SEM Capital Investment

Market Systems Development Plan 2019- 2021

Abstract

This document outlines the capital projects planned for SEMO to further stabilise and support the operation of the SEM systems in the period between 1 October 2019 and 30 September 2021.

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Executive Summary

The Market System Development Plan (MSDP) is produced by SONI and EirGrid, in their capacity as licenced Market Operators, to facilitate the development of the Single Electricity Market (SEM) Trading and Settlement Systems. This document outlines market system capital projects which have been delivered or are being planned by the Single Electricity Market Operator (SEMO) for the period from 1st October 2019 to 30th September 2021.

SEMO has identified eleven (11) capital projects that are deemed necessary to fulfil its core objectives, in particular:

- provide further stability that allows for the successful migration from project capital to the BAU/biannual release model;
- efficient discharge of its Market Operator obligations;
- facilitate the efficient, economic and coordinated operation of the SEM;
- facilitate the participation of electricity undertakings engaged in the generation, supply or sale of electricity; and
- promotion of competition in the wholesale electricity markets on the island of Ireland.

These projects resolve high priority incident and defects, implement important changes to improve system functionality and provide for the support required to enable the re-pricing, resettlement and M+4 and M+13 settlement activities to be carried out.

In developing this list of eleven capital projects, SEMO prioritised initiatives that provide further market stability, as well as those that reduce the risks and financial exposure of market participants and consumers. This investment in critical operational bottlenecks will improve the Market Participant experience, allowing additional market offerings into the future.

The multifaceted nature of the market applications and associated architecture, enterprise and infrastructure, means that:

- There is a requirement for ongoing maintenance and improvement over time;
- Changes impact on more systems and processes and, therefore, require a longer delivery period than was the case for the previous SEM market; and
- Significant capital investment is required over time to support the needs of the market.

This document outlines business cases for each individual project highlighting the problem to be solved, the need case and the associated risks and benefits on completion.

Comments on this consultation paper are invited from interested parties. Preferably these should be referenced against relevant sections and sub-sections of this document. Responses should be submitted to info@sem-o.com by **5pm on 15th October 2020**.

1. Introduction

SONI and EirGrid, in their capacity as licenced Market Operators, are required to produce a Market Systems Development Plan (MSDP) for approval by the Utility Regulator (UR) and the Commission for Regulation of Utilities (CRU) for the development of the Single Electricity Market (SEM) Trading and Settlement System. This two year plan is produced in accordance with Condition 16 of the SONI Market Operator Licence and in accordance with Condition 4 of the EirGrid Market Operator Licence.

This document is the MSDP developed by SEMO for the period from 1st October 2019 to 30th September 2021. It identifies changes that the Single Electricity Market Operator (SEMO) believes will facilitate the effective operation, administration and development of the SEM and proposes capital investment projects essential to support the needs of the market.

Market Operators' Objectives

One of the core objectives of SEMO is to facilitate the efficient, economic and coordinated operation, administration and development of the Single Electricity Market in a financially secure manner.[1]

The current SEM market went live on 1st October 2018 following completion of the Integrated Single Electricity Market (I-SEM) Project. Acknowledging the need to launch the market in line with agreed delivery timescales, the market went live with a number of open defects and consequential workarounds in place. As a result of this and additional defects identified after go-live SEMO was unable to move into its *Business As Usual* mode of operation as quickly as originally intended.

Subject matter expert resources needed to be maintained in the market teams to manage and resolve defects following go-live and to work with vendors in supporting critical market updates. The market still experiences some Market Incidents, as a result of the known defects and manual workarounds in place at go-live.

In the period covered by this plan the priorities of SEMO are to provide further market stability alongside the reduction of risks and financial exposure of market participants and consumers alike. Whilst SEMO's focus remains on the delivery of critical market changes to achieve these goals in addition to implementing SEM Committee decisions related to the market, further consideration is also given to delivering market changes to improve system functionality.

This MSDP includes eleven (11) projects deemed necessary to further stabilise the market and improve service levels, to provide system, service resilience and fulfil regulatory obligations. SEMO will continue to make sure that the wholesale market is efficient and effective, while also ensuring that the market is ready to deal with new participants, including Demand Side Response, interconnectors and new technologies e.g. large scale batteries. Capital investments in SEMO systems are essential in order to

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[1] Trading and Settlement Code – 07 April 2017

maintain markets during the transition to a low carbon electricity sector and ensure that the SEM remains both transparent and efficient in its delivery of services to customers.

Next Steps

Comments on this consultation paper are invited from interested parties. Preferably these should be referenced against the relevant sections and sub-sections of this document. If confidentiality is required, this should be made explicitly clear in the response, otherwise submissions will be published on the SEMO website[2]. Please note that, in any event, all responses will be provided to the Regulatory Authorities (RAs). **The closing date for responses is 5pm on 15th October 2020.**

- Comments should be submitted to info@sem-o.com;

- SEMO will consider all comments received on the consultation paper and make recommendations to the RAs based on these;

- The RAs may approve/reject the recommendations proposed by SEMO in light of the responses received; and

- SEMO will implement in accordance with the regulatory decision.

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[2] www.sem-o.com

Capital Investment Background

In 2018 the Single Electricity Market Committee (SEMC) published its *SEMO Price Control Decision Paper SEM-18-003*. Due to the level of uncertainty regarding the level of *predictable business capex* expenditure required within the duration of the price control no capital provisions were accounted for in this decision.

At the time the Price Control was determined, there was an expectation that the new market would be able to move into Business As Usual (BAU) application delivery within weeks of go-live. This proved not to be the case. The market was ultimately launched with certain elements deferred for implementation post go-live, a large number of temporary workarounds in place, a significant number of known defects and further defects identified post go-live. In order to ensure that the market functioned effectively during this initial phase, SEMO has had to concentrate resources on ensuring that core market activities were executed.

SEMO had (since go-live) also maintained strategic resources to manage and resolve the defects and work with vendors to support critical market change updates. The SEMC provided initial capital funding to SEMO for the period from go-live to April 2019 via the Post Production Support and Day 1+ projects to support this work.

The Post Production Support project provided an augmented level of support than originally planned to deal with the higher than anticipated volume of incidents and first-time issues requiring speedy resolution and to ensure that an acceptable level of performance was delivered. This work included activities to stabilise the complex and interdependent market systems and business processes that support the current SEM market.

The Day1+ project dealt with the triage, design, development, testing, development and management of priority defects, necessary system changes and critical modifications.

Since April 2019, SEMO has been engaging with the RAs on the capital requirements for SEMO and has continued to incur capital costs in order to maintain critical systems supporting market operation.

SEMO has required, and continues to require, significant capital investment to optimise operational procedures in the short term to ensure a stable market and to have the capacity to deliver SEMC and EU directed change in the longer term.

The following section provides some background information on the multifaceted technological solutions associated with the operation of the previous SEM and current SEM markets and some capital expenditure information for comparative purposes.

Migration from Project Capital to Business as Usual Capital

For the first circa year and a half of operation, following go-live in 2007, SEMO utilised project resources to resolve defects and deliver urgent market changes. The concept of "predictable capex" did not

appear in the SEMO revenue framework until 2009/2010. In the 2010-2013 Price Control framework new capex allocations were introduced: *Bi-Annual IT Market Release Support Capex*; *Predictable Business Capex*; and *Unpredictable Business Capex*.

The regulatory framework therefore provided a route to secure additional capital, to be submitted for and approved by the SEMC as required, to enable large scale works (e.g. Market System Development Plans) where they were not in the baseline control.

Figure 1 below shows the capital requirements for the 2007-2018 SEM.

| Go Live 2007 €47.8m | Day 1 + €10.7m | Oct 2009 €2.6 m | April / Oct 2010 €18m | Intraday Trading 2012 €26m* | Total €105.1m |
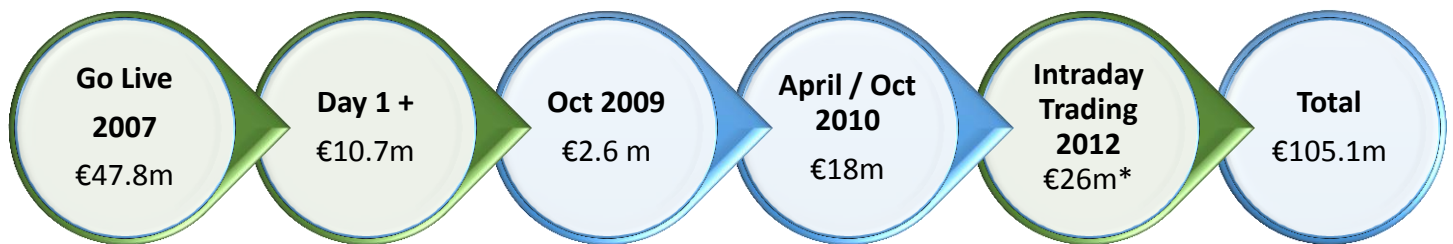
Figure 1- SEM Capital Investment – Project Implementation through to 2012[3]

For comparison, SEM Capital Figures displayed in 2019 money in Figure 2 below:

| Go Live 2007 €50.6m | Day 1+ €11.2m | Oct 2009 €2.7m | April / Oct 2010 €19m | Intraday Trading 2012 €26.7m | Total €110.2m |
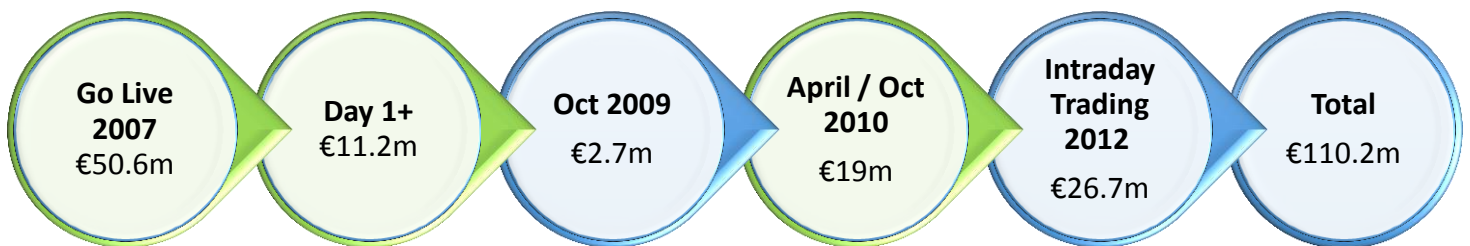
Figure 2 – SEM Capital Investment - Project Implementation through to 2012 in 2019 terms

At go-live of the current SEM, while the market was operating as intended, the aggressive delivery timescales, coupled with the design and intricacy of the new market led to the market launching with open defects and consequential workarounds in place. This was acknowledged and supported by the RAs. SEMO intended on further stabilising its market systems through the use of the Bi-annual release

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[3] Additional Details outlining the Evolution of Capex Provisions and Approvals in SEM 2007-2013 is included in Appendix 1
* €26m is the total TSO/SEMO costs for implementation of Intraday Trading. c. €7.8m (2012 monies) pertains to SEMO

mechanism. However, the new and more complex competitive trading arrangements led to a higher than expected volume of queries and disputes, both of which require detailed analysis and support. In the same period, the suite of systems that link together to enable the current SEM operate on a 24 hour basis across the various market timeframes, required, and continue to require, additional support for monitoring, incident management, developing work-arounds and repricing/resettlement activities.

