing setting and potential futures of the system. De Geus states that "Space must be created for people to experiment and take risks. At the same time people cannot simply do what they like at the expense of the organisation's common purpose. Clearly one needs both empowered people and effective control." *EFs* will enable stakeholders to develop solutions with a suitable level of governance.

The above approaches and thinking should be taken into account when considering the following key aspects that will be central to the day-to-day function of *EFs*:

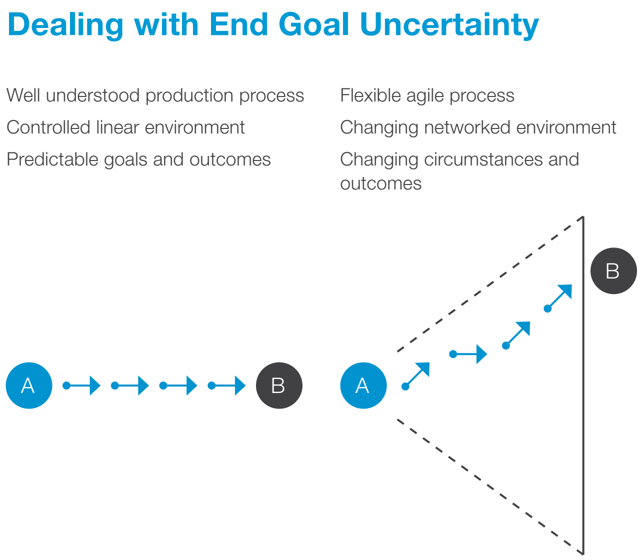
- Goals and work approach.
- Relationships and communication.
- Flexibility and responsibility.

4.2.1.1 Goals and work approach

Traditional goal setting and goal management approaches are often linked to a rigid, process-orientated outlook, and are not necessarily adaptive and agile. There is significant uncertainty regarding the end goal(s) of the future power system, and hence there is a need for agility and flexibility in approach. We suggest that the *EFs* employ the concept of "fuzzy goals", as discussed in Section 4.2.1. This is aligned with a work approach that is network orientated (in this context, 'network' refers to the relationship professional and their interaction rather than the power network), with a large number of stakeholders. This aligns with developments over the last two decades in the application of "fuzzy logic" in control systems (e.g. climate control, automatic transmissions, video cameras). These control systems have had to generate outputs that were more aligned to human decisions and heuristic processes than purely a mechanistic computer-orientated logic.

[3]http://www.ariedegeus.com/

Figure 4-4: Predictable and Fuzzy Goals and Working



Employing the "fuzzy goals" approach does not mean that the outcomes will be intangible or woolly and unusable. In fact, the outcomes will be 'crisp and clear', as the sought outcomes can be refined throughout the process of development. To achieve this, the process of achieving goals needs to be flexible and the work approach and supporting systems need to be focusing on desired outcomes and iterative improvement. These different approaches are illustrated in Figure 4-4 above.

4.2.1.2 Relationships and communication

As has been discussed in the previous sections, it is the particular relationships and the exchange of information specific to a particular process that will shape and determine its outcomes. The required relationships, communication activities and associated planning cannot be set in stone at the beginning of the development process. In trying to do this, one is effectively predicting the outcome, and not benefiting from, or acknowledging the need of, a multi-modal multi-stakeholder environment.

Such network-based working environment will enable diverse and varied communications and relationships. This would, however, traditionally create significant complexity as far as stakeholder co-ordination and collaboration is concerned. It is therefore critical that tools that support this working approach are used. These tools and working environments are not new and have been broadly adopted in some sectors particularly in Silicon Valley, e.g. Slack[4].

These tools will allow stakeholders to be guided and supported in what for many will be a new way of working. Interactions and activity will be actively managed using sociograms to measure and ensure inclusion. This will help to ensure that all participants are active and contributing.

4.2.1.3 Flexibility and responsibility

How can one provide for flexibility in a future power system when all participants, incumbents and new entrants are expected to want to secure their own interests? According to the renowned architect, Christopher Alexander, "the order in a system fundamentally depends on the process used to build the system".[5] From this we can infer that, to some degree, building a flexible energy system means building a system using a flexible approach.

This by no means removes the need for responsibility, as is often the consequence where agile development approaches are not properly implemented. Agile methodologies must be correctly implemented, and this is another driver for the tracking of all interactions. While a certain degree of latitude should be provided so that thinking, resting and thought can form part of a productive day, contributions and input should also carry weight. Participants should be discouraged from "grandstanding" or disruptive contributions. Agility is not an excuse for doing very little work during the process and then raising demands close to process end that delays delivery – the process will be formalised in terms of responsibility and expectations. This will be the initial step in applying new tools and methods, around transparency and visibility of key interactions. This is in line with transformative approaches to governance and trust being realised through blockchain and related technologies and approaches. It is envisaged that such approaches could be further developed to accelerate changes to regulations and standards development in a positive way.

4.2.2 The EF and the Common EF

One of the earliest assertions was that *EFs* should be aligned to functions. This allows *EFs* to reflect key aspects of functions, and will become integral with functions to ensure they can continue to support the function as the market and system evolve (iteration). *EFs* for different functions could be grouped together as functions could be grouped together. This would need to be based on some underlying motivation, such as attribute commonality and the efficiency this could deliver – the linkages with the underlying functions would remain. This horizontally orientated enablement meant that an *EF* could be optimised to meet all the needs of a function efficiently.

It became clear that most *EFs* would have a number of enablement needs and barriers to overcome in common. For example, most functions would require some form of regulatory or industry process change or whole system security requirements. It would not be efficient for each *EF* to replicate the capabilities and activities involved in this.

Time and efficiency savings could be realised if these vertical or domain-specific enablement capabilities were delivered by a particular and focused type of *EF* that would be aligned to a specific domain rather than a function. These *EFs* could work in a similar way to product release roadmaps and could be managed like a programme. They could gather, categorise and plan implementation of domain-specific needs for all functions – the benefit of this from a programme management and roadmap planning perspective is clear. These domain enablers were called '*Common EFs*'. *Common EFs* are likely to cover the domains listed below.

We have organised the domains from the most influential to the least influential (legislation drives regulation, regulation drives standards, etc.)

[4]Slack is a collaboration and communication environment co-founded by British entrepreneur Cal Henderson. It has been adopted heavily in Silicon Valley, where these principles of integrated highly collaborative work practices are the norm.
[5]Coplien, J and Harrison, N; Organisational Patterns of Agile Software Development; p19, Prentice Hall, 2005.

- Legislation.
- Regulation.
- Standards.
- Safety.
- Security (including cyber security).
- Industry processes.
- Customer communications.

There would likely be ongoing interactions between *EFs* and *Common EFs* as new requirements become known or priorities for functions change. There would also possibly be interactions between the different types of *Common EF*.

4.3 EF creation

4.3.1 EF architecture for EF creation

There is a clear and formalised structure around the creation and cohesion of *EFs* – this structure is known as the *EF* architecture. Each *EF* will continue to make use of key components of the *EF* architecture during its lifetime. *EFs* will have interconnections with other *EFs*, and will also be able to adapt and improve on their own. This is how function F1 – the ability to change has been incorporated and internalised within the whole *EF* process. These capabilities taken together with the linkages between different *EFs* and FPSA functions are the formalised structure of the change process – and hence should be considered the *EF* architecture. The role and positioning of the *EF* architecture is presented in Figure 4-5 below. The core components of the architecture and how they translate operationally are covered in Section 4.3.2 the *EF* assembly process and in later sections.

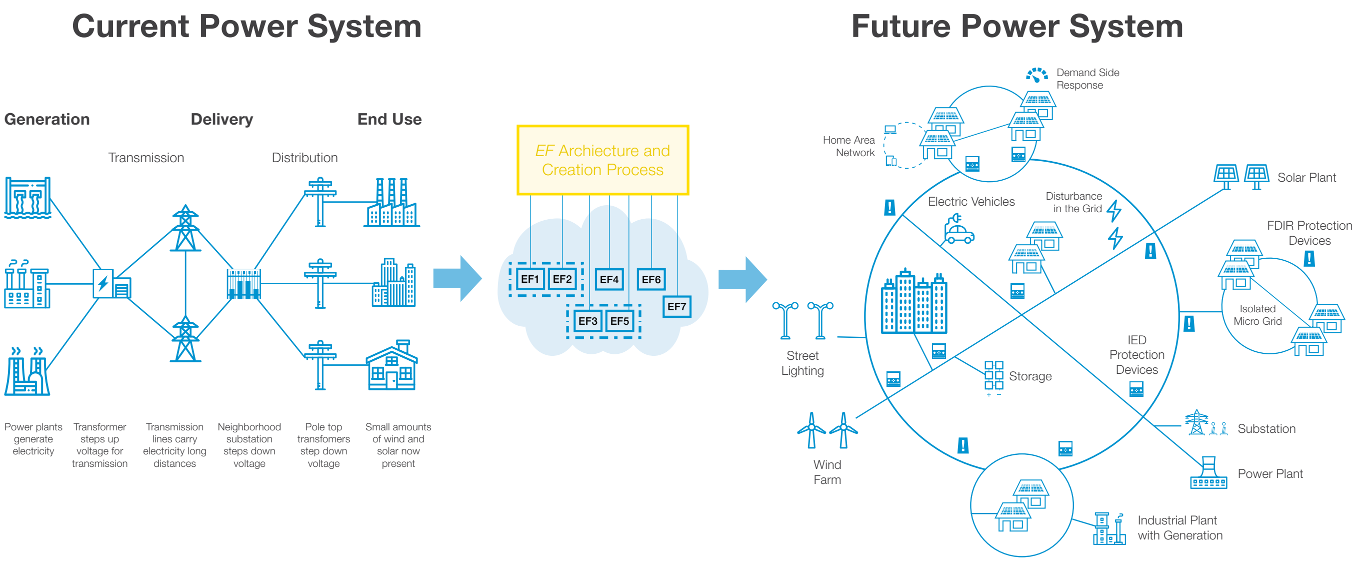
4.3.2 EF assembly process

The process of assembling an *EF* for a particular function can be visualised as a highly customised assembly or manufacturing process. Many of the components that need to be brought together are well understood by the relevant stakeholders, and the detail will hence be customised according to the functions particular attributes (needs and barriers). This customisation ensures that the *EF* provides the most efficient and effective enablement capability possible. The process for creating *EFs* must provide the initial *EF* structure, while also allowing the *EF* to evolve. *EFs* are therefore supportive, modular and reconfigurable, similar to scaffolding.

The *EF* assembly process comprises the following key components:

- The *EF* itself.
- The *Enablement Organisation*.
- The pre-structuring activities.
- The *Common EF*.
- The stakeholder network (an inclusive and self-selecting group).

Figure 4-5: *EF* Architecture Structures the Creation Process



Source: http://www.sciencedirect.com/science/article/pii/S1364032115008771

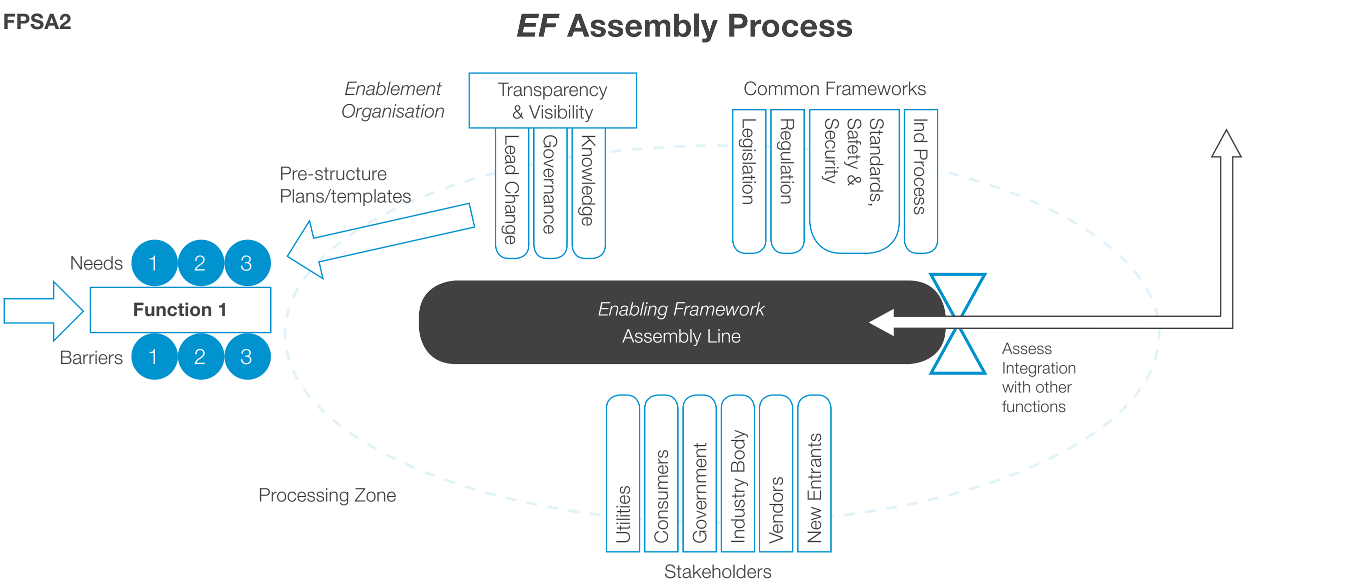
Source: http://psm.ucy.ac.cy/research-projects/

Figure 4-6 below shows the structure of the *EF* assembly environment. The *EF* creation process can be visualised as moving from left to right across Figure 4-4, starting with 'Function 1'. Function 1's needs and barriers are key elements that affect how the *Enablement Organisation*, stakeholders and common *EFs* contribute to the assembly process (which occurs in the *EF* assembly line space). The *Enablement Organisation* plays the most significant role and pre-structures a number of aspects of the *EF* to make it ready for the assembly line and process. This involves providing the *EF* with initial plans, tools and capabilities in order to kick-start the process. The objective is to accelerate the process of *EF* readiness, to realise efficiencies and to standardise this iterative process. This process includes initial views on key stakeholders, a literature review and presentation of main key options for *EF* progress, an initial project plan and budget as well as establishing the collaboration environment and providing document and reporting templates, and so forth.

The *Enablement Organisation* is a key and enduring facilitation capability within the *EF* creation process. It is responsible for the creation of *EFs*. A member of the *Enablement Organisation* acts as a chairperson in the stakeholder network which is responsible for *EF* and operational-related decisions and design. The *Enablement Organisation* plays a supportive role in *EF* function, providing governance and ensuring the efficient execution of the *EF*.

The next step in the *EF* assembly process is the formation of the stakeholder network. This will be partly informed by *Enablement Organisation* pre-structuring and will also seek to involve stakeholders not yet identified. The *Enablement Organisation* will purposefully create awareness around the formation of the stakeholder network and seek to recruit new participants, to ensure inclusive engagement. The *Enablement Organisation* will then support the stakeholder network through the remaining steps of establishing and activating the *EF*.

Figure 4-6: *EF* Assembly Process Commencement



These steps will include further development of plans, tools, engagement and various other administrative functions. A further key aspect of the assembly process is the engagement between the *EF* and the *Common EF*. During this stage of assembly, the *EF* ensures that the function-specified requirements that are relevant to *Common EFs* are provided to the *Common EF* in the form of 'customisations' to incorporate into their programme of work. These requirements will then be monitored, managed and updated on a regular basis to align delivery and priorities. Similar engagements and relationships will also be established with other *EFs* and functions where interdependencies exist.

After completion of the *EF* assembly process, the *EF* is empowered to enable its associated function (or group of functions). The *EF* will have and develop various artefacts relating to the activities it needs to perform. These artefacts could, for example, be the tools necessary to deliver the function, such as a calculator to determine the contribution to system security by certain flexible assets, or plans/blueprints for a protocol for co-ordinating the operation of multiple flexible assets. Artefacts are discussed in more detail in later sections of this document and are also touched on during the testing.

At this stage, the *EF* should be a semi-autonomous entity, with the power to interact with other *EFs* and functions and also to iterate and improve on its plans and processes.

Progress and delivery expectations in terms of the function enablement will be tracked and governed by the *Enablement Organisation*. A member of the *Enablement Organisation* will act as the chairperson of the stakeholder network. The completed *EF* assembly process is illustrated in Figure 4-7.

It will also be observed in Figure 4-7 that the *Common EFs* have received 'customisations' from the *EF*. It is now the responsibility of the *Common EF* to deliver, however the *EF* will still need to interact with the *Common EF* to ensure co-ordinated delivery.

Figure 4-7: *EF* Assembly Completion

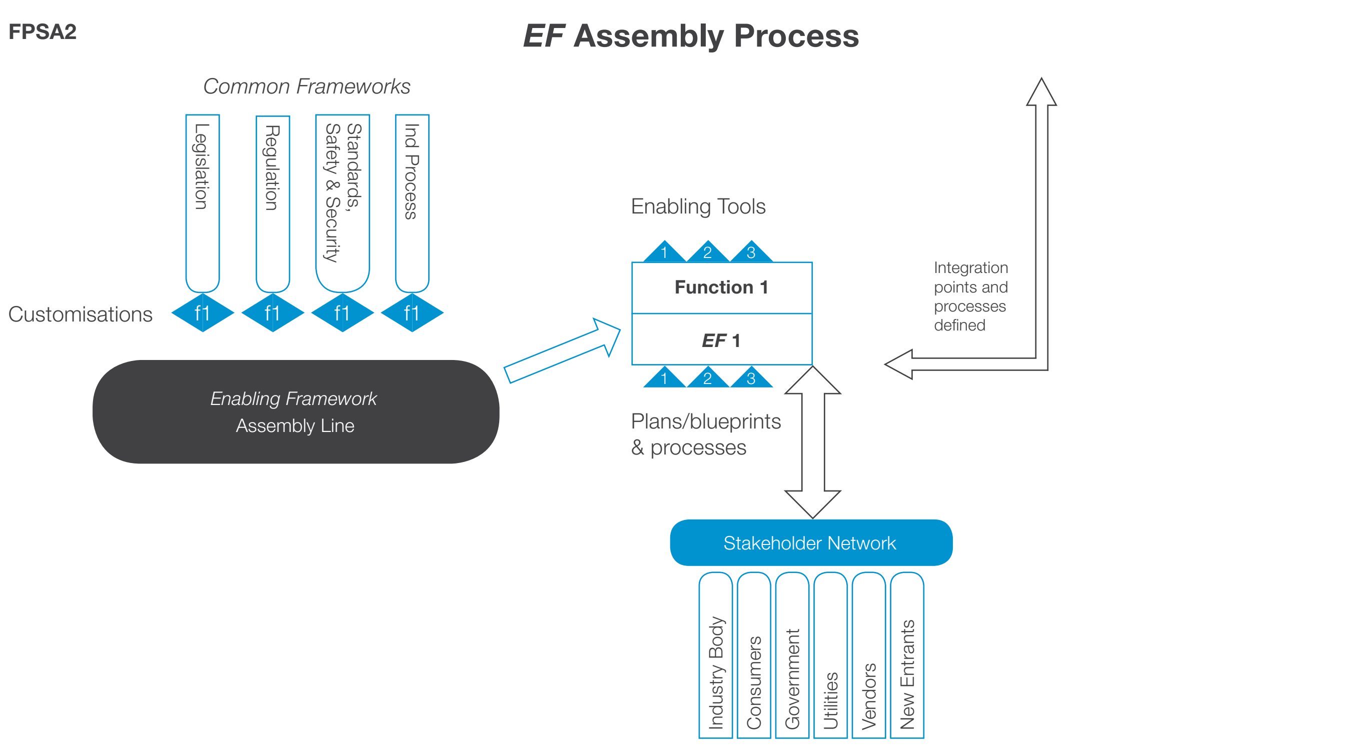
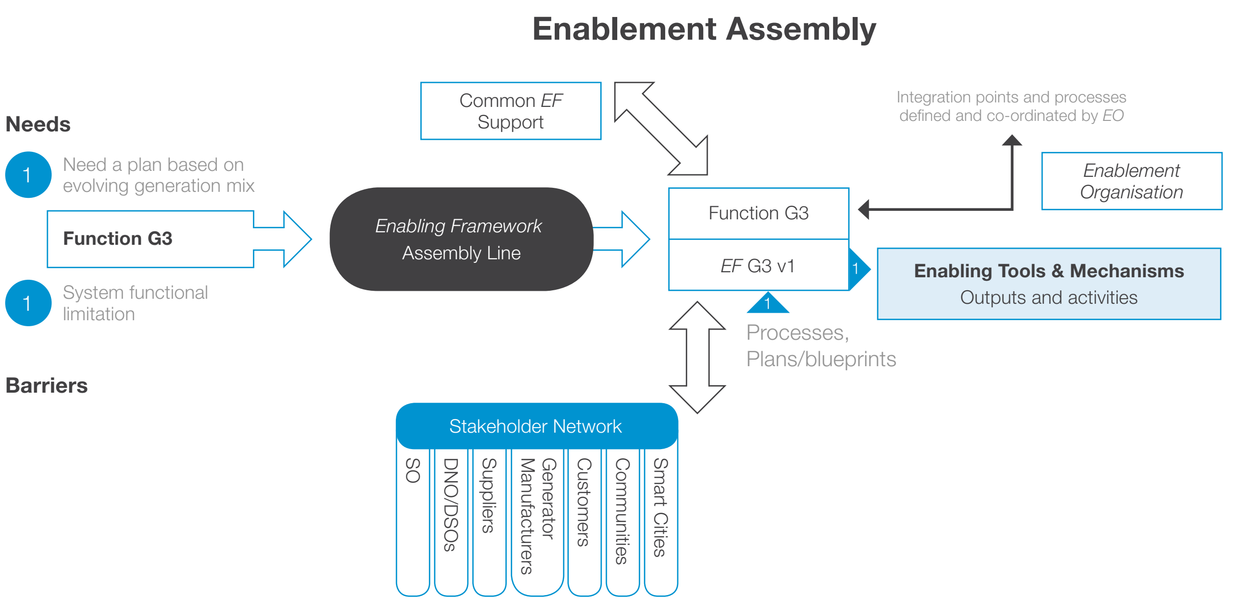


Figure 4-7 illustrates the assembly and completion aspects of the *EF* creation process, and includes a few further details taken from the testing of the *EF* assembly process for a function. Function G3 (the Black Start function) has been used in Figure 4-8 to provide a more tangible contextualisation.