The level and scale of change required to the core Market Management System (MMS) meant that continuous releases were needed to deliver critical functionality and regulatory directed changes in a timely, consistent and stable fashion following go-live before moving to a regular Bi-Annual Release cycle in 2020. As can be appreciated with any new market, incidents and defects need to be resolved in a timely fashion. This safeguards the integrity and effective operation of the market and allows it to reach a level of stability that allows the Business As Usual or Biannual release model to take over. This typically takes about 24 months.

SEM 2007-2018 Market

The 2007-2018 SEM Market had relatively simple system architecture with Pricing, Scheduling and Settlement capabilities. The systems were fully ring fenced with only 5 interfaces and a relatively small number of reports. The market operated from 9am to 5pm Monday to Sunday. The systems were completely isolated with no capability to interact with external stakeholders.
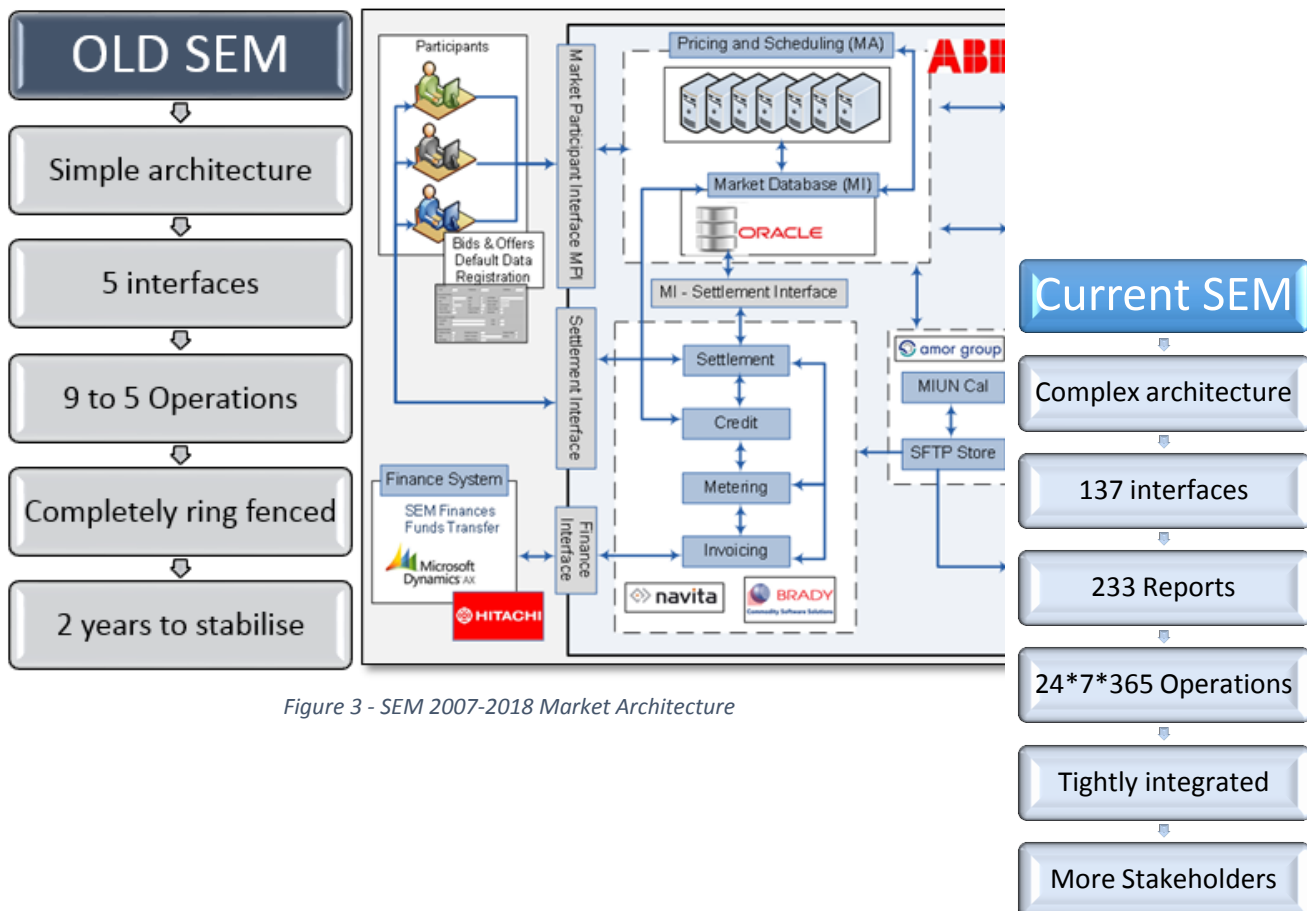
Figure 3 - SEM 2007-2018 Market Architecture

Current SEM Market

The new market systems are more integrated than those of the former market with over 137 interfaces and 233 reports to produce on a daily basis (see Figure 4 below). System availability is now 24/7. The Market Operator systems are tightly coupled to the TSO and NEMO systems that in turn are coupled to multiple market stakeholders. External change is being driven by Elexon, National Grid, ECC, Coreso, JAO, EPEX and NordPool.

Figure 4 – Current SEM Application Architecture

2. Capital Investment Requirements

Considerable capital investment in Market Systems is required over the period 2019 - 2021. These investments are required to further stabilise the market, improve service levels and provide system and service resilience.

Capital Investment is required

- •To support delivery of continuous high quality market system releases
- •To secure market critical third party vendor resources
- •To support the market analysis needs in order to respond Regulatory Authority Market Monitoring Unit (MMU) queries in a timely fashion
- •To support re-pricing and resettlement activities
- •To support formal queries and disputes
- •To enhance the performance of market systems
- •To improve market services
- •To support the data needs of participants
- •To prevent code breaches
- •To improve stakeholder communications
- •To support the delivery EU mandated changes
- •To improve market system security
- •To improve market participant service levels
- •To reduce the risk and exposure of high impacting market incidents through proactive investments
- •To deliver on corporate and legal obligations e.g. data archiving
- •To support audits and compliance
- •To support the training needs of the Market Operator and participants

Figure 5 - Reasons why capital investment is required

Risk of Under Investment

Ongoing capital investment is essential to support the operation of the market. The projects outlined in this submission, and the associated capital investment, are required to support the resolution of high priority incidents, defects and the implementation of change requests. The scope of work set out also provides for the necessary and urgent support required to enable the re-pricing, resettlement and M+4 and M+13 settlement activities to be carried out. The delivery of these essential services, which are urgently required by the Market Operator and participants, cannot be delivered without sustained capital investment. It is of absolute importance that the market stabilisation continues, so all stakeholders can maintain trust in the services being delivered.

Business Investment Layers

Each of the business cases outlined in this document is aimed at driving improvements at one or more of the following four business layers:

- **Business Support** – this investment supports the day to day operations of the employees working internally within the company. This represents an area where most of the business efficiencies and service improvements can be realised.
- **Application / Market System** – Application / Market System investment delivers market functionality and services in line with SEMC design decisions. Defects, market modifications and change requests all tend to be delivered at this investment layer.
- **Infrastructure** – Ongoing infrastructure investment is required to reduce the number of market exceptions by investing in secure resilient hardware and software. Data storage and archiving solutions were not fully architected or delivered as part of the I-SEM Project. These data management activities need to be considered and invested in.
- **Information / data** – Information crosses all business layers. Infrastructure data can provide alerts on participant connectivity, and hardware and software exceptions that may be detrimental to market services. Information from the Market Applications is critical to both the Regulatory Authorities and Participants for day to day decision support making. Timely accurate and relevant data is of particular importance to all internal and external stakeholders. The Market Operator is also obliged to feed data to EU agencies in a timely manner.
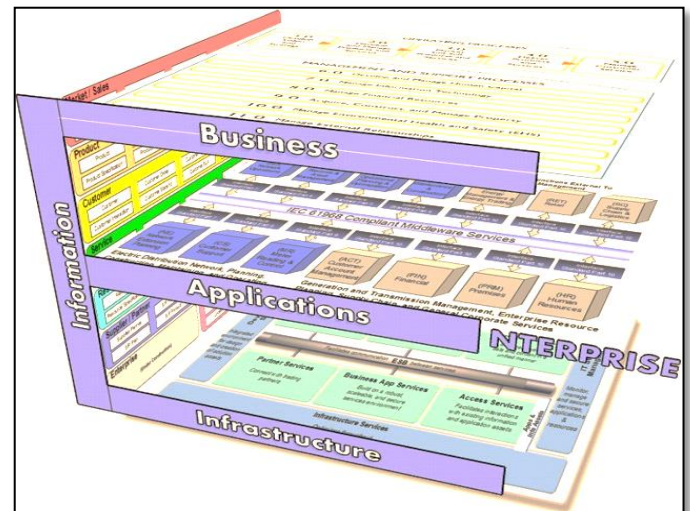
Business Support

- •Analytical Tools
- •Content Management
- •Disputes and Formal Query Management
- •Training
- •Helpdesk

Application / Market Systems

- •Registration
- •Balancing
- •Credit Management
- •Settlement
- •Capacity Qualification / Auctions
- •Day Ahead and Intraday Trading
- •Funds Transfer

Infrastructure

- •Hardware
- •Software
- •Telecommunications

Information/data

- •Website Development
- •REMIT / Transparency
- •Dynamic Reports

Capital Investment Summary

Capital Investment is required in the following areas:

1. **Application / System Development Capital** – Capital is required to deliver services outlined in the SEMC decisions and to support the ongoing delivery of market modifications. This capital is used predominantly to secure third party vendor capacity to deliver consistent high quality and timely functionality.

2. **Ongoing Project Support Capital** – It was previously acknowledged that the market systems went operational despite a number of documented market system defects. Project resources are therefore required to:

   i. deliver urgent defect and change request management;
   ii. to resolve market incidents and problems;
   iii. to support numerous temporary workarounds;
   iv. to monitor systems and services; and
   v. to help with specific tasks such as repricing, M+4 and M+13 resettlement.

3. **Market System Infrastructure Capital** – This capital investment is required to target hardware weak points, software updates, licence requirements and upgrades. Capital for data archiving and data retrieval which was not planned for prior to go-live now need to be delivered.