The enablement process and the creation of *EFs* need to be capable of offering a scalable approach without specific boundaries. It should also be recognised that benefits will arise from prioritisation and the efficient use of resources and leveraging of expertise. This prioritisation and optimisation may change over time – communication between different parts of the *EF* architecture will therefore be critical. The sequencing of *EFs* and *common EFs* could inform the first steps for enablement including initial demonstration projects needed as part of the energy system transformation, and will be part of building up the range and depth of skills and capability. Interdependencies are therefore key to the *EF* assembly process, and the sequencing of *EF* assembly is desirable.

Figure 4-8: Full *EF* Assembly Process Example G3



5. *EF* Components and Operation in More Detail

The key components of *EFs* and the *EF* assembly process outlined in earlier sections are presented in more detail in this section. In this section they are not presented in the synchronous order in which they are applied. The operation and objectives of *EF* components have been developed by considering stakeholder views and WP feedback on existing industry processes and environment (as presented in Section 3). Details of *EFs* have also been informed by testing, as discussed in Section 6.

It should be noted that additional work will be required to define *EFs* to a level that will allow them to be operationally implemented. This is a conscious decision to ensure that wider stakeholder participation and agreement is garnered, thereby increasing the broadness of engagement and overall ownership of this new process. This is likely to include further work on the tools that will be required, the identification of roles, responsibilities and accountabilities, elaboration on decision-making and funding, among others.

5.1 *EF* outline operational attributes

In order to provide a clearer understanding of the *EF* operation and the *EF* assembly process, we will examine each of the key *EF* assembly process components in more detail, and seek in particular to provide more clarity on:

1. Activities, roles, responsibilities and conceptual model and principles of operation of the key *EF* assembly process components.
2. Technical or structural underpinnings e.g. hierarchies.
3. Interconnections and support required e.g. tools and interactions.

The elaboration given in subsequent sub-sections is not intended to be a comprehensive operational definition. It should, however, be sufficient to prove that the design and development of the various elements of the *EF*, together with *EF* testing, are robust and can operate effectively once implemented.

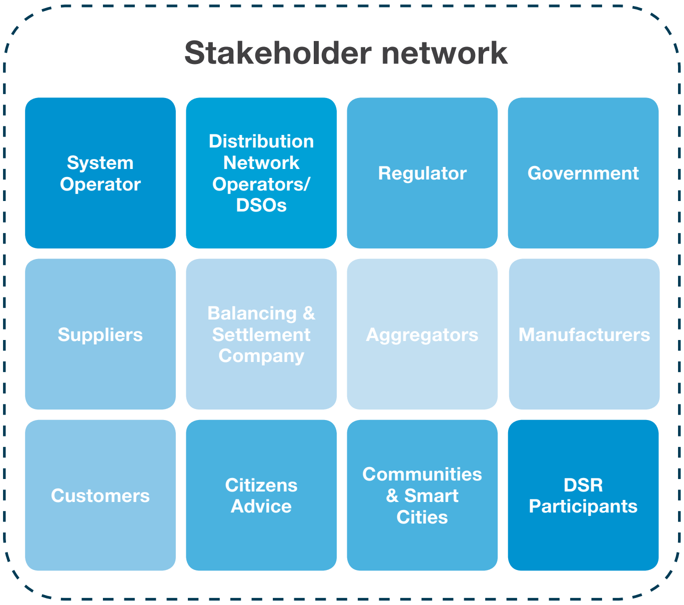
5.2 *EF* inputs

As detailed in FPSA2 project WP2 and WP3, function needs and barriers are inputs to *EFs*. A full definition of the needs of a function is required in order to enable the entire functionality. It is essential to identify barriers (or issues) that presently inhibit the full range of future functionality and that must be overcome. In line with a whole-system approach, the inputs to *EFs* must consider all domains, including technical, regulation, standards, commercial and societal.

In order to avoid constraints on innovation and on the development of alternative methods for delivering functionality, it is important that the inputs to *EFs* are seen in their broadest context so that all potential solutions can be considered and any bias to the enablement approach managed. For example, compliance with existing standards should not be a barrier because these standards could be changed by the *EF* process if *EF* investigations show this to be acceptable.

The inputs provide an understanding of the required actions of the *EF* and its outputs. For example, a need of the Black Start function (function G3) may be the provision of a plan for Black Start that is acceptable to society in terms of the duration of interruption, level of disruption, cost and environmental impact. This need could translate within the *EF* to a survey of customer tolerance that will inform the evaluation of Black Start options and the selection of the preferred solution. A barrier to function G3 may be the inability of control systems to operate during network outages, highlighting the requirement for the *EF* to research the impact of this issue and develop any necessary capability.

Figure 5-1: Potential Stakeholder Network participants



5.3 *EF* stakeholder network

The stakeholder network is a collection of connected stakeholders from across the industry, market and society, that are required to provide the inclusive participation and joined up contribution that will be necessary to give the *EF* process its legitimacy and ensure that the new power system is developed to meet all of society's needs. The stakeholder network will act as the significant decision-making and content creation body for particular *EFs*. The network's decisions and associated designs will have a high level of legitimacy due to it having a fully inclusive membership, open on a democratic basis.

An involved and effective stakeholder network is critical to the speed, efficiency and effectiveness of *EFs*. Integrating stakeholder engagement at the centre of the enablement and network development process could be viewed as a more agile consultation mechanism. This mechanism benefits from a collaborative approach and continuous sharing of information. Transparency and standardised working practices will be essential to enable the stakeholder network to effectively make decisions.

5.3.1 Stakeholder network membership

The stakeholder network will comprise representatives of all interested parties to facilitate collaborative working and empowerment. In a changing environment that is shifting away from traditional roles, a wide-ranging stakeholder network is essential to make sure that all perspectives are considered and potential opportunities fully exploited. Membership of each *EF* stakeholder network shall be open to all, but is likely to be informed by the particular needs of a function. For example, generator manufacturers would likely want to participate in the *EF* addressing future Black Start capability (function G3), but are less likely to want to contribute to the enablement of the function delivering revised market structures (function H5). A range of potential members is presented in Figure 5-1.

The *Enablement Organisation* will assemble the initial stakeholder network and define the quorum as one of its pre-structuring activities. A key aspect of the formation of the stakeholder network will be to create awareness of its formation, perhaps through advertising or specific portals. This will allow previously unengaged parties and new entrants to participate.

We envisage two levels of stakeholder network participation:

1. Active stakeholder network.
2. Subscribers/followers and community participation.

The stakeholder network will comprise a core active stakeholder network and a number of other subscribed/interested “followers”. Active stakeholder network members who do not fulfil their role as per agreed expectations will, after sufficient warning, be replaced by subscribed stakeholders that are keen to be involved.

Groups of functions to be enabled together, or at least requiring co-operation between their *EFs*, could be identified by recognising stakeholders’ overlapping interests across functions.

The specific needs and barriers of a function will define the necessary roles for enablement of that function and hence will also define what would make an effective stakeholder network member. Some stakeholder network participants may be easily identified and recruited directly, for example, the System Operator should be involved in the *EF* for future Black Start functionality (function G3). However, we recognise that awareness creation will be required to ensure that all stakeholders are informed and given adequate notice of the potential to participate.

Large-scale participants will have access to greater resources, making them more capable of contributing to *EFs* than smaller-scale stakeholders. We propose that stakeholders that do not have the means to participate actively will be means tested and gain funded consultancy support if validated.

5.3.2 Stakeholder network operation

The active stakeholder network will develop, define and execute all plans relating to the enablement of the function. This could include, but is not limited to:

- Validating function needs and confirming details of function barriers.
- Designing the *EFs*, including being responsible for their ongoing review and update.
- Drafting of blueprints or plans for function implementation.
- Designing and monitoring of R&D and Demonstration projects.
- Horizon scanning and developing reports.
- Interacting with the *EFs* of other functions.
- Co-operating with *common EFs*.

The operation of the stakeholder network will need to be managed and be governed and should employ tools to ensure a collaborative environment and techniques to ensure efficient and effective interactions and handling of issues. For example, detailed discussions could be conducted in focus groups and these could operate with time limits so that they concentrate on key messages in a prompt manner. Visibility is considered to be crucial to ensure positive behaviour and forward momentum of *EF* operation. Therefore all possible practices shall be open and all interactions will be tracked to provide an audit trail leading to robust and justified decision making.

Active stakeholder network decisions and activities will be democratically decided. The stakeholder network Chairperson, who shall be a representative of the *Enablement Organisation*, will not have a vote in decision-making, and will be responsible for facilitating dispute resolution. It is envisaged that the Chairperson shall engage the *Enablement Organisation* for arbitration when deadlock occurs on a vote or when a vote is disputed. It is important that the *EF* programme is not delayed by such disputes and so the quickest resolution should always be sought and resolution should occur in parallel.

5.4 *EF* pre-structuring

EF pre-structuring refers to the E*nablement Organisation’s* initial actions. This is the first step in the *EF* assembly process and the intention is that it should help the work to start promptly.

Pre-structuring will comprise many activities, including the following:

- Establish the stakeholder network through engagement and awareness creation.
- Establish the baseline by reviewing the context of the function, including existing approaches.
- Develop initial outline options or *EF* delivery requirements.
- Structure initial skeleton of project management and support capabilities.
- Establish common templates and documentation standards.
- Estimate the initial budget for *EF* operation.

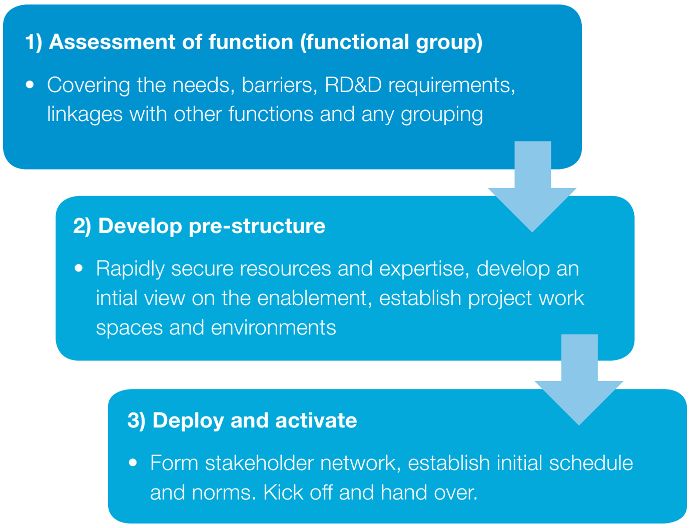
A rapid three-step implementation of the pre-structuring process is shown in Figure 5-2 opposite.

Starting with horizon scanning and an assessment of the function or function group, the pre-structure process will draw upon a broad body of resources. Pre-structuring shall develop ideas rapidly, understanding that they will not be complete and that the stakeholder network will subsequently progress and modify them.

Pre-structuring offers an opportunity to build the *Enablement Organisation's* skills, competency and its broad understanding. This will be essential to support the enablement of and co-ordination with other frameworks.

In order to speed up the *EF* progress, pre-structuring shall undertake initial work to develop a basic document and planning templates. This may take the form of initial views of potential changes and design options for new arrangements, making sure that they do not predicate any particular solution. For example, pre-structuring for Black Start functionality (function G3) could include an evaluation of existing Black Start procedures and development of the outline of alternative ideas for future options. It would be inappropriate for pre-structuring to do the same for function H6 which seeks to "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" because the market will develop the options. However, pre-structuring for function H6 may usefully develop an initial outline of the process

Figure 5-2: Three steps of pre-structuring



for evaluating the new parties' propositions and how the enabling requirements will be prioritised.

Pre-structuring will establish the standard processes, tools and templates to be used within the operation of the *EF*. The purpose of this is to provide the consistency between the *EFs* that will facilitate co-ordination, make them more accessible and improve efficiency.

5.5 *Common EFs*

Common EFs are focused on a single domain which relates to an area of requirements shared by multiple *EFs* for individual functions or an area of requirements shared by groups of functions. The objective of common *EFs* is to overcome overlapping barriers identified by all or numerous *EFs*. *Common EFs* overcome overlapping barriers by providing synchronised enablement, thereby facilitating a broad range of functions.

Common EFs are likely to cover the following domains:

- Legislation.
- Regulation.
- Standards.
- Safety.
- Security (including Cyber).
- Industry processes.
- Customer communications.

The key activities of *Common EFs* will include:

- Receipt of information of the issues facing other *EFs*.
- Evaluation of the requirements of multiple *EFs* to establish co-ordinated plans.
- Scheduling and execution of delivery.
- Responding to changes in requirements, critical paths and dependencies.
- Identifying, addressing and mitigating interdependencies and risks.
- Documentation.

Instead of being operated by a dedicated stakeholder network (as is the case for functional *EFs*), *Common EFs* will be delivered by the lead organisation within that domain, for example, Ofgem would lead the *Common EF* relating to regulation. When a *Common EF* crosses more than one organisation, the delivery would be split into sub-projects led by the corresponding organisation. As was the case for functional *EFs*, *Common EFs* leads and participants are expected to source their own funding, unless this is not feasible due to their size.

Successful delivery of each *Common EFs* project will be assured by obtaining commitment at a senior level from within each delivery organisation. For example, a Member of Parliament could commit to the legislation *Common EF*. Consequently, it is expected that the programme board for each *Common EF* will comprise the representatives shown in Figure 5-3. Stakeholder involvement will continue to be important to *Common EFs* and therefore ongoing stakeholder communities shall be established to support enablement and evolution of functions as stakeholder interests' change.

The programmes will be supported by the *Enablement Organisation*, which may be a source of knowledge, tools and project leadership/management.

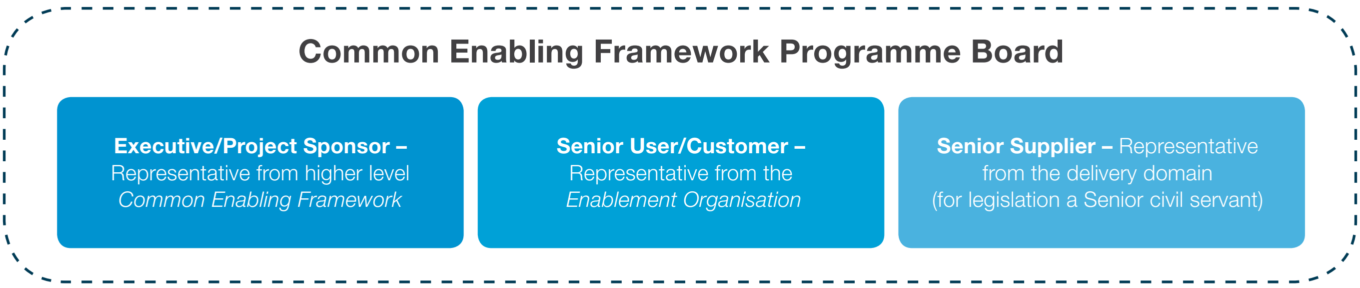
Common EFs are characterised by their interactions with other *EFs*. Understanding of issues and instructions to make changes shall originate from the functional *EFs* rather than from within the common framework. Regular liaison between the *EFs* and *Common EFs* shall ensure a common understanding of evolving requirements and dependencies. The ability to interact efficiently and effectively will be a key feature in the design of *Common EFs* because they are critical in ensuring alignment of *EF* plans and activities.

Common EFs shall support efficient enablement by delivering packages of changes in a sequence that takes account of the barriers that are viewed to be the most important and on the critical path. These programmes will seek to manage and streamline the mitigation of barriers. They will remove challenges within their domain through a series of releases, recognising that *Common EFs* will change in workload and scale, and are also likely to be enduring. In order to be lasting, enablement is therefore likely to be an iterative process.

5.6 *EF Enablement Organisation*

The *Enablement Organisation* is the mechanism within the *EF* assembly process that fulfils a variety of necessary facilitation roles. Broadly it is responsible for the smooth creation of *EFs* and their subsequent operation. It assists with decision-making, provides governance and ensures the efficient execution of *EFs*. It is feasible that multiple parties will fulfil the role of the *Enablement Organisation*. The *Enablement*

Figure 5-3: Common *EF* Programme Board membership



Organisation will operate in an independent, impartial and faciliatory manner to support the delivery of *EFs*, without dictating the strategy of any function or group of functions. Operating in an open and transparent manner, the focus shall be on establishing an environment for iterative change and improvement of the energy system as well as efficient delivery.

5.6.1 Need for an Enablement Organisation

In order for the *Enablement Organisation* to align with the *EF* guiding principles listed in Table 5-1, it needs to perform the listed roles:

These roles are best served by the *Enablement Organisation* because:

- Inherently, co-ordination requires continuity.
- Efficient handling of knowledge and information needs a single repository.
- Learning from supervising and delivering the process needs to be fed back into the enablement strategy with an overview of the whole.
- Overarching knowledge is needed to provide effective and rapid conflict resolution leading to rapid arbitration (should this be required).

Table 5-1: Mapping of Enablement Roles to Guiding Principles

Enablement Role	Mapped Guiding Principles
Facilitate change – setting the foundations and conditions for change and monitoring progress, it will also act as arbiter in dead-lock.	• Facilitate conflict resolution. • Make use of innovative approaches to accelerate decisions and support system change.
Governance – will include adherence to principles and provide trust services, in terms of measurement, verification and assurance.	• Support and harmonise technical and economic evaluation. • Facilitate conflict resolution.
Knowledge – will ensure knowledge and information is provided and captured for all activities, also ensuring harmonisation of approaches and measurement through tools and benchmarks.	• Ongoing feedback from and iteration of all activities. • Transparency and visibility.
Co-ordination – ensure that various activities and parties come together effectively in the delivery across the *EFs*. Also facilitate activities related to the *Common EFs*.	• Stakeholders integrated into the process. • Facilitate conflict resolution • Maximise synergies. • Enhance co-ordination and facilitation.

5.6.2 Enablement roles

5.6.2.1 Facilitate change

The *Enablement Organisation* shall facilitate change from the outset by initialising the creation of *EFs* thorough the aforementioned pre-structuring activities before handing over to the stakeholder network. Subsequently, the facilitate change enablement role shall focus on monitoring the operation and progress of the *EF* to protect the rate at which enablement is provided. Programmes will be tracked, checks made against milestones and quality assured by using agreed tools and standardised approaches. Stakeholder participation will be observed using an agreed approach to provide transparency. Importantly, stakeholder participation should also establish when a lack of participation is inhibiting the advancement of projects.

5.6.2.2 Governance

The *Enablement Organisation* shall be part of ensuring that efficient transformation is delivered, thereby ensuring that *EFs* are valid. Suitable governance, including programme monitoring, reporting, financial oversight, independent assessment, benchmarking, risk review and change management shall be provided to achieve these objectives.

In particular, governance shall establish robust decision-making and arbitration processes and work with other governance authorities. The *Enablement Organisation* does not imply that all skills and authority have to reside within it; it seeks to serve as the epicentre of co-ordination between all relevant parties to ensure delivery and consistency across the whole-system.

5.6.2.3 Knowledge creation and management

The *Enablement Organisation* needs knowledge to deliver its services and provide co-ordination. A standardised approach to knowledge capture, organisation, reporting and dissemination is recommended to support the efficient operation of *EFs*. The emphasis shall be on comprehensive knowledge collation from across industry at all stages of *EF* operation including pre-structuring and making this information readily accessible. Sources may include reports and all stakeholder and community discussions, comments and inputs. It is recognised that the approach to knowledge management would need to be compliant with confidentiality requirements. Open access and transparency are likely to be necessary conditions of stakeholder participation.

5.6.2.4 Co-ordination

The *Enablement Organisation's* future role in providing whole-system co-ordination between all *EFs* is an answer to the criticism that existing processes address issues in isolation. Co-ordination is required because decisions made in one *EF* may affect other functionalities. A holistic approach is necessary to deliver decisions which are of optimal benefit to all system participants. A systematic approach to such co-ordination is encouraged because whole system overview and decision making provision needs to be robust to produce justifiable outcomes.

5.6.3 Enablement Organisation structure

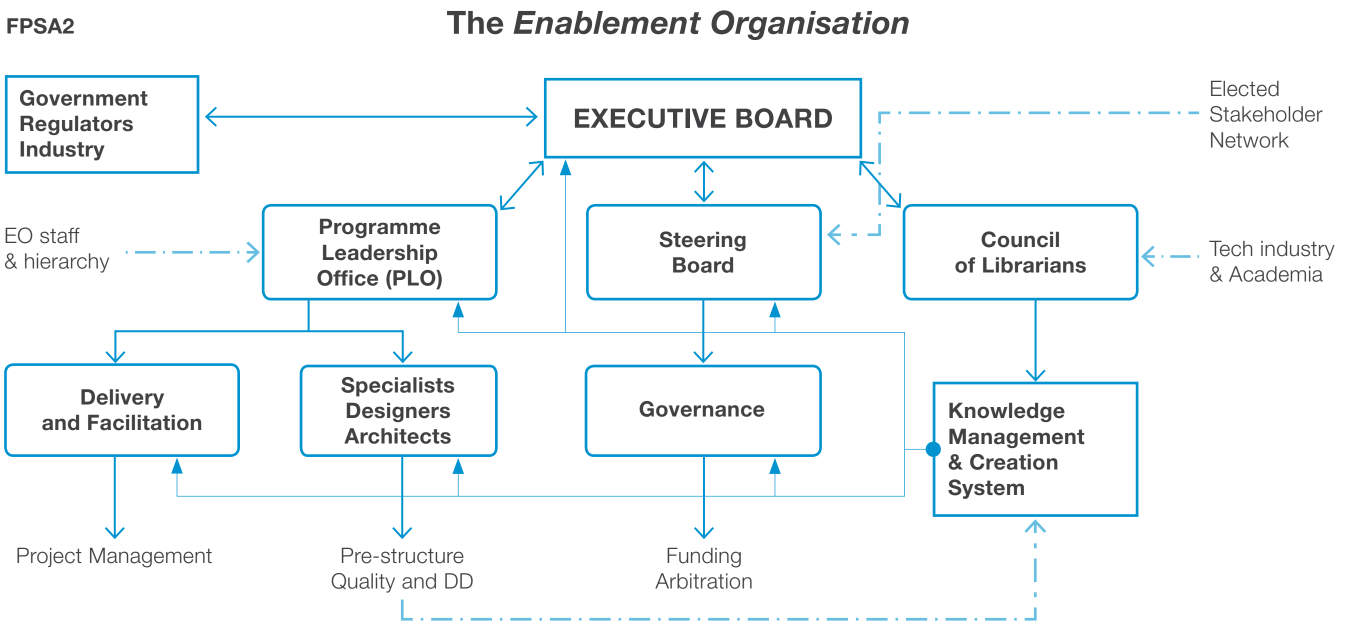
To illustrate how the *Enablement Organisation* may be shaped and operate across its key operational areas, we have developed an example high-level organogram as shown in Figure 5-4 below.