4. **Market Service Resilience** – Investment is required to monitor functionality, interfaces, telecommunication links and business processes. In addition, security investment is also required to ensure safety of the market systems and participant actions. The Market Operator will also be charged with implementing European security directives[4].

5. **Market Operational Support Capital** – This capital investment is designed to support the Market Operational support activities. Tools are required for a detailed market analysis, to support dispute and formal query management processes, compliance tracking and content management capability to meet GDPR obligations.

6. **Participant / Regulatory Support Capital** – This capital investment is required to support the participant and regulatory data requirements: the dynamic reporting and regulatory market monitoring needs. Participants also require support for their staff training and system access requirements.

   Table 1 outlines the business cases which correspond to the capital investment areas outlined in this section, the cost breakdown can be found in Appendix 2.

Capital Investment Area	Business Case
Application / System Development Capital	1. Market System Release Capital
Ongoing Project Support Capital	2. Release Support Capital
	3. Settlement Support and Resettlement (M+4, M+13)

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[4] Such as the minimum security requirements protecting the EU Energy System, the requirements under the Clean Energy package for the proposed development of a network code on Cyber Security and the NIS (Network Information Security) Directive

Capital Investment Area	Business Case
Market System Infrastructure Capital	4. Market System Data Archiving
	5. Additional Market Environments
Market Service Resilience	6. Market Monitoring Systems
	7. MMS Performance Enhancements
Market Operational Support Capital	8. Market Analysis Tools
	9. Compliance Management
Participant / Regulatory Support Capital	10. Website Development
	11. Participant Urgent Communication

Table 1- Capital Investment Areas and corresponding business cases

3. Business Cases

The following section contains the description of business cases for the eleven market systems development initiatives identified by SEMO that require development. The business case template used is structured as follows:

Purpose:

The Business Case is used to obtain Regulatory commitment and approval for investment in business change, through rationale for the investment. The business cases support the identified SEM business needs and answer the following questions.

Questions:

- Is the need clearly stated?
- Have the benefits been clearly identified?
- Are the reasons for investment and investment benefits consistent with the strategy and objectives of the SEM?
- Is it clear how the benefits will be realised?
- Are the risks explicitly stated?

1. Market System Release Capital

This relates to the capital required to procure Vendor Support Hours. It is essential for delivering functional changes and regulatory approved market modifications for the I-SEM Market Systems.

Business
Applications
Infrastructure
Information
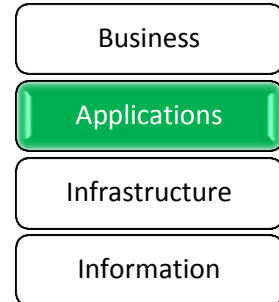
Need Case

The SEM Market architecture is an extremely complicated grouping of IT systems with many pieces of interdependent functionality. These regulatory approved market services rely on efficient functionality and timely data to support and deliver the various market services. The current set of SEM market systems were successfully launched with the understanding that there were several defects that required resolution post go-live.

Along with defects there were also a large number of:

- Urgent <u>augmentations</u> required to existing functionality
- Additional business and Participant <u>change requests</u> that needed to be accommodated
- <u>SEMC approved changes</u> that were postponed until post go-live
- Multiple regulatory approved <u>market modifications</u> to the:
  - Trading & Settlement Code and Agreed Procedures
  - Capacity Market Code and Agreed Procedures
  - SEMOpx modifications
  - AoLR modifications

SEM Market Services

- Registration
- Balancing
- Settlement
- Capacity
- Day Ahead
- Intraday Trading
- Funds Transfer
- Credit management
- System scheduling
- AoLR

We can therefore conclude that there is a large volume of work which will have to be delivered continually over the coming years.

Ad hoc Releases	3-Monthly Releases	Packaged Releases	Biannual Releases
• As and when required	• Until December 2019	• Targeting functional bottlenecks	• April 2020
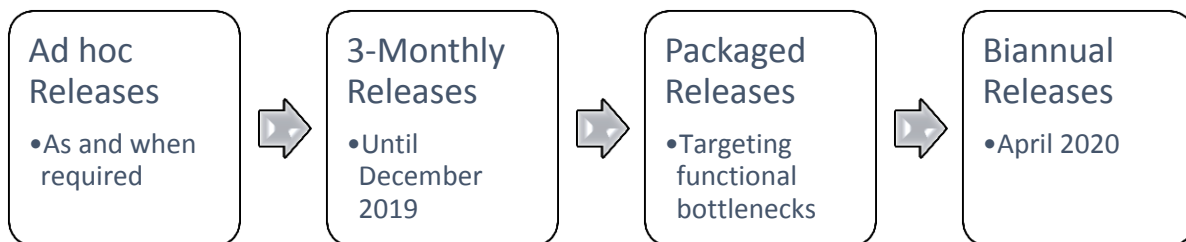
Figure 6 - Release Types and frequency

The level and scale of change required to the core Market Management System (MMS) meant that continuous releases were needed to deliver critical functionality and regulatory directed changes in a timely consistent and stable fashion following go-live before we move to a regular Bi-Annual Release cycle in 2020.

The procurement of Vendor Support Hours is a standard feature of Price Controls and was a key element of the Bi-Annual Release Capex provided for in previous pre I-SEM Price Controls for SEMO.

The project resources needed to support the detailed design, support, Testing and Release planning that oversee and govern the use of these vendor hours are set out in Business Case 2.

Urgent Ad hoc change methodology (6 to 10 weeks delivery)

Urgent change requests such as defects or stabilising change requests require different resource profile to that of Business as Usual setup. Urgent change requests are rapidly developed and deployed within a matter of weeks and are heavily dependent on Detailed Design, Build, Test and Deployment Resources. The Build resources are generally off site with 3rd Party Vendors. This rapid application development is very dependent on having sufficient Design Subject Matter Experts and experienced Test resources which are typically project type resources.

1 Planning	2 Analysis	3 High Level Design	4 Detailed Design	5 Build	6 Test	7 Deploy	8 Maintain
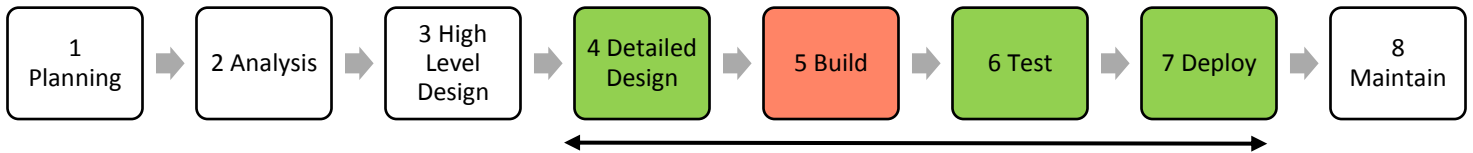
Figure 7 - Rapid Systems Development SDLC Lifecycle (6 to 10 weeks)

Business as Usual Change

The Business as Usual development of code modifications and participant change requests is typically a 13 month delivery lifecycle. After a modification is approved it is planned for the next biannual release to determine if there is the resource capacity to deliver the change. Analysis and Design work (steps 2 to 4) is carried out by a Functional Analyst and signed off for delivery with our vendor. Our vendor builds the system to the provided design and Test resources are contracted in for a 1 to 2 month period prior to deployment.

1 Planning	2 Analysis	3 High Level Design	4 Detailed Design	5 Build	6 Test	7 Deploy	8 Maintain
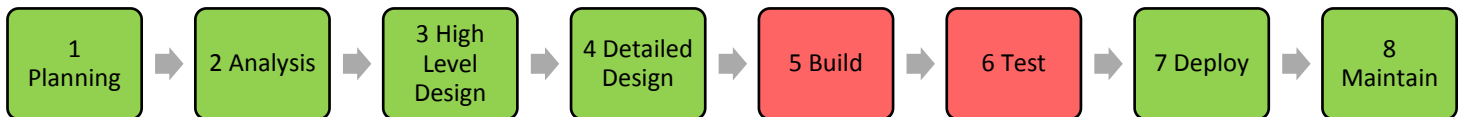
Figure 8 - Biannual Release Development SDLC Lifecycle (13 Months)

Urgent Ad hoc Change Methodology vs. BAU resourcing Conclusion

Rapid / Urgent system development requires full time project resources until the market reaches a level of stability that allows the Business As Usual or Biannual release model to take over. This typically takes about 24 months.

Why Regular Releases

Regular and planned IT release schedules allow SEMO to co-ordinate IT resources and retain vendor expertise and support for the development of the Market Systems. In the original SEM market the biannual release strategy significantly reduced development costs and allowed SEMO to focus on the implementation of key market rules to the benefit of the SEM. The release strategy also provided additional clarity to Participants, allowing internal planning and design activities to be scheduled in advance. As such it is ultimately SEMO's intention to employ a similar strategy to support enduring BAU activities.

Benefits

Regular releases with a vendor can provide considerable Resource, Cost and Release Delivery business benefits as outlined below.

Resource
- Ensures the availability and retention of key vendor resources and expertise.
- Maximises the use of SEMO IT resources,
- Participants can more easily align their resources requirements through planned releases.

Cost
- The Biannual release BAU model has delivered high quality releases at efficeint the costs.
- Test resources are brought in temporarily saving the need for permanent hires

Delivery
- Market Participants are well served with regular controlled and planned releases.
- Legislative and Regulatory directed changes can be delivered in line with legislated delivery dates.

Figure 9 - Business benefits of Vendor Support & moving to a Regular Release Strategy

SEMO recognises that there are internal and external pressures to implement change in a timely and accurate manner. As a result, SEMO does not believe that an ad-hoc or very frequent release approach is appropriate. SEMO are of the opinion that a bi-annual release strategy represents a balanced and prudent approach. This approach is the standard in other similar electricity markets and has many advantages including:

Clarity
- Vendors, Regulators and Particpants have clarity of the release schedule, content and key dates for change requests.

Resource Efficiency
- More efficient use of SEMO and Market Participant resources. Essential Vendor support expertise is retained.

Robustness
- More robust Central Market Systems enhancing participant and investor confidence in the SEM.

Cost
- If the release scope is known well in advance it gives SEMO more time for cost effective negotiation with vendors.

Testing
- Structured and planned testing phases can be implemented (Factory, System Integration, User Acceptance, Market Test etc.)

Higher Release Output
- Higher rates of change to systems are possible through a unified, well-understood and controlled release process.

Scope
- Market Participants are clear about the scope and content of the releases and have the time necessary to assess impacts.

Quality
- A regular coordinated process allows for better quality control resulting in fewer emergency releases and defects.

Enhanced Flexibility
- Can quickly understand the impact of changes to respond positively to urgent demands.