This example *enablement organisational* structure seeks to benefit from best practice across various organisation types. This structure also seeks to ensure the longevity of the *Enablement Organisation*. It will be important to retain organisational knowledge given the time it is likely to take for the new functionality to be implemented. The structure also reflects current thinking around the separation of powers in order to improve internal governance. This ensures that the *Enablement Organisation* provides a balanced and supporting capability for the functions and *EFs* and, most importantly, for all stakeholders in the industry.

5.7 *EF* governance, decision-making and accountability

Assessments and determinations on the appropriateness of the governance model and full exploration of the decision-making and accountability aspects of *EF* should be dealt with in detail in the next phase of work. The *EFs* presented here are flexible enough to accommodate many modalities in terms of these needs and moreover should enable these to be changed and adapted should certain approaches be found to be ineffective.

Figure 5-4: Example *Enablement Organisation* Structure



6. *Enabling Framework* Testing

6.1 Testing objectives

Testing of the proposed process for creating *EFs* and their structure was undertaken to validate that the requirements of functions can be met by *EFs*. Specifically, the testing checked the suitability of *EFs* to enable the needs of a function and to overcome its barriers.

The testing process also provided an opportunity for learning to improve *EFs*. In particular, the testing objectives included the following:

- Demonstrate and clarify *EF* operation.
- Observe how the definitions of needs and barriers affect the operation of *EFs* and so provide feedback to improve these definitions for further application.
- Identify and answer additional questions about the operation of *EFs* and so develop further details.
- Explore the operation of individual *EF* components.
- Identify the need for tools to aid the operation of *EFs*.

6.2 Testing methodology

Testing was undertaken by 'walking through' the *EF* creation process using functions carefully selected to be test cases.

Key questions were developed to structure and standardise the examination of the test cases. The testing process was guided by stepping through the questions to ensure that all aspects were explored and the testing objectives were met. The list of *EF* testing questions is shown in Table 6-1. Answers to these questions informed one or many of the key components of the *EF* assembly process.

The testing started with the definitions of needs and barriers. Questions considered how needs and barriers would inform the outputs of the *EF*. In particular, the testing checked that needs and barriers were not aligned with any particular solution which would result in constrained enablement plans and limit subsequent functionality.

Functional requirements were considered within the wider context of all functions to establish how *EFs* would operate as part of a whole system approach and how interactions would be managed within their outputs.

Questions were posed to encourage deeper thinking to uncover details within the operation of the *EF* process and the plans they deliver. This was done in order to inform the manner in which subsequent implementation might proceed. All stages of assembling *EFs* were addressed. Questions also covered who would be responsible for different aspects of the process and who would have authority throughout the process. Possible approaches and tools necessary to yield efficient and effective *EFs* were considered.

6.3 Selection of the test case functions

The following criteria were used to identify the FPSA functions that match the objectives of the testing well and select the test cases:

- Demonstrate the range of *EF* capabilities by reflecting the application of *EFs* to resolve technical, regulatory and commercial barriers.
- Demonstrate the capability to create extreme *EFs*.
- Illustrate a range of *EF* outputs.
- Include the need for common *EFs*.
- Exhibit the operation of all *EF* components.
- Be recognisable and understood by a range of stakeholders.
- Show incorporation of extensive transformation and inclusion new participants, including those 'beyond the meter'.

Three functions that were considered to be a good match with the requirements were chosen for the test cases. They were subsequently used in the testing of the application of *EFs* undertaken by WP4, including a workshop involving WP2 and WP3. These functions were:

Function G3 – "Plan for the timely restoration of supplies following a total or partial shutdown (Black Start)."

Function H5 – "Provide a market structure that enables customers to have choices within the power system."

Table 6-1: Questions for *EF* Testing

Testing Step 1 – Exploring *EF* Inputs and Outputs
• What are the specific needs and barriers of this function? • Which stakeholders need to be involved in this case? • What is the enablement that is needed to deliver the function needs and overcome the function barriers? • What will be delivered by the *EF*? • What are the dependencies of other *EFs*?
Testing Step 2 – Exploring *EF* components
• Which key aspects of the *EF* architecture will enable this? • What specific pre-structuring activity is required? • What are the requirements of the common *EF*? • What will be required of the *Enablement Organisation*?
Testing Step 3 – Exploring *EF* operation
• What processes, plans, mechanisms and tools will be part of the *EF*? • What funding is envisaged to develop, trial and demonstrate this function? What funding sources are envisaged? • What form of implementation and demonstration must the *EF* deliver? Research, development, implementation or monitoring?

Function H6 – "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."

Functions H5 and H6 are closely related and therefore offered the potential advantage of being able to explore how groups of functions would be treated by *EFs*.

6.4 Test case outcomes

Key messages arising from the test cases are summarised in the following sub-sections, whilst detailed responses to the questions leading the testing of the application of *EFs* are given in Appendix B.

6.4.1 Function G3 test case

New Black Start participants and processes will be required as existing Black Start approaches become unsustainable due to the removal of large synchronous generators. When testing function G3, it was concluded that although the *Enablement Organisation* will be able to immediately identify the more obvious stakeholders, further stakeholders may have the desire to contribute to, or be informed about, the *EF* process and progress. On this basis, it was recommended that the *EF* should advertise and recruit all parties interested in participating. As with all changes with commercial effects on existing and new service providers, there could be cases where winners and losers are perceived that will need some measure of dispassion adjudication. There is therefore a recognised need and support for the *Enablement Organisation* to provide arbitration and robust decision-making, potentially based on a suitable democratic process.

The application of *EFs* to function G3 during the testing process was characterised by technical requirements and the continuous influence of the evolving network infrastructure and connections. It was recognised that establishing the baseline as part of pre-structuring, through a review of existing GB and international approaches to Black Start, could accelerate the operation of the *EF* and make it more efficient.

Options for future Black Start approaches using existing network components were envisaged during testing of the application of *EFs* to function G3. Consequently, the identified barriers were initially aligned with particular solutions and this was judged to potentially bias enablement and exclude new participants. It was concluded that needs and barriers should be neutral to solutions.

Black Start options are affected by rapid developments within specific aspects of the energy system as well as across the whole power system and its architecture. This has informed *EFs* being required to undertake ongoing horizon scanning and monitoring of all other functions. This uncertainty also highlights that the requirement for agility and co-ordination with other *EFs* is crucial to ensure that all emerging Black Start opportunities are explored and to deliver a whole systems approach. A further implication is that the requirements for and capabilities of this *EF* would likely need to change as the whole system changed.

During the testing, it was noted that the steps necessary to overcome the identified regulatory and commercial barriers of alternative Black Start approaches will influence the selection of the preferred and adopted black start option. Interaction with *Common EFs* that impacted and influenced these areas would therefore be important, and it was concluded that they shall provide a service to the *EF*. They shall inform the decision-making by judging the possibilities and identifying the implications of the required commercial, industry process and regulatory adjustments. Subsequently the common frameworks shall receive instruction from the *EF* to develop and implement the necessary changes to support the adopted approach.

The need for the *EF* to consider cyber security, communications with stakeholders and societal impact in terms of customers' expectations and attitudes were identified within the testing, leading to the conclusion that these would be best addressed by common *EFs*.

6.4.2 Function H5 test case

In contrast with the Black Start test case, the test case of function H5, to "Provide a market structure that enables customers to have choices within the power system.", was dominated by legislative enablement. However, technical and societal aspects remain as significant influences. This highlights the importance of a diverse stakeholder network to make sure that all perspectives are taken into consideration.

The *EF* for function H5 must allow new parties to bring new opportunities to the market. The market design therefore needs to be flexible to accommodate emerging future and unknown requirements. An example of one such potential possibility is the emerging use of blockchain-based settlement which can simplify the transfer of money and potentially unleash applications for new small industry participants. New aspects, such as peer-to-peer trading, may not be brought to bear by traditional participants within the industry and it is therefore important that the *Enablement Organisation* facilitates appropriate involvement in the stakeholder network with financial support where necessary. To a large extent, function H5 *EF* is a facilitator for the customer choice enabled through function H6, and as such it must also inform function H6 with regards to the feasibility of choices. This interaction informs the need for co-ordination between *EFs*. A close relationship with other functions will require a mechanism to facilitate whole system consideration of interactions between functions. This mechanism could inform synchronised decision-making whilst enabling all those individual functions.

6.4.3 Function H6 test case

Customer choices are best driven by suppliers and potential suppliers (energy, service and/or other actors, who are collectively known as proposition developers). These developers are responsible for the development of propositions, their evaluation and their delivery to the market. For this reason, the role of the function H6 *EF* is quite different to the role of the *EFs* in the other test cases. This *EF* does not need to be involved with the detailed development of propositions. Instead, it needs to be available to hear about proposition developer issues in meeting consumer needs. It then needs to communicate these barriers to appropriate common *EFs*.

In addition, this *EF* will be required to arrange an independent review of the implications of all proposals. Employing a wider knowledge of the whole industry should facilitate the identification of further points, such as the need for alternative system charging or the need for different data handling and security. Interaction with other frameworks will be important to prioritise enablement based upon a whole systems approach and extraction of maximum benefit from new provisions.

The levelling of the 'playing field' is also very important in the case of the *EF* for function H6. Incumbents and larger suppliers (for instance) may have inherently greater resources and knowledge than new or smaller participants. Greater resources and knowledge is beneficial when developing customer choice and shaping the market. New participants, such as community energy schemes, are likely to be less well-resourced and therefore this *EF* should provide a mechanism to provide appropriate support. The nature of new participants' development may be innovative and therefore may satisfy the criteria for innovation funding.

6.4.4 Summary of learning arising from testing

The testing of the three test cases has confirmed the importance of all elements involved in the *EF* creation process and the roles they play. It has also informed further details within these *EF* elements and their requirements. Learning arising from the testing is summarised in Figure 6-2.

Figure 6-2: Summary of test case learning

EFs – results from testing

- *EFs* work with functions requiring technical, commercial and governance enablement
- Structure supports interaction between *EFs*
- *EFs* can be effective when they are required to support new functionality driven by the market and when enablement involves the development of options, selection, trials and implementation
- Needs and barriers should be solution-neutral to avoid bias within enablement
- Horizon scanning and agility are essential in a rapidly changing environment

Pre-structuring
- Pre-structuring can deliver efficiency
- Document baseline

Common Frameworks
- Provide information to *EFs*
- Receive instructions from *EFs*

Enablement organisation
- Address disparity between large incumbents and new participants
- Conflict resolution
- Co-ordination is required to deliver whole-system approach

Stakeholder organisation
- Requirement to advertise & promote stakeholder involvement
- Stakeholder diversity is important for alternative perspectives
- Robust decision-making process is required

7. Work Package 4 Methodology

A robust, multi-perspective, norm challenging, and flexible approach that utilises, references and builds on prior industry work has been adopted to balance structure and agility. The methodology, as with the frameworks it identifies and develops, was agile and flexible, catering effectively for the various stakeholder roles and needs. The development of the process for creating frameworks sought to embody the approach that the frameworks themselves will apply. The methodology adopted within WP4 is as shown in Figure 7-1 below.