Figure 10 - The benefits of a stable and consistent vendor release strategy

Risks of no releases

Quality stable market development is essential to the Market Operator, Market Participants and the Regulatory Authorities alike. Delayed market change presents each of the stakeholders with a series of risks. Consistent high quality releases will mitigate:

Market Operator Risks	Market Risks	Participant Risks
Multiple disputes, formal queries which results in labour intensive corrective events	Changes to local market arrangements cannot be algined with the current MMS.	Instability is a risk to long term financing and imposes costly credit cover facilities
Running a market with known defects is damaging to the Market Operators reputation	Market monitoring activities are difficult to carry out.	Reputational risk to participants
Missed KPIs if market stability is not delivered	Adhoc oppurtunities for adhoc improvements are missed	Excessive exposure to unstable financial fluctuations could make a business insolvent

Figure 11 - Risks to the various parties of not having releases

2. Release Support Capital

This business case details the need for project resources to support, oversee and govern the use of the vendor hours (Market System Release Capital) as set out in Business Case 1.
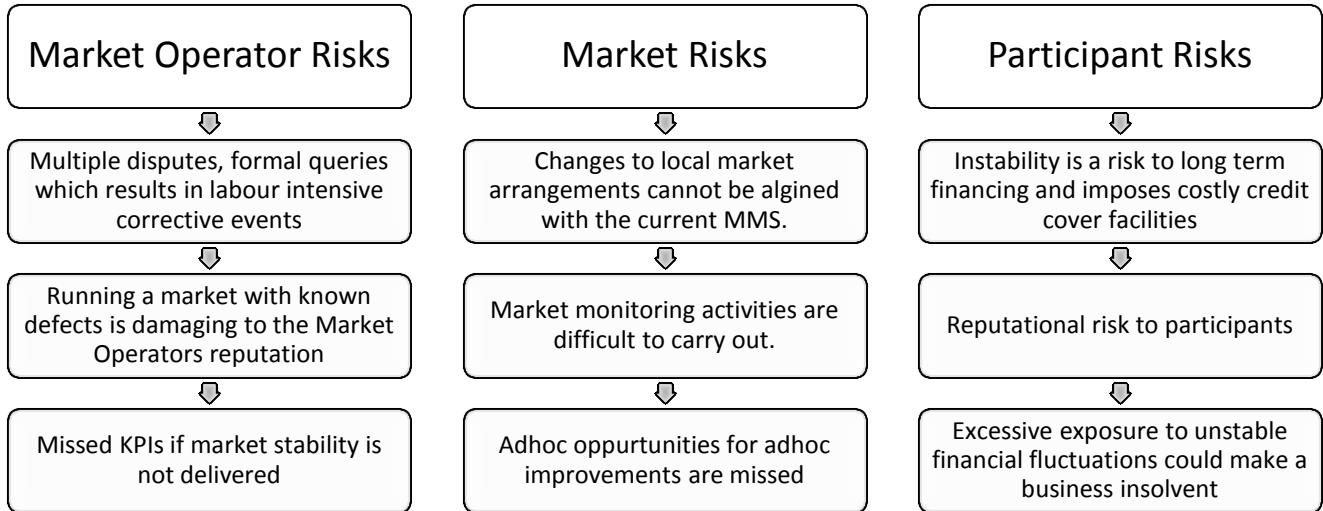
Business
Applications
Infrastructure
Information

The underlying resource provision in the SEMO Price Control Decision for the current SEM operation was premised and benchmarked against an assumed stable SEM market operation (c. 6 years post SEM go-live), and was not designed to provide for the volume and scale of change necessary to firstly stabilise the market and then deliver consistent high quality market change.
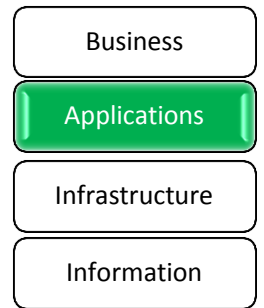
Need Case

The current SEM market was successfully delivered on October 1st 2018. As the RAs are aware, the aggressive delivery timescales, the design intricacy and very nature of a new market made it necessary to go-live with a sizeable number of open defects and consequential workarounds in place, with a lot of new issues coming to the fore, particularly, during the first circa 18 months of the new market.

In the period since the new market went live, market participants have required, and continue to require, a higher level of support than was originally envisaged and planned for. The new and more complex competitive trading arrangements have also led to a higher than expected volume of defects and change requests which require detailed analysis, testing and release support.

As can be appreciated with any new market, incidents and defects need to be resolved in a timely fashion in order to safeguard the integrity of the market and minimise business, commercial and regulatory impacts. Some of the issues that market stakeholders have experienced or are currently experiencing are:

Market Issues

- Several pricing events that are related to design defects that require repricing and resettlement runs
- Delays of Settlement runs
- High volumes of disputes and formal queries
- Emergency modifications to resolve incorrect or unintended market outcomes
- General and Local Communications Failures
- A number of major market events requiring further investigation

Market incidents need to be understood and resolved in a timely manner and, where material may require a fix within hours, with an even quicker initial response. Enduring patches and solutions (e.g. defects, material modifications and system augmentations) need to be developed, tested and

implemented, sometimes within days, to avoid incidents reoccurring and commercially impacting market participants.

There continues to be a consistent need for system changes, requiring increased coordination and management. Defects continue to be identified and require solution, vendor management, and test and release support.

As a consequence of incidents, problems and changes impacting the overall change management function, SEMO expects a number of areas in the illustrated model to require additional support. Without the required additional support capital SEMO cannot deliver the required change.

Proposed Solution

To continue to provide a secure efficient high quality marketplace and deliver on the Market Operator obligations, there is a need for enhanced support of the SEMO Change Management function, including overall programme management and governance, test management and execution and vendor management.

With over 100 open change requests, there is a consistent need for heightened rigour around release and change management. In addition, due to core components in the central systems requiring enhancements, additional SME input is required in a focused testing function.

Underlying this level of change is a continuing high level of defects which all require analysis, investigation and management. Although system defects continue to be resolved in a controlled and reasonable fashion, the overall defect landscape remains at circa 300 in the Market Management system.

To ensure limited disruption to the Market, and to deliver upon SEMO's obligations as Market Operator, there is a need for SEMO to manage and deliver change to the market systems.

Benefit

Having a sufficiently resourced, well organised Change Management process enhances the speed, quality and volume of change management. Each party clearly understands what is required of them and when. Clear Change Management processes reduce the risk of additional defects and helps resolve functional bottlenecks in a timely fashion. The diagram below highlights the business benefits of using a change management structure and supporting processes.
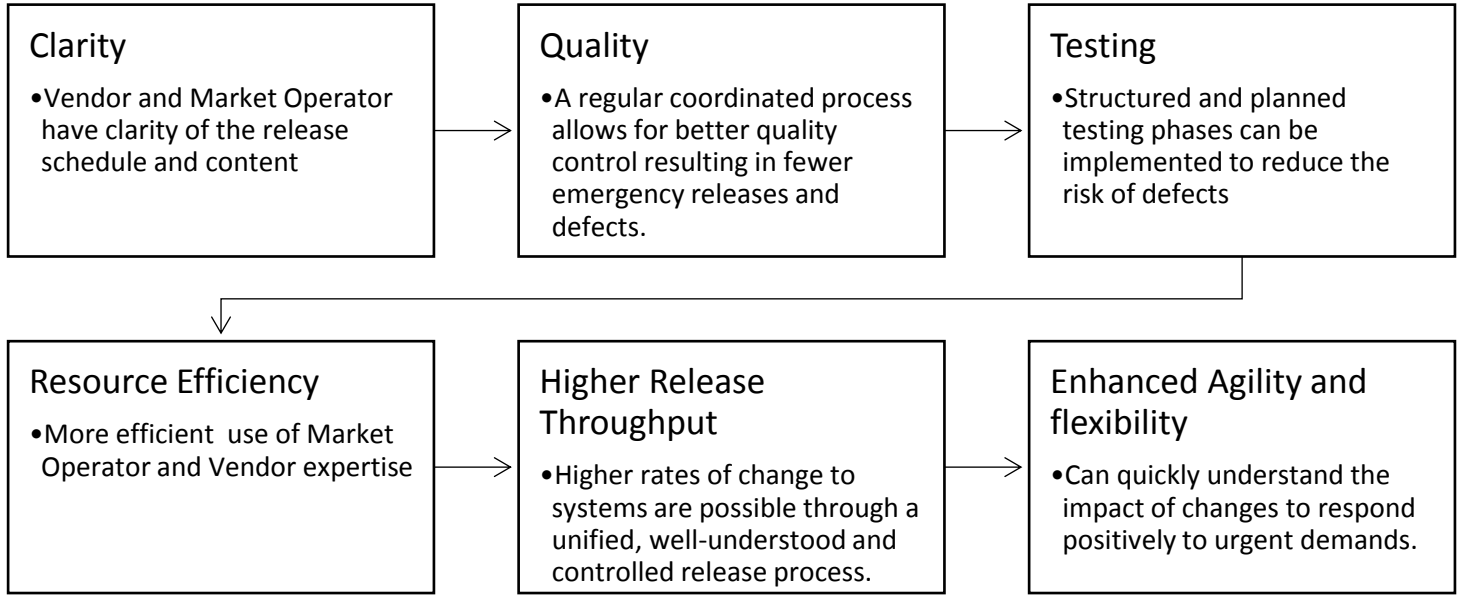
Clarity	Quality	Testing
•Vendor and Market Operator have clarity of the release schedule and content	•A regular coordinated process allows for better quality control resulting in fewer emergency releases and defects.	•Structured and planned testing phases can be implemented to reduce the risk of defects

Resource Efficiency	Higher Release Throughput	Enhanced Agility and flexibility
•More efficient use of Market Operator and Vendor expertise	•Higher rates of change to systems are possible through a unified, well-understood and controlled release process.	•Can quickly understand the impact of changes to respond positively to urgent demands.

Figure 12 - Change Management

Risk

Change management is a key element to maintaining a stable market. Any delay or issue in providing this critical market service presents significant risks to SEM stakeholders. Risks broken down by type are articulated below.

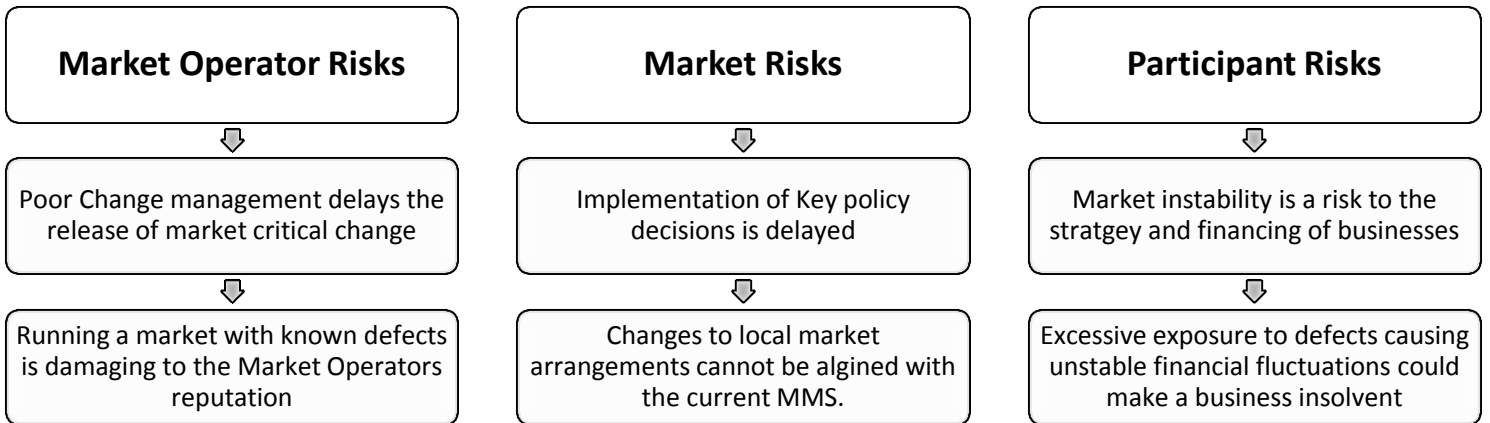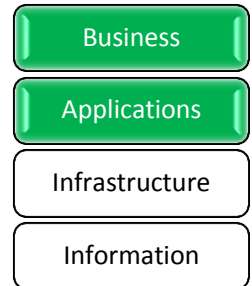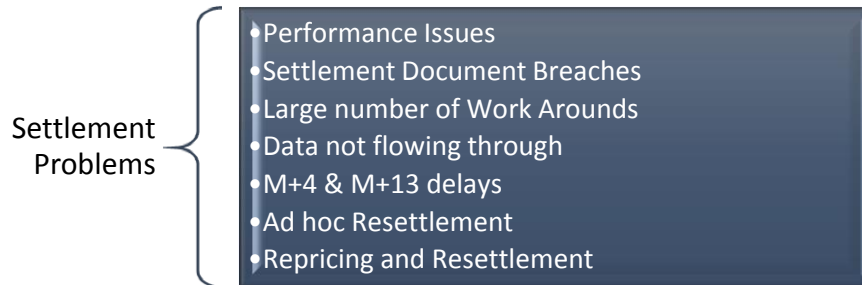| Market Operator Risks	Market Risks	Participant Risks
Poor Change management delays the release of market critical change	Implementation of Key policy decisions is delayed	Market instability is a risk to the stratgey and financing of businesses
Running a market with known defects is damaging to the Market Operators reputation	Changes to local market arrangements cannot be algined with the current MMS.	Excessive exposure to defects causing unstable financial fluctuations could make a business insolvent

Figure 13 - Risks by type

3. Settlement Support and Resettlement (M+4, M+13)

Need Case

The Settlement system was launched with a number of defects, on the understanding that these defects would be resolved post go-live. While defects in the Counterparty, Settlement and Billing (CSB) platform are on a trajectory to resolution, the following issues are still being experienced:

Settlement Problems
- Performance Issues
- Settlement Document Breaches
- Large number of Work Arounds
- Data not flowing through
- M+4 & M+13 delays
- Ad hoc Resettlement
- Repricing and Resettlement

Initial Settlement Problems

There are currently a number of complex manual work-arounds in place which are impacting settlement timelines. Settlement activities which should be a 9 to 5 activity currently require extended working days and significant weekend work. SEMO is dependent on key internal resources and had retained I-SEM Project and external vendor resources to support the settlement activities, via the Post Production Support and Day 1 + arrangements (up to Sept '19).

Re-Settlement

As set out above there has been challenges in delivering Initial Settlement services. This in turn means that the capability to deliver the required M+4, M+13 and ad-hoc resettlements activities are being severely impacted. A dedicated M+4 settlements team is in place to deliver on the M+4 scheduled settlements pending defect fixes. The analysis work is required to resettle a large number of participants with component charges over a period of significant defects and ongoing defects requires substantial resourcing and subject matter expertise, to resolve to the detailed level required of participants.

Settlement Disputes, Formal and General Queries

There was a significant volume of Disputes and Formal queries following go-live. SEMO has never experienced this level and scale of Disputes and Formal Queries with 96 Disputes and 480 Formal Queries to date (June 2020). The SEMO Price Control decision was benchmarked against assumed stable SEM market operation. As a result the underlying resource provision in the Price Control determination is insufficient to properly investigate and analyse disputes and formal queries. General Queries are also adding to the Settlement staff workload which is currently stretched significantly beyond its capability to deliver.

Settlement Statements

The focus to date has been on getting Settlement statements issued as a result it has been necessary for the settlement team to develop, document and implement manual checks in the work procedures. These are onerous and time consuming task that require automation. While additional quality initiatives are now in place it is not possible to catch all errors.

Settlement and Staffing

The Settlement team are required to work using workarounds for known defects and issues. The implications of making an incorrect settlement step for even one of the workarounds currently in place could have serious consequences for Participant Cash Flows. Continuous training is required along with suitable training environments for Controllers to learn how to execute settlement process steps. Ongoing experienced resources and vendor expertise are required to support staff. Settlement Releases There are defects within all aspects of the system MMS and CSB that require workaround and manual intervention. These workarounds are labour intensive. Additional resources will be needed to automate these processes, which will lead to efficiencies and further stability in the longer term.

Settlement Risks

Settlement risks are summarised in the table below

Settlement Risks

- Breaches to the Trading & Settlement Code due to delayed and inaccurate settlement documentation
- Numerous work arounds which introduce the possibility of human error
- Defects arising necessitating new work arounds
- Settlement staff need continuous training but a sufficient training environments to train safely and properly is not currently available
- Risk of issuing inaccurate settlement publications to market participants
- Risk of continued delayed settlements publications to market participants
- Risk of market participant's losing confidence in Market Settlements systems

Benefits

This additional time limited project support will provide the following benefits

- To be able to produce accurate timeliness of settlements publications (Indicative/Initial/M+4/Ad-hoc).
- Improve on the quality of the accuracy of the settlement data being published thus reducing the numbers of Disputes and Formal queries
- Will make Settlements Operations more efficient through the automation of manual steps and targeted investment toward settlement bottlenecks and known settlement exceptions
- Will facilitate the transfer of essential knowledge from the Project Team to internal subject matter experts
- Additional environments will improves training for the Market Operations Settlement staff

4. Market System Data Archiving

Business

Applications

Infrastructure

Information

Data is one of the most important assets to SEMO. It is therefore essential that market data is maintained in an efficient, scalable and secure solution. Investment in suitable secure data archiving solutions for database and file systems is necessary as the volume of data increases over the next few years.

This business case is designed to address Market System Data / Archiving needs. The Central Market systems generate large volumes of useful data which many parties would like access to. Data Archiving is a legal obligation on SEMO to store central market systems data for a seven year period. The archiving solution was not required as part of the go-live infrastructure but needs to be put in place.

Regulatory Data Storage Obligation

The *Agreed Procedure 5 Data Storage and IT Security* sets out the requirements for SEMO rules in relation to data storage and IT security requirements described in the Trading and Settlement Code. This Business Case details the business and participant needs and justifications for investment in SEMO's data storage infrastructure.

This Agreed Procedure specifies the standards that the Market Operator should apply to its Isolated Market Systems. These standards are used by Parties as guidelines for data storage and data access in respect of their Isolated Market Systems. Specifically this AP calls out the below requirements.

AP5 Requirements

- In order to maintain the integrity and availability of information, processing and communication services **data shall be stored in at least two sites**.
- The Market Operator shall employ an **offline electronic back-up solution of market data** which shall allow recovery of market data as soon as reasonably practicable for disaster recovery and shall also facilitate the requirement to store market data over the long term.
- **Market data shall be stored for a period of not less than six years**.

Need Case

The new SEM arrangements are supported by a multifaceted topography of fully connected systems, with over 100 interfaces, over 100,000 daily transactions and significant computational algorithms which in turn lead to massive volumes of data being created on a daily basis. To support the SEMO rules for data archiving, SEMO requires investment in the underlying infrastructure in both Dublin and Belfast for the delivery of a data archiving solution.

At present data is stored predominantly online, with very limited archiving capability. The current arrangements are not sufficient to meet the regulatory requirement of storing two years of data online, and seven years of data offline. As a direct result of this, SEMO is experiencing storage space problems as the data builds on a daily basis. This is putting a significant amount of pressure on the current architecture, and has resulted in performance degradation across the I-SEM central systems.

Archiving within the current infrastructure would prove to be difficult, as the time to retrieve the data would be extensive while there is no data management in place. Given the scale of the data that is retained on a daily basis, there needs to be a structure placed on the data in terms of layering and/or segmenting.

More importantly SEMO cannot currently fulfil participant and regulatory data requests which are impacting the data analysis needs of all market stakeholders including the Market Monitoring Unit (MMU).

Proposed Solution

SEMO requires a data storage solution that will help reduce its disk space requirements. There are several software options that will provide a comprehensive approach to managing the lifecycle of a system's data from creation to the time when it becomes obsolete and deleted. These software options are generally GUI based tools for managing the various environments under its remit, and so facilitate ease of use. They also help to set rules for when data should be moved, archived or deleted. The software will also illustrate the storage requirements and costs savings associated with moving any sets of data.

Benefits

A data storage solution would have the following benefits:

Cost Savings	Potentially using less disk space would result in significant cost savings
Performance Improvements	Tiering/Partitioning of data will also help performance as only the critical data will be housed on the primary layer
Improved Efficiency	Efficient use of resources as replicating all data regardless of usefulness does not make sense
Regulatory compliance	Regulatory compliance – will ensure that SEMO is storing the correct level of data as required
Data Discovery	Implementing an archiving solution would allow SEMO to more easily locate necessary data for key market functions

Risk Analysis

Without a data storage solution in place, there is a risk of running out of space due to the scale of data being stored and potentially inefficient storage / tiering of that data. This is a critical risk that could affect the availability and performance of the market systems. It will also continue to contribute significantly to SEMO's overall costs as ultimately borne by customers.

It will not be possible in the medium term to continue without a formal solution to SEMO's data management requirement. SEMO cannot continue to store large amounts of data without considering tiering or partitioning. There is no doubt that the amount of data in the market systems will continue to grow, so SEMO needs to be proactive in how it is going to manage this. In recent times, SEMO has had to

purchase extra storage when space became critically low. There should not be a need to perform such emergency actions.

5. Additional Market Environments

Currently there are insufficient market environments to carry out all the activities required of SEMO. SEMO requires additional environments for emergency software/application patches, fixes to defects, training, regression testing etc.