This methodology broadly followed the *EFs* through the following maturation stages:

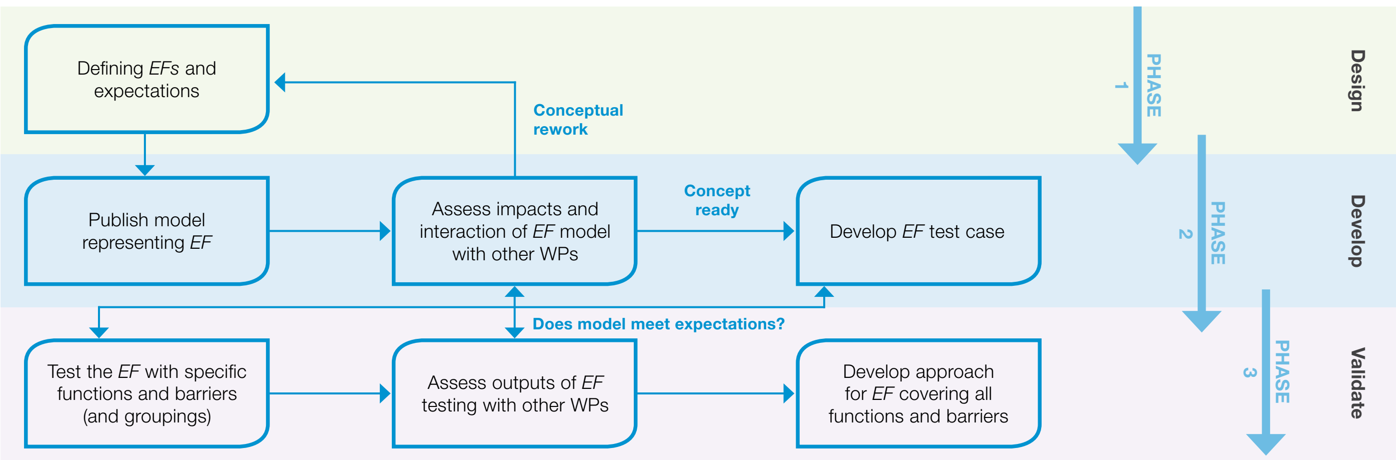
1. **Design** – focus on the definition and agreeing the high-level *EF* model.
2. **Development** – elaboration of key elements of the *EF* to ensure real-world context relevance and effectiveness.
3. **Validation** – testing of a number of test cases to confirm that the *EFs* are fit-for-purpose and to examine operational detail of the *EFs*.

In practice, each of the project's phases featured elements of the others, however, each phase will be more closely aligned to the corresponding *EF* maturation stage.

The WP4 methodology included the following key activity areas:

1. Discovery activities – research and brainstorming.
2. Engaging with other Work Packages and understanding their interaction with WP4.

Figure 7-1: FPSA WP4 Methodology



3. Developing initial *EF* model to assess the structure and language with FPSA2 stakeholders.
4. Further developing understanding of *EF* requirements, roles and responsibilities.
5. Testing *EFs* to demonstrate their operation and produce learning to inform further *EF* development.
6. Documenting the process and outcomes.

7.1 Discovery Activities

As encouraged by the FPSA2 Steering Group, WP4 approached the definition and development of *EFs* with an open mind, seeking to work without pre-conceptions and applied a creative process that could surface new ideas and conceptions. To support this approach, discovery activities were undertaken (see Figure 7-2 below right). Many of these activities happened in parallel and were iterative in nature.

Background research looked at models and approaches developed in adjacent fields:

- Change and transformation models.
- Change in highly complex systems.
- Change leadership and complex system leadership.
- Whole-system change.

The adopted methodology informed different aspects of the *EFs* and delivered a robust approach to gathering the evidence behind each decision.

7.2 Interactions with other WPs

The need for WP4 to interact and iterate with all WPs was recognised from the start, especially as the development of *EFs* is a new activity not previously covered in FPSA1. Close interaction with WP1 has ensured consistency of vision, response to stakeholder views and incorporation of a long-term view. Co-operation with WP2 has enabled the transfer of information with regards to the functional requirements and ensures that the frameworks are structured to meet the enablement needs of those functions. Iteration with WP3 has provided an understanding of industry barriers that the *EFs* must overcome.

Interactions with other WPs have taken varied forms including written communications, telephone conversations and meetings. Focused workshops have been conducted to explore how needs and barriers will work with *EFs* and examine the application of *EFs* to the test cases.

Close working with the FPSA Steering Group whom have experience within multiple aspects of the industry has provided valuable insight into the views of a wider stakeholder group. This has helped to refine *EFs*, and in particular has assisted the understanding of terminology sensitivities.

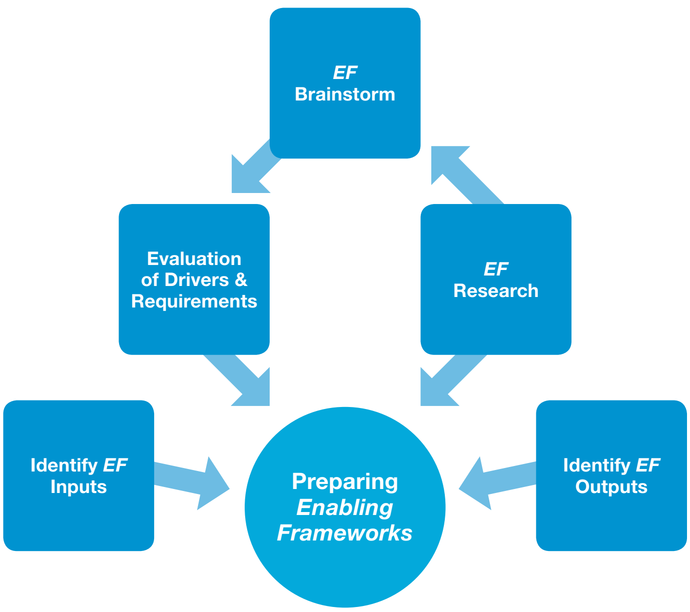
7.3 Developing the initial *EF* model

An initial model was developed to promote discussion and inform improvements to the simple starting point. It facilitated WP4 team thinking, sharing with the wider FPSA2 team, gathering their feedback and the ability to iterate and refine the *EF* model quickly. Numerous iterations of the initial model were developed to further understand the questions identified through the discovery activities. Each small or significant iteration helped to clarify and develop learning.

7.4 Testing EFs

Test cases were examined in accordance with the methodology described in Section 6.2. Stepping through the application of *EFs* to specific functions raised numerous questions. The answers informed further *EF* details.

Figure 7-2: Preparation for developing *EFs*



8. Next Steps

The next steps need to be thought of in the context of the industry, in particular the emerging transformation facilitated by technical and commercial innovations. In this report, we have demonstrated that *EFs* are a robust and workable approach to deliver the future power system. What is needed next at a high level includes the following:

1. Further development of *EF* implementation details, including accountability, decision-making and funding, which should include further stakeholder engagement. This process should seek to surface and address key areas of concern from stakeholders. In particular design of the decision-making process should receive special attention.

2. The tools and capabilities needed to support implementation, need to be further investigated and developed. For example: inclusivity, accessibility and visibility are central to the *EF* approach, therefore advanced digital collaboration platforms will be needed to effectively and efficiently deal with the complexity and size of stakeholder engagement.

3. This project has demonstrated the potential power of iterative learning and agile project management. These approaches should be embraced in the next phase of the FPSA programme where the *EF* process is put into operation through trials and demonstration.

4. Determination of what mandate is required for *EFs* to move to the implementation phase, and what engagement with key stakeholders and actors in the sector and beyond would be required.

5. Thought as to how the urgency, importance and momentum of the *EF* work will be maintained to ensure it does not succumb to delays and misunderstanding or deliberate blocking. A potential action, would be to demonstrate *EFs* as part of the Research, Development, Demonstration (RD&D) and Innovation actions and investments prior to full implementation (under a limited trial of delegated authority and accountability). This initial step could commence the transition plan, to full scale adoption in a step wise approach as highlighted in the report.

6. The manner in which change management is built into the process of *EF* could have major ramifications. How will the process adapt to and accommodate innovation? What impact will this have on the deployment and uptake of new technology, business models and consumer behaviours? Large scale trials will test this change management process and should itself be subject to change and learning.

9. Appendix A – Function Numbering and Definitions

FPSA2	FPSA1	FPSA2 Function Definition	FPSA1 Function Definition
F1	0.1	Enable the power sector to manage necessary changes across the sector when faced with new developments or changes to its objectives and operating environment.	Enable the power sector to respond readily to change, and ensure the timely introduction and implementation of new functions.
A1	1.1	Provide mechanisms to model portfolios of generation, other energy resources, EU interconnection and ancillary services to measure these against the GB carbon reduction, security of supply and energy affordability policy objectives and plan for the delivery of those portfolios that best meet these objectives.	Provide a mechanism to ensure the portfolio of generation, EU Interconnectors, other dispatchable energy resources and ancillary services delivers carbon, security of supply, and affordability policy objectives.
F2	2.1	Identify, counter and learn from threats to operability of the power system from all parts of the power sector both above and beyond the meter.	Identify, counter and learn from threats to operability of the power system from all parts of the power sector both above and beyond the meter.
F3	2.2	Monitor the impact of customer behavioural changes on system operability and propose solutions to resulting operability issues as necessary.	Monitor the impact of customer needs on system operability and propose solutions as necessary.
G1	2.3	Plan for the timely restoration of supplies following a pro-longed local failure (Cold Start).	Plan for the timely restoration of supplies following a pro-longed local failure (Cold Start).
G2	2.4	Provide the ability to move between different modes of overall operation in the event or threat of a system emergency.	Provide the ability to move between different modes of overall operation in the event or threat of a system emergency.
F4	2.5	Identify and protect, on an ongoing basis, against cyber security threats to the operability of the power system which originate from inside and outside the power sector. Detect and respond to existing, new and unforeseen cyber security incidents promptly as required.	Identify and protect, on an ongoing basis, against cyber security threats to operability of the power system originating from inside and outside the power sector. Detect and respond to cyber security incidents.
G3	2.6	Plan for the timely restoration of supplies following a total or partial shutdown (Black Start).	Plan for the timely restoration of supplies following a national failure (Black Start).
B1	3.1	Account for the impact of operational interactions (potentially including cross-vector, cross-border and intra-power system) in system planning and forecasting of demand, generation, energy resources and ancillary services on the power system.	Assess the impact of gas and other energy vectors when forecasting the volumes of demand, generation and other dispatchable energy resources and ancillary services on the power system.
C1	3.2	Forecast all demand, generation, other energy resources and ancillary services across all voltage levels within the power system.	Forecast all demand, generation and other dispatchable energy resources and ancillary services within the power system.
E1	3.3	Ensure that monitoring is in place to support the use of active system management.	Ensure that monitoring is in place to support the use of active system management.
D1	4.1	Use appropriate approaches, including smart technologies, to maximise the capacity of the power system to accommodate the connection and integration of new demand, generation, other energy resources and ancillary services.	Use appropriate approaches, including smart technologies, to maximise the capacity of the power system to accommodate the connection and integration of new demand, generation and other dispatchable energy resources and ancillary services.