Regulatory Reference

The Trading and Settlement Code Part A includes obligations on the Market Operator in relation to Testing and Upgrading of Isolated Market Systems and Communication Channels. Section 2.2.3 of the Agreed Procedure 11: Market System Operation, Testing, Upgrading and Support sets out the requirements for SEMO in relation to the testing of releases of market systems in advance of the deployment to the production environment.

Need Case

MMS/CSB Environments: SEMO is currently maintaining nine MMS/CSB environments, including the production environment. The other eight environments facilitate testing activities as well and providing a progressive release management process. The diagram below provides an overview of the environments and the nature of connectivity with internal and external systems. As can be seen there are three connected environments: Integration, End To End and Production environments. There is a CCQT/PIT (Common Corporate Qualifier Test / Participant Interface Testing) environment which facilities testing by Participants and MDPs (Meter Data Providers). There is a necessity for ongoing review of the test environments for various testing activities.
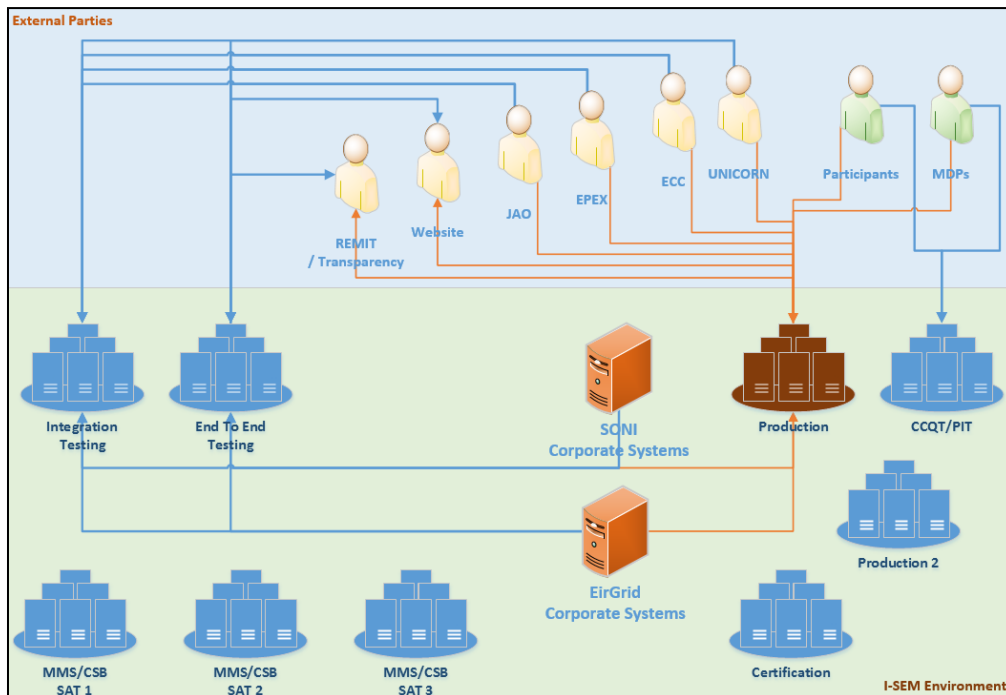

Figure 14 - MMS/CSB Environments

Environments Support and Maintenance: To facilitate testing activities it is necessary to support and maintain each environment. For isolated, non-connected implementations of MMS/CSB, daily data loading activities are required to maintain the ongoing stable operation of the system.

MMS/CSB Architecture Enhancement: The market (MMS) and settlement (CSB) systems databases, currently share the same physical database infrastructure which is inflexible, inefficient and leads to CPU performance issues. The performance issues have directly impacted settlement runs resulting in the late publication of settlement documents. This database arrangement also provides no flexibility when managing outages and leads to impacts on market operations. Investment is required to relocate the databases, creating an additional environment, which would provide the opportunity to deliver performance improvements using dedicated server resources, data partitioning and archiving.

MMS/CSB P2 Environment: This environment will contain infrastructure architecture similar to the production environment for MMS/CSB, which is necessary for the testing of non-functional defects. It is essential that the failover mechanism is in place for the efficient use of the P2 environment, for efficient major release management, business continuity.

MMS/CSB Training Environment: There is a requirement to dedicate one of the MMS/CSB environments as a Training environment for Participants. To facilitate this requirement will require the re-purposing of an existing environment in order to remove the requirement for an additional environment.

Oracle Middleware Environment Pre-Production: There is a requirement for an OMW clustered environment which replicates the architectural implementation of the production environment. The need arises for this environment for the purpose of testing non-functional changes and defects prior to deployment to production. In two separate instances, since the commencement of the current SEM markets, it has been necessary to complete two roll-back situations where work tested correctly in the single node pre-production environment had issues when moved to the clustered live production environment. In addition this environment would be used for a production environment role change which would facilitate no downtime, and hence no market interruption, when releasing to production. There would be a cost associated with implementing this environment including infrastructure components (servers etc.), server room changes, deployment, installation, and licensing costs.

Proposed Solution
Testing Non-Production Environments

- **Emergency patches/fixes to defects:** An environment is required for deployment of emergency patches/fixes to defects. This environment would need up-to-date synced copy of Production along with data feeds as per the Production environment.
- **Fortnightly Common Information Model (CIM) uploads:** An environment where the fortnightly CIM model uploads and associated feed updates can be tested in advance of deployment to the production system. This environment can also be used to test the deployment of MMS patches/updates and testing the registration of new units and de-registration:
    - The data contained in this environment should be a mirror of that in the Production environment synced at least fortnightly in advance of testing new CIM files.

- o Participant data should be available (ABB Data Loader suggested as a means to make participant data available to environment).
- **Training Environment:** An environment which can be used for development and training purposes:
  - o The data contained in this environment should be a mirror of that in the Production environment synced periodically on request. The environment is urgently required for Settlement training.
  - o Participant training
- **P2 Environment**
  - o P2 infrastructure has been delivered for MMS and CSB – however a failover mechanism solution was not delivered, implemented or tested. This is essential for the efficient use of the P2 environment, for efficient major release management and business continuity.
  - o Further assessment is required on the P2 environment to assess whether the following applications are required in it: EDIL, GDX, and Dynamics.
- **MMS/CSB Environments:** SEMO is currently maintaining nine MMS/CSB environments including the production environment. Each environment is used for different testing activities, including certification, SEMOpx and Participant Communication testing. The MMS/CSB systems within each environment require data submitted in order to operate. Many of the environments are standalone environments where there are no systems to submit any data. In this scenario, it is necessary to implement a data loading solution to submit the data on a daily basis to support and maintain.
- **Oracle Middleware (OMW) Environment Pre-Production**
  There is a requirement for an OMW clustered environment which replicates the architectural implementation of the production environment. The OMW architectural solution is a highly available production implementation for the SEM. The need for this environment arises for the purpose of testing non-functional changes and defects prior to deployment to production. Currently these tests are being carried out in an environment with a single instance of OMW, which does not replicate the production environment.

6. Market Monitoring Systems

Monitoring the various market events is proving to be a very onerous task, resource intensive and thus costly. A monitoring system that gathers alert information needs to be developed and deployed to proactively manage issues before they initiate unwanted market events. Sections 2.3 and 2.4 of the ***Agreed Procedure 11: Market System Operation, Testing, Upgrading and Support*** sets out the requirements for SEMO rules in relation to problem management function, rectification timelines, interim arrangements and pot event reporting.
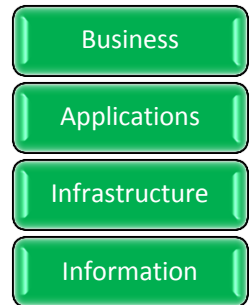

Need Case

SEMO needs to implement a suite of system monitoring and reporting tools to provide end-to-end service management solution that supports improving availability and performance across IT systems. With this in place, SEMO will achieve the benefits of automated monitoring, alerting and reporting and will adopt a proactive approach to identifying and resolving issues that will help to maintain the market systems availability to the market participants.

The I-SEM Markets Systems architecture consists of IT Infrastructure, Applications and Data on which the current SEM Market relies. The Market Operator must therefore ensure that systems function correctly in order to facilitate the various participant interactions with the market. There is a strong reliance on ensuring that all business functions, applications and infrastructure devices are operating as expected on a 24 hour 365 days basis, outside of maintenance windows.

To deliver on these very high service levels the Market Operator needs to be able to proactively monitor the various market services we are obliged to deliver. It is therefore necessary to invest in a market system monitoring system that can ensure that any issues encountered can be identified at the earliest time to prevent or reduce the impact on market functions.

Participants depend on this very high level market service availability to be able to execute their market activities. Market services are distributed across many different business layers with each needing monitoring. Hardware, Software, Telecommunication Links, Middleware, Data feeds and Participant connectivity all need to be monitored in order to be able to deliver service levels required.
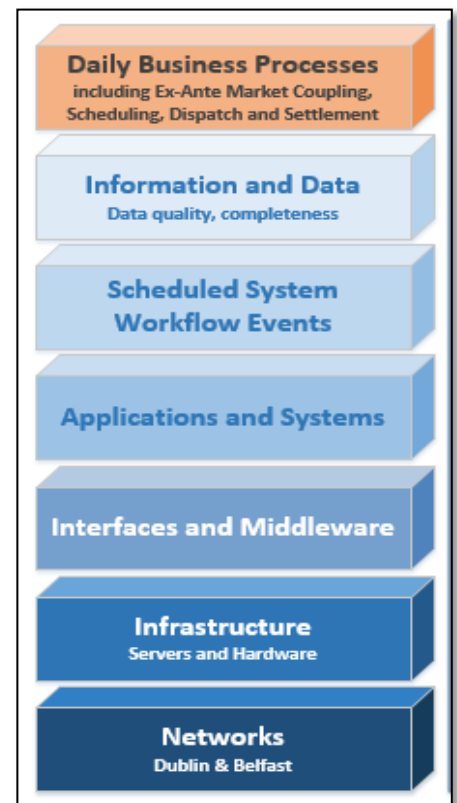
Proposed Solution

Infrastructure

Currently, SEMO has market monitoring capability in place for its market and corporate infrastructure that require executing several manual steps. There is a strong need for an overarching infrastructure monitoring system and reporting tool which can automatically observe, monitor and check the full suite of SEM architecture components to ensure the availability of the infrastructure to support the market systems. In the existing set up, the monitoring and reporting are performed on a reactive basis when issues arise and need investigation. Manual and reactive checks are not an optimal use of the resources. In line with industry standard, this process should be completely automated, and manual intervention should only be required when an issue is highlighted.

System / Application monitoring

Currently there is no centralised automated monitoring system to alert SEMO if a system application is non-responsive or if certain interfaces fail. This inherently leads to impacts to the market functions until the issue is discovered and fixed. There have been isolated incidents where a system application like the MPI (Market Participant Interface) has been unavailable leading to a General Communications Failure being reported in the current SEM. In some case external stakeholders or participants have informed us of system/application incidents.

Figure 15 provides an overview of all the market systems and interfaces across that require 24/7 monitoring and support.

Figure 15- Market Systems & interfaces

A coordinated approach to the monitoring of each of the various applications and interfaces is therefore required to identify any potential service degradation before participants encounter issues. Continuous monitoring, resilient redundant architecture along with a self-healing capability is the ultimate objective for the Market Operator.

Business Processes – To Support Market Services

Many of the daily business processes completed by SEMO require resources to manually check that data is delivered and available for processing. The list of processes that require manual checks are detailed in *Figure 16*. Validation by SEMO resources that data has been successfully delivered is time consuming and inefficient.

Ex-Ante Markets	Balancing Market	Settlement	Market Reporting
This functional area includes running multiple Ex-ante Markets (Auctions and Continuous Market). This incorporates all pre-coupling, coupling and post-coupling relating to all activities for a trading day.	This functional area includes core balancing market functionality and target system impacts, including: a) Long term scheduling b) Real time commitment c) Real time dispatch d) Individual grid model e) Dispatch tool, including interactions with EDIL f) Imbalance pricing	This functional area includes all settlement activities, including: a) Checking all data has been received and is available b) Running Instruction Profiler (QBOA) c) Pushing data from MMS to CSB d) Importing data into CSB e) Indicative Settlement f) Initial Settlements g) Settlement Documents	This functional area includes all SEMO reporting obligations including: a) Trading & Settlement Code b) SEMOpx Code c) Capacity Code d) REMIT e) Transparency

Figure 16 – Business Process Monitoring checks

Benefits

The implementation of a market system monitoring and reporting tool can provide immediate and long term strategic benefits including:

Fault Identification - Monitoring to detect errors related to the SEMO IT infrastructure, applications or business processes. Faults can consist of errors such as the loss of network connectivity, a database server going off line, an interface failing or no data availability. The early identification of these faults can enable SEMO to be proactive in resolving issues before they ever impact the market services.

Performance monitoring - Performance monitoring is specifically concerned with detecting less than desirable application performance, such as slowing processing times, database or other back end resource response times. Generally, performance issues arise in an application as the user load increases. Performance problems are important events to detect in the lifetime of an application since they, like fault events, negatively affect the user experience for the market participants.

Configuration monitoring - Configuration monitoring is a safeguard designed to ensure that configuration variables affecting the application and the backend resources remain at some predetermined configuration settings. The SEMO IT systems and infrastructure are located in Dublin and Belfast through communication links. In both sites there are large number of environments with several instances of applications, for the purpose of redundancy and back up. In the event of such an event, configuration issues can lead to market system impacts.

Security monitoring - Security monitoring detects intrusion attempts by unauthorized system users.

Reliability – The reduction of faults and impacts to the market systems, with improved reliability, will improve the operation of the markets for Participants.

Cost Savings – Faster resolution of faults and the reduction in the number of manual checks completed by market operator resources are two costs that can be significantly reduced with a market system monitoring capability.

Increased availability of the market systems as issues will have been investigated earlier than before and prior to them becoming critical. This will also result in improved trust and confidence of market participant in the market systems and services.

Improved performance of the market systems will be possible as adjustments can be made to the IT infrastructure based on a deep understanding of performance metrics.

Better utilisation of IT personnel to focus on deployments and issue resolution rather than maintenance

Risk Analysis

Given the criticality of the market systems being available, it is essential that SEMO adopts a proactive approach to their systems monitoring. In the current set-up, which is reactive and manual, resource constraints mean that it is not possible to review every facet of the infrastructure on a daily basis.

With the implementation of a monitoring and status dashboard, the systems analyst would be able to work through the issues as they arise and before they become major issues that could affect the availability of the market systems for the participants. Additionally, given the standard lifetime of IT infrastructure and where SEMO assets are currently in that lifetime, it is of utmost importance that the market system performance is constantly monitored. Automated report monitoring will also allow the IT team to set KPI's on key infrastructure components and analyse trends in performance and reliability.

7. MMS Performance Enhancements

The Market Management System (MMS) has some bottlenecks and growth areas which for a small amount of investment could significantly improve its overall performance. This business case proposes some performance enhancements to the MMS system. These enhancements should not be considered as Market System Release Capital as they are not required as a result of a defect, functional change or regulatory approved market modification. The proposed enhancements are changes which have been identified which would ensure continued high performing systems and mitigate the risk of system performance impacts as the volume of data increases and the SEM market systems mature.

| Business |
| Applications |
| Infrastructure |
| Information |
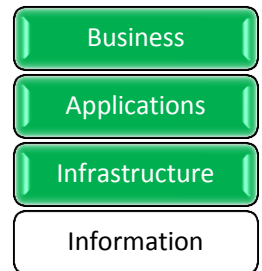
Need Case

The MMS is the central system for managing and administrating the Balancing Market. Its main component Clearing, Settlement and Billing (CSB) is the system responsible for the Settlement of the Balancing Market and Capacity Market. As the MMS/CSB is a key system in the overall system landscape of the SEM markets it is critical that its performance is maintained at a high level. There are many factors which impact the performance of the MMS/CSB system including infrastructure, design, data and storage. There are multiple applications within the MMS which providing different functionality including registration, scheduling/dispatch, and instruction profiling / imbalance price calculation and reporting.
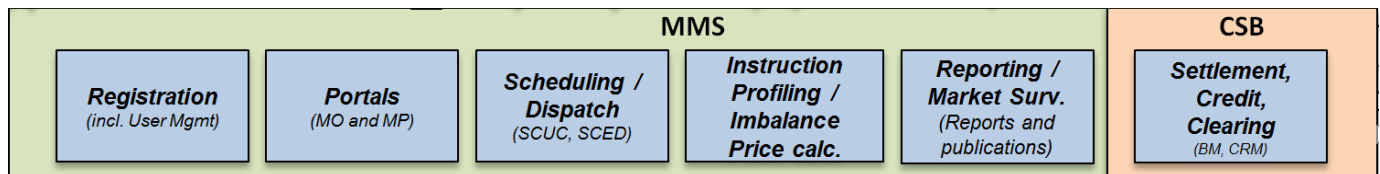
MMS					CSB
Registration (incl. User Mgmt)	**Portals** (MO and MP)	**Scheduling / Dispatch** (SCUC, SCED)	**Instruction Profiling / Imbalance Price calc.**	**Reporting / Market Surv.** (Reports and publications)	**Settlement, Credit, Clearing** (BM, CRM)

Figure 17 - MMS/CSB system

Currently there are a number of issues affecting the performance of MMS/CSB including;

- **No MMS Redundancy – Single Point of Failure:** if the MMS were to fail, for example due to a hardware issue, there is not any backup system to provide fail over. In this case it means, from an operations perspective, that we are dispatching based on the last available Long Term Scheduling (LTS) information which is based on Complex Commercial Offer Data (COD). Economic dispatch based on Simple COD could be quite different. This coupled with the fact that no flags will be generated at the time could lead to high Dispatch Balancing Costs (DBC). Given the effect on pricing and settlement and ultimately DBC it is important that a backup system is in place that we can failover to.
- **MMS workflow performance:** Slow performance impacting Control Centres e.g. Real Time Dispatch (RTD) runs not completing, Group Constraints Manager taking hours to update. Straight-forward control centre tasks such as updating constraints are taking too long and distracting from other tasks, leading to late running of schedules, potentially inefficient or insecure schedules, out-of-date RTD runs and therefore flags.

- **MMS Data Storage:** Not storing data in ISEMDS / Looker / Website / MPI for analysis for long enough. Unable to respond adequately to customer queries/disputes and audit questions, and unable to complete long-term trend-type analysis.
    - Data is being purged from MMS and subsequently from ISEMDS. This means we have lost data that is not in archived save cases. Also data in archived save cases is available to a small number of people. This makes data analysis extremely difficult for analysts across the group and we may not be able to answer internal or external queries. This data is also required for transparency and audit purposes to protect the transparency and integrity of the market.
    - Identification of key tables within MMS that need to be copied from ISEMDS into a location on a server that is not purged (e.g. DIP). The storage capacity of this server will no doubt need to be expanded to accommodate this. The benefit of this is that key data will be available to analyse as required from Internal or external queries.
- **MMS/EDIL/ICMP Outages / Software Upgrades / Patches:** Shutting down of MMS for long periods affected DBC. A process to avoid generators being settled on their simple commercial offer data at times when the back-up price is being used is needed. This has occurred during outages of MMS and in particular pricing system. A planned outage of pricing resulted in an increase to DBC of €850k from one unit alone on 29th Jan 2019. This process also needs to be viewed in relation to unplanned outages of pricing.
- **Reduced Time Lags for RTD:** Improvement is required in the latency between initialisation of RTD for a schedule and the sending of Dispatch Instructions (Dis) associated with that schedule. In addition the Improved Resource Dispatch performance (RD is currently off).

Proposed Solution

The MMS contains a number of key market functions including Registration, Scheduling / Dispatch, Instruction Profiling / Imbalance Price Calculation and Reporting.

- **MMS CSB Architecture:** The market (MMS) and settlement (CSB) systems databases currently share the same physical database infrastructure which is inflexible, inefficient and leads to CPU performance issues. The performance issues have directly impacted settlement runs resulting in the late publication of settlement documents. This database arrangement also provides no flexibility when managing outages and leads to impacts on market operations. Investment is required to relocate the databases which would provide the opportunity to deliver performance improvements using dedicated server resources, data partitioning and archiving.
- **Scheduling Applications:** There are three scheduling applications which can be differentiated by the time horizons they produce schedules for, how often they run and the resolution of the schedules they produce. There is a critical functional requirement that the calculation of the three schedules when started complete within the times noted in the table below. In the event that the calculations fail to complete, then the schedule will not be generated for the study horizon which will have a cascading effect impacting the next schedule that runs. In the event that the systems fail to generate schedules then the operator will not have schedules on which to operate the electricity grid. There is a risk that as the data volume increases as the market matures, it will have a negative impact of the system's ability to calculate the schedules. To mitigate the risk of failing it will be

necessary to continuously invest in the systems infrastructure. The three types of scheduling applications are detailed in the table below:

Schedule	Frequency	Resolution	Study Horizon
Long Term Scheduling (LTS)	~Every 4 hrs	30 mins	*~30 hrs
Real-Time Commitment (RTC)	~15 mins	15 mins	4 hrs
Real-Time Dispatch (RTD)	~5 mins	5 mins	1 hr

Figure 18 -Scheduling Applications

8. Market Analysis Tools

The goal of the electricity market is to deliver a reference representing the fair value considering the economic and technical conditions. Consistent and accurate market analysis helps to ensure orderly markets, where buyers and sellers are willing to participate because they feel confident in the fairness and accuracy of prices.

```
Business
Applications
Infrastructure
Information
```

Consistent good quality clear market analysis is essential for decision support. Market Analysis tools are critical for analysing very complex market scenarios and for further explaining to participants how various market events occurred and what the impacts are associated with that particular market event.