FPSA2	FPSA1	FPSA2 Function Definition	FPSA1 Function Definition
B2	5.1	Provide mechanisms by which planning can be co-ordinated between all appropriate parties (potentially including cross-border, cross-vector, and intra-power system operational interactions) to drive optimisation, with assigned responsibility for security of supply.	Provide mechanisms by which planning can be co-ordinated between all appropriate parties to drive optimisation, with assigned responsibility for security of supply
E2	5.2	Review the power sector's developing operational characteristics to validate the assumptions made during the investment planning process.	Review the power sector's developing operational characteristics to validate the assumptions made during the investment planning process.
C2	6.1	Collate and distribute information throughout the power sector on the availability and performance of the generation, other energy resources and ancillary services, and any associated operational restrictions.	Collate and distribute information throughout the power sector on the availability and performance of the generation and other dispatchable energy resources and ancillary services, and any associated operational restrictions.
C3	7.1	Collect outage information from all parties of significance within the power sector, co-ordinate with affected parties, identify clashes and resolve, with assigned responsibility for security of supply.	Collect outage information from all parties of significance within the power sector, co-ordinate with affected parties, identify clashes and resolve, with assigned responsibility for security of supply.
C4	8.1	Forecast and model all generation and other energy resources and ancillary services with operational, cost, and security implications for the power sector.	Forecast and model all generation and other dispatchable energy resources and ancillary services with operational, cost, and security implications for the power sector.
E3	8.2	Provide the capability to observe energy resources across the whole system and mechanisms for intervention.	Enable the dispatch of generation and other dispatchable energy resources and ancillary services within the power system to deliver system security and maximise the use of low carbon generation at optimal overall cost.
B3	9.1	Provide operational planning processes that facilitate engagement with all affected stakeholders (potentially including cross-border, cross-vector, and intra-power system operational interactions), taking account of the appropriate level of engagement for different stakeholders.	Provide an operational planning process that engages with all affected stakeholders.
E4	9.2	Identify by modelling and simulation constraints arising from credible events/faults, and plan remedial action.	Identify by modelling and simulation constraints arising from credible events/faults, and plan remedial action.
C5	10.1	Identify available generation, other energy resources and ancillary services and associated operational restrictions in real time.	Identify available generation and other dispatchable energy resources and ancillary services and associated operational restrictions in real time.
E5	11.1	Monitor the effectiveness of, and execute as required, remedial action (including market mechanisms and smart capabilities for the delivery of demand control, generation constraint and other actions) in response to all events/faults.	Monitor the effectiveness of, and execute as required, remedial action for the delivery of demand control, generation constraint and other actions in response to all events/faults.
E6	11.2	Co-ordinate demand, generation, other energy resources and ancillary services within the power system to deliver system security and maximise the use of low carbon generation at optimal overall cost.	Co-ordinate demand, generation and other dispatchable energy resources and ancillary services within the power system to deliver system security and maximise the use of low carbon generation at optimal overall cost.
E7	12.1	Provide monitoring and control of those parts of the system under active management, including network assets, demand, generation and other energy resources and ancillary services.	Provide monitoring and control of those parts of the system under active management, including network assets, demand, generation and other dispatchable energy resources and ancillary services.

FPSA2	FPSA1	FPSA2 Function Definition	FPSA1 Function Definition
B4	13.1	Enable the delivery of demand control, generation constraint, co-ordination with other system operators (potentially including cross-border, cross-vector, and intra-power system operational interactions) and other actions in response to all system incidents.	Enable the delivery of demand control, generation constraint and other actions in response to all extreme events.
E8	14.1	Provide automated and secure management of demand, generation, other offered energy resources and ancillary services, including Smart Appliances, HEMS and BEMS.	Provide automated and secure management of demand, generation and other offered energy resources and ancillary services, including Smart Appliances, HEMS and BEMS.
C6	14.2	Collate and distribute information throughout the power sector on the performance of demand, generation, other energy resources and ancillary services in order to enable settlement.	Collate and distribute information throughout the power sector on the performance of demand, generation and other dispatchable energy resources and ancillary services in order to enable settlement.
H1	15.1	Provide aligned financial incentives across the power sector (e.g. innovative or flexible tariffs) encompassing power, energy and ancillary services which provide appropriate signals to users and do not distort competition while giving consideration to their impact on customers.	Provide aligned financial incentives across the power sector, e.g. innovative or flexible tariffs.
H2	15.2	Enable settlement for all existing customer profile classes to support flexible tariffs, e.g. half-hourly using smart or advanced meters.	Enable settlement for all existing customer profile classes to support flexible tariffs, e.g. half-hourly using smart or advanced meters.
H3	15.3	Implement and co-ordinate a framework where the roles and value propositions of all significant stakeholders across the power sector can be managed.	Co-ordinate the roles and value propositions of all significant stakeholders across the power sector.
B5	15.4	Collaborate with other energy sectors (potentially including cross-border, cross-vector and intra-power system operational interactions) in order to allow the market to operate across multiple sites and vectors.	Collaborate with other energy sectors to optimise across multiple sites and vectors.
H4	15.5	Provide market mechanisms e.g. peer-to-peer trading, to allow all customers to access the value realised by their actions.	Provide a mechanism for peer-to-peer trading with appropriate charging for use of the power system.
H5	16.1	Provide a market structure that enables customers to have choices within the power system.	Provide a market process that facilitates active engagement of customers, e.g. aggregators, smart city schemes.
H6	16.2	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.	Provide a full range of customer choices including individual, community and smart city services.
C7	16.3	Monitor and settle the delivery of contracted demand, generation, other energy resources and ancillary services.	Monitor and settle the delivery of contracted demand, generation and other dispatchable energy resources and ancillary services.

10. Appendix B – Test Case Outputs

A.1 Function G3 test case - "Plan for the timely restoration of supplies following a total or partial shutdown (Black Start)."

Testing Step 1 - Exploring *EF* Inputs and Outputs	
What are the specific needs and barriers of this function?[6]	**Technical:** Barriers are around involvement of new service providers and processes as existing arrangements become inadequate. **Commercial:** New business models for alternative Black Start arrangements are not adequately supported by existing market structures. **Societal:** The barriers are societal expectations and limited tolerance. Tolerance could relate to participation in approaches such as DSM, tolerance to seeing unused local renewable assets and tolerance to disruption to community energy systems that customers have paid for, whilst expectations could be around security of supply. **Governance:** A barrier is that existing governance best supports the present solution, but not alternatives.
Which stakeholders need to be involved?	SO, DNO/DSO, Government, Generator Manufacturers, DSR participants, Customers including individuals, Communities and Smart Cities.
What is the enablement that is needed to deliver the function needs and overcome the function barriers?	**Technical:** Enable a plan to identify options for future Black Start. Optioneering across all technical domains including power infrastructure, telecommunications, cyber security and including new participants and new processes assessed via detailed quantitative evaluations. Then for the preferred options undertake trials to inform implementation. The plan must be agile to respond to the rapid anticipated changes in the whole power system. **Commercial:** Optioneering will inform the legislative common framework that will be requested to provide an appropriate market structure. **Governance:** *EFs* will inform the regulatory, standards and industry process common framework requesting the changes necessary to support alternative Black Start arrangements. **Societal:** Enablement must consider societal interests and impacts at local and national levels.
What will be delivered by the *EF*?	**Technical:** Agile plan for investigating alternative Black Start options, trials and implementation. **Commercial:** Inputs to legislative common framework. **Governance:** Input to regulatory, standards and industry process common frameworks.
What are the dependencies of other *EFs*?	Other functions will potentially deliver new participants and infrastructure that could offer further options for Black Start.

[6] It should be noted that only summaries of the needs and barriers are provided here whilst detailed descriptions are given in the WP2 and WP3 final reports.

Testing Step 2 - Exploring *EF* components	
Which key aspects of the *EF* architecture will enable this?	Agility is required due to the dependence on the emergence of new participants that may emerge under the influence of on other functions. The requirements and capabilities for this *EF* would likely need to change as the whole system changes.
What specific pre-structuring activity is required?	Review of existing Black Start procedures and international approaches shall be undertaken to inform the background of the delivery of the plans to explore Black Start options.
What are the requirements of the common *EF*?	Legislative common framework, regulatory common framework, standards common framework, industry process commons framework, cyber security common framework.
What will be required of the *Enablement Organisation*?	Horizon scanning is essential due to the anticipated rapid changes in specific aspects of the energy system as well as across the whole power system. Co-ordination with many other *EFs* to ensure a whole-system approach. Arbitration is likely to be required as there may be resistance to new Black Start approaches because income streams of large existing participants may be impacted.
Testing Step 3 - Exploring *EF* operation	
What processes, plans, mechanisms and tools will be part of the *EF*?	Robust optioneering leading to well justified decision-making. Efficient communication to a large stakeholder group. Democratic processes for fair decision-making.
What funding is envisaged to develop, trial and demonstrate this function? What funding sources are envisaged?	Funding is required for the operation of the *Enablement Organisation* and subsidies for participating means tested stakeholders. Existing funding sources shall finance the development of options and subsequent trialling, for example innovation funding and regulatory allowances.
What form of implementation and demonstration must the *EF* deliver? Research, development, implementation or monitoring?	*EFs* will need to facilitate research, development and deployment of any necessary hardware and software necessary to deliver future Black Start.

A.2 Function H5 test case - "Provide a market structure that enables customers to have choices within the power system."

Testing Step 1 - Exploring *EF* Inputs and Outputs	
What are the specific needs and barriers of this function?[7]	**Commercial:** New business models and market structures are required to support new customer choices including consumer-led and/or community energy propositions and blockchain mechanisms. **Technical:** Barriers are around the provision of data and modelling to evaluate and operate new markets. **Societal:** The challenge is delivering a market structure which supports customers' needs and preferences, but these may not be predictable. **Governance:** Customer choices supported by the market structures also need to be permitted within the governance.
Which stakeholders need to be involved?	SO, DNO/DSO, Balancing and Settlement Code company, Suppliers, Customers including individuals, Communities and Smart Cities.
What is the enablement that is needed to deliver the function needs and overcome the function barriers?	**Commercial:** Enable the enduring identification of an appropriate adaptive market structure and its implementation, requiring the design of options for market structure, their evaluation, selection and then the implementation of the preferred option. **Technical:** Include technical information, such as the requirement for new monitoring, communications and data flows, within the evaluation of market structure options and then enable appropriate implementation. **Governance:** *EFs* will inform the Regulatory, Standards and Industry Process Common Framework requesting the changes necessary to support the same customer choices as the new market structure. **Societal:** Enablement must consider societal interests and impacts.
What will be delivered by the *EF*?	**Commercial:** Plan for investigating alternative market structures and implementation of appropriate legislative change via the Common Framework. **Technical:** Support decision-making by investigating the monitoring and communications necessary to deliver market structure options. **Governance:** Input to Regulatory, Standards and Industry Process Common Frameworks.
What are the dependencies of other *EFs*?	Likely interactions will be other functions in the market and settlement time scale, in particular function H6.

[7]It should be noted that only summaries of the needs and barriers are provided here whilst detailed descriptions are given in the WP2 and WP3 final reports.

Testing Step 2 - Exploring *EF* components	
Which key aspects of the *EF* architecture will enable this?	Co-ordination is required due to the dependence on other functions.
What specific pre-structuring activity is required?	Review to understand the context, for example European constraints and impact analysis, leading to initial development of market design options and the evaluation criteria to be applied within delivery of the *EF*.
What are the requirements of the common *EF*?	Legislative common framework, regulatory common framework, standards common framework, industry process commons framework, cyber security common framework.
What will be required of the *Enablement Organisation*?	The *EF* must involve the new parties bringing new opportunities to the market, but they may not be traditional participants within the industry and therefore it is important that the *Enablement Organisation* facilitates appropriate involvement in the stakeholder network with financial support where necessary. Co-ordination with many other *EFs* to ensure a whole system approach. Arbitration is likely to be required as there may be resistance to change from existing suppliers and network operators affected by change in use of system charging.
Testing Step 3 - Exploring *EF* operation	
What processes, plans, mechanisms and tools will be part of the *EF*?	The close relationship with other functions requires a mechanism to facilitate whole system consideration of interactions between functions to inform synchronised decision-making within the enablement of all those individual functions. Efficient communication to a large stakeholder group. Democratic processes for fair decision-making.
What funding is envisaged to develop, trial and demonstrate this function? What funding sources are envisaged?	Funding is required for the operation of the *Enablement Organisation* and subsidies for participating means tested stakeholders. Existing organisations, for example Elexon and the regulator, are likely to fund their own participation in the development of new market structures.
What form of implementation and demonstration must the *EF* deliver? Research, development, implementation or monitoring?	*EFs* shall need to facilitate research, development and deployment of the new legislation and regulation necessary to deliver future market structures and potentially systems associated with the provision of data.

A.3 Function H6 test case - "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."

Testing Step 1 - Exploring *EF* Inputs and Outputs	
What are the specific needs and barriers of this function? [8]	**Commercial:** New innovative customer choices, including consumer-led and/or community energy propositions. **Technical:** Barriers are around the provision of monitoring and data management necessary to deliver new customer choices. Also, there will be technical challenges of integrating independently managed schemes for example smart city and community energy schemes. **Societal:** Potentially difficulty in engaging with certain segments and lack of knowledge meaning that customers cannot make informed choices, resulting in a barrier to the design of an engaged market process. **Governance:** Some existing regulation, standards and industry process acts an obstacle to consumer-led propositions and broad range of business models/services - an example might be the barriers to peer-to-peer trading.
Which stakeholders need to be involved?	SO, DNO/DSO, balancing and settlement code company, suppliers, customers including individuals, communities and smart cities.
What is the enablement that is needed to deliver the function needs and overcome the function barriers?	**Commercial:** The market will develop new propositions based upon their own analysis, whilst the *EF* needs to provide an equitable manner that new commercial propositions can be considered, prioritised and enabled. **Technical:** Include technical information, such as the requirement for new monitoring, communications and data flows, within the evaluation of market structure options and then enable appropriate implementation. **Governance:** *EFs* will inform the regulatory, standards and industry process common framework so that regulatory changes can be made where these are in the interests of the system as a whole. **Societal:** Enable a mechanism for new parties to engage with customers.
What will be delivered by the *EF*?	**Commercial:** The *EF* shall deliver a plan for the prioritised enablement of new commercial options delivered by the market. **Technical:** Enablement shall deliver a plan that will determine the monitoring and communications necessary to support new commercial options and its installation. **Governance:** Input to regulatory, standards and industry process common frameworks. The *EF* will assess the enabling requirements which in this case are likely to relate to other functions. The *EF* of H6 will prioritise the enabling requirements when they co-ordinate with other *EFs*.
What are the dependencies of other *EFs*?	Likely interactions will be other functions in the market and settlement time scale, in particular function H5.

[8]It should be noted that only summaries of the needs and barriers are provided here whilst detailed descriptions are given in the WP2 and WP3 final reports.

Testing Step 2 - Exploring *EF* components	
Which key aspects of the *EF* architecture will enable this?	Co-ordination is required due to the dependence on other functions.
What specific pre-structuring activity is required?	Development of initial outline of the process for evaluating new parties' propositions and how the enabling requirements will be prioritised.
What are the requirements of the *Common EF*?	Legislative common framework, regulatory, standards and industry process common framework, cyber security common framework.
What will be required of the *Enablement Organisation*?	Market participants will be responsible for creating commercial products, marketing and delivering them to customers. In this case, the *EF* is responsible for identifying, prioritising and organising the implementation of the enablement necessary to support the market.
Testing Step 3 - Exploring *EF* operation	
What processes, plans, mechanisms and tools will be part of the *EF*?	The close relationship with other functions requires a mechanism to facilitate whole system consideration of interactions between functions to inform synchronised decision-making within the enablement of all those individual functions.
What funding is envisaged to develop, trial and demonstrate this function? What funding sources are envisaged?	Proposition developers are likely to fund their own participation in the development of new commercial propositions.
What form of implementation and demonstration must the *EF* deliver? Research, development, implementation or monitoring?	Based upon market participants developing and implementing new commercial propositions, the *EF* performs a monitoring role to ensure appropriate support for the market.

11. Appendix C – Evidence from Literature Review

11.1.1 Redesigned process with quicker, more flexible and iterative change

In an Ernst & Young (EY) report[9] on cleantech in the UK, the point is made that a transformational policy framework and associated delivery mechanisms are needed if the UK is to benefit from system and growth effects of the growing cleantech sector. These are the key requirements to unlock significant capital for the investment into critical infrastructure – it is in fact supportive of all of the key findings. This perspective is further supported by a report[10] published by six NGO's that highlights that the UK is falling far behind in the global race towards a low carbon economy.

Peter Emery of ENWL highlights[11] that the right steps have been made to de-risk change and support innovation, however believes that changing regulation to allow DNO's to access markets for, and to make returns on, innovation investments are likely to be more effective and lower cost to the customer.

11.1.2 Inclusion of old and new participants with support for nascent stakeholders

Caroline Kuzemko's journal article[12] in Energy Research & Social Science clearly highlights the capture of governance structures that prevent market access and entry of new players into the UK energy market. This highlights the need for inter-disciplinary work and evolution in the area of governance and energy system change. Peter Emery's statements[11] would also seem to indicate that he favours allowing a broader school of stakeholders to gain access to innovation funding, as a market of innovations would deliver lower cost and increase the pace of innovation.

Dr Mary Gillie of Energy Local, highlighted[13] the need for supporting smaller scale energy producers and prosumers and providing information to users from the bottom up to allow for matching of community generation with community usage. This kind of thinking is echoed by James Johnston[14] of Open Utility who sees the need for opening up the market and facilitating the idea of peer-to-peer trading.

Value could arise from the greater involvement of social movements such as initiatives like Open Energy Monitoring (Mengi), which may not have the resources to promote the benefits they can provide for consumers and others; however, their knowledge and capability should be supported, potentially with the same safeguards as a public good.

11.1.3 Improved co-ordination, facilitation, planning and conflict resolution

Rachel Fletcher a senior partner at Ofgem, stated[15] that changes are needed to the way in which the industry operates, allowing for more flexibility and less rigid regulation and more of a focus on customers. In the increasingly uncertain future Chris Evans[16] from Rolton group highlights the need for BEIS to deliver a long-term vision on energy policy. With this uncertainty, it is unlikely that a robust policy can be developed to support the sector with significant changes in terms of the roles and responsibilities of stakeholders and the way they interact.

This is expanded upon by Iain Conn[17] at Centrica who highlights the importance of shifting power from governments to consumers to enable markets to function better. This can only be achieved if the cross-sector institutional arrangements are revised, allowing the consumers' needs and companies' focus on this being a strong factor driving the right behaviours.

[9] http://www.cleanenergypipeline.com/Resources/CE/ResearchReports/EYCleantechandtheUK.pdf
[10] http://www.dailymail.co.uk/wires/pa/article-3632281/Government-warned-clean-tech-revolution-backtracking.html
[11] https://networks.online/gphsn/interview/1000278/kid-block-interview-peter-emery/page/3
[12] http://www.sciencedirect.com/science/article/pii/S2214629615301006
[13] http://www.thenews.coop/108810/news/co-operatives/local-energy-local-communities/
[14] https://www.goodenergy.co.uk/media-centre/2016-press-releases/open-utility-unveils-the-power-of-piclo-britain-s-first-online-peer-to-peer-marketplace-for-renewable-energy-050516/
[15] https://www.ofgem.gov.uk/publications-and-updates/rachel-fletcher-speech-utility-week-conference-future-retail-energy-market-regulation-greater-focus-principles
[16] http://utilityweek.co.uk/news/market-view-renewables%E2%80%99-long-term-future/1292872#.WJzaORuLTIV
[17] https://www.centrica.com/news/iain-conn-ceo-speaks-utility-week-energy-summit-2016

The Solar Trade Association (STA)[18] is pushing for fundamental rather than incremental change, enabling greater joined up thinking across all aspects of energy policy and correction of deficiencies in the existing arrangements.

Citizens Advice[19] have raised concerns that considering separate technologies, actors and policies (as is currently done) could result in overlapping aspects and conflicts may be missed, and suggest rather a 'suite' of policies combining multiple requirements that can be agile and responsive.

11.1.4 Supports innovation in technical, commercial and social dimensions

The Royal Academy of Engineering[20] has highlighted strong evidence, including demonstration projects, for the need for broader and more integrated thinking across competencies (technical, consumer, commercial) to assess how the energy system of the future could operate across contexts in the UK. Fresh thinking and new ways of working between existing and new stakeholders are required to deliver more diverse approach and engagement. This view is also supported by Caroline Kuzemko's journal article in Energy Research & Social Science mentioned earlier.

The STA[18] also highlights the need for alignment and change across all aspects of energy policy. This point is aligned with the views of Dr Mary Gillie and James Johnston that innovation needs to happen across local social contexts as well as in terms of new commercial and technical considerations.

It is important to note that the principle at play here is that the scale and nature of change requires a new process or architecture. This new architecture will include existing roles, capabilities and functions, and will integrate within this new approach. It is not feasible to attempt to augment the existing process incrementally to achieve this end. The architecture/process is not an end in itself, rather it is simply there to enable the functions. Creating *EFs* will be an iterative process that does not from the outset align to the objectives of the functions and the broader change they embody poses unacceptable inefficiency and risk. This is based on challenges made by Tempus Energy[21] and others on the nature of the UK market not being a 'level playing field'.

[18]https://networks.online/gphsn/news/1000433/smart-power-hindered-piecemeal-changes-network-charging
[19]https://www.citizensadvice.org.uk/about-us/policy/policy-research-topics/energy-policy-research-and-consultation-responses/energy-consultation-responses/response-to-ofgembeis-call-for-evidence-on-a-smart-flexible-energy-system/
[20]http://www.raeng.org.uk/publications/reports/a-critical-time-for-uk-energy-policy
[21]https://www.euractiv.com/section/uk-europe/opinion/uk-energy-regulation-fails-consumers/

Future Power System Architecture Project 2

Final Report

Work Package 4:

Enabling Framework Identification

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.

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