Regulatory Obligations

The Market Operator has obligations for monitoring the performance and quality of its operations in accordance with EirGrid's Market Operator Licence Condition 10[5] and SONI's Market Operator Licence Condition 17[6].

Trading & Settlement Code [7] obligations:

- Monthly reporting to the Regulatory Authorities about:
  - *the performance by the Market Operator of its rights, powers, functions and obligations under the Code; and*
  - *factual information relating to the exercise of rights and the carrying out of functions by Parties under the Code. [B.16.2 Information Sharing]*
- Annual audit of operations and implementation and the operations, trading arrangements, procedures and processes under the Code *[B.16.1.3]*

Need Case

Analysis activities common to most market operators:

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[5] EirGrid Market Operator Licence March 2017
[6] SONI SEM Operator Licence March 2017
[7] SEM Trading & Settlement Code Part B

An operational monitoring function	A price and market results validation function	An analysis and reporting function
•Real-time oversight of data and process quality to flag exceptional data inputs, data outputs, process alarms, market participation and general market/system conditions •Identifies and activates market interventions when needed -pausing the market, back-up prices, use of contingency data, raising system performance issues as needed.	•Departures from normal price and schedule outcomes are flagged and reviewed, in part to validate that the results are correct (no manifest errors), and also to prepare for stakeholder queries	•Management KPI reporting to track agreed performance criteria •Summary market results reporting for stakeholders and to monitor trends •Investigations of scheduling errors, process errors, unintended outcomes, disputes, other possible non-compliance that would be relevant to regulatory reporting and the oversight of external auditors •Analysis to support of Rule/Code changes/modifications

Many different parties both internally and externally require data to carry out their market activities. A number of business cases in this document support the need for access to large volumes of market data for analysis work. This business case however targets the provision of market analytical tools to support the Market Operator analysis team with answering complex market queries and to respond to specific market concerns and trends. Market analysis stakeholders are outlined in Figure 19.
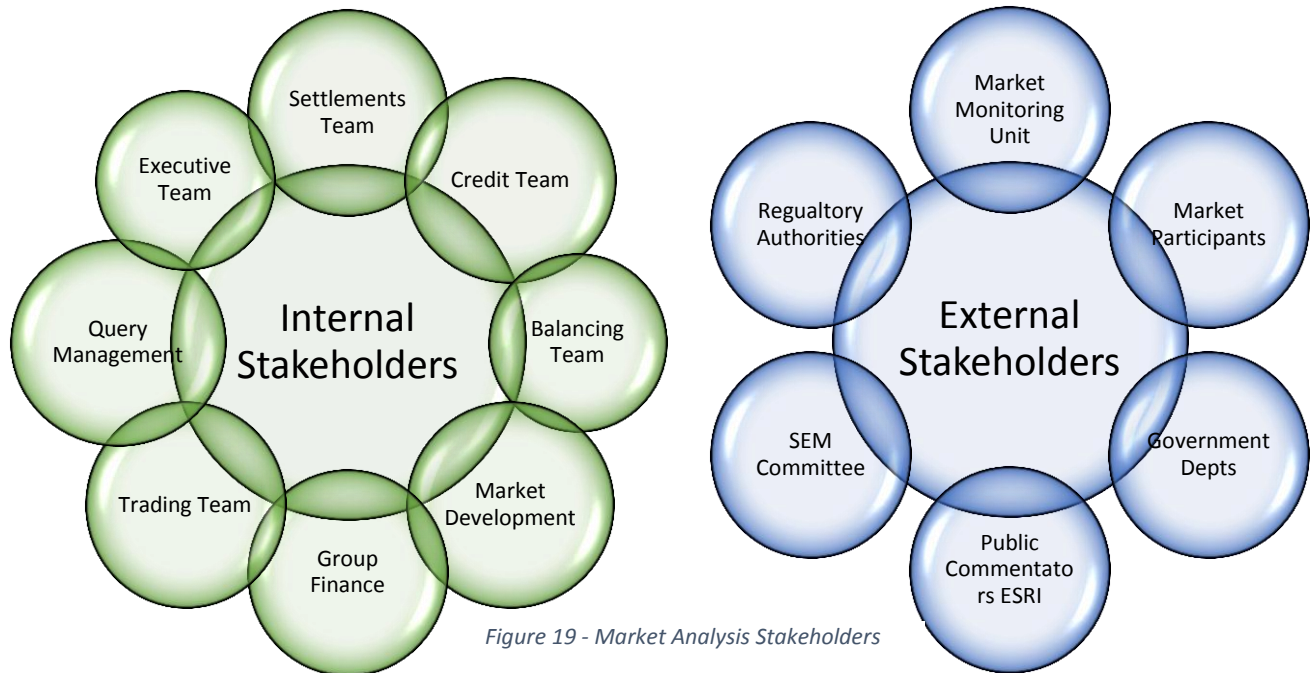

Figure 19 - Market Analysis Stakeholders

Each stakeholder has their own specific analysis needs and requirements to be able to answer questions to support their own particular need. Analysis query types which are of most concern include:

- **Pricing** - The Imbalance Settlement Price is the primary price used for settlement in the Balancing Market, and therefore it is an important signal for the whole market. It is the primary signal which "Balance Responsibility" is implemented.
- **Settlement** queries relate to financial settlement of payments and charges under the Trading & Settlement Code, through determination of payments, charges, fees and costs, detailed in Settlement Documents issued by the Market Operator to Participants.

Figure 20 below gives a breakdown of the various query types that the market operator analytical group, have focused on, these queries come from both internal teams and external queries via the Front Office team. 63% of key analytical queries typically relate to Pricing and Settlement activities.
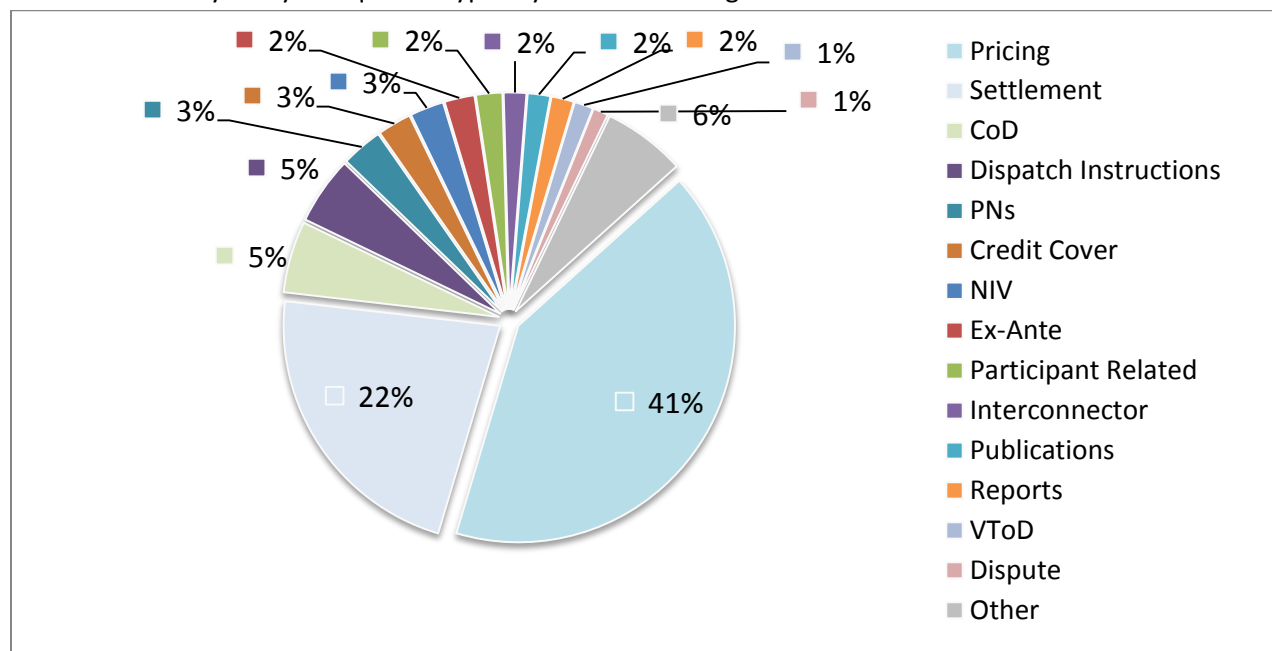

Figure 20 - Breakdown of Internal Analyst Team queries

As the market is new and was launched with a number of defects this has resulted in a wide range of analysis work. The analytical work is very reactive requiring a multiplicity of analysis tools and database technologies.

To deliver on its objectives the Analytical Team need to

- Systematically and completely record and evaluate data regarding exchange trading and the settlement of exchange transactions
- Understand the price formation mechanism
- Understand Market Participant behaviours
- Establish and maintain effective arrangements and procedures to identify breaches of Rules and Regulations,
- Conduct any necessary investigations
- Cooperate with all supervisory and regulatory authorities
- Participate in all working groups related to market issues

The SEM 2007-2018 market was much simpler with fewer and smaller datasets produced. As a result, the legacy analytics capability is mostly delivered outside of the production environment, by an array of spreadsheet tools and visuals. The primary analytics tool is Excel-based which is populated by manual export of data from applications into CSV files, which are then loaded into worksheets, manually transformed and manipulated to produce information.

The current capability does not meet the SEMO's needs. Data preparation for common help-desk queries can in some cases take a full working day, as market data is not readily or quickly accessible. Frequently used data must be extracted from multiple sources e.g. CSV files, XML, savecases, product database, MS access database. This data is mostly in raw form, with inconsistent naming and control conventions. This makes data extraction, transformation and preparation for analysis excessively time-consuming. Excel spreadsheets must be utilised for consolidation of data from multiple sources.

At present SEMO is unable to validate and reconcile market results as part of a continuous market and system oversight function. It is unable to transform, view and analyse market data within operational time-frames, limiting the ability to prudently manage the delivery of market services. This has created a service delivery risk that this investment is intended to mitigate.

A substantial amount of market revenue flows need to be validated and redistributed among market stakeholders. The monitory value is significant and errors in analysis could have a seriously impact the financials of participants or impacts to the market.

There are a number of processes that require data analytics e.g. Modifications Process. At present it is challenging to provide high quality quantitative information to key stakeholders such as the Modification Panel in a timely manner.

SEMO therefore requires an analytics platform that meets the challenges of the new market's volume, speed and complexity of data.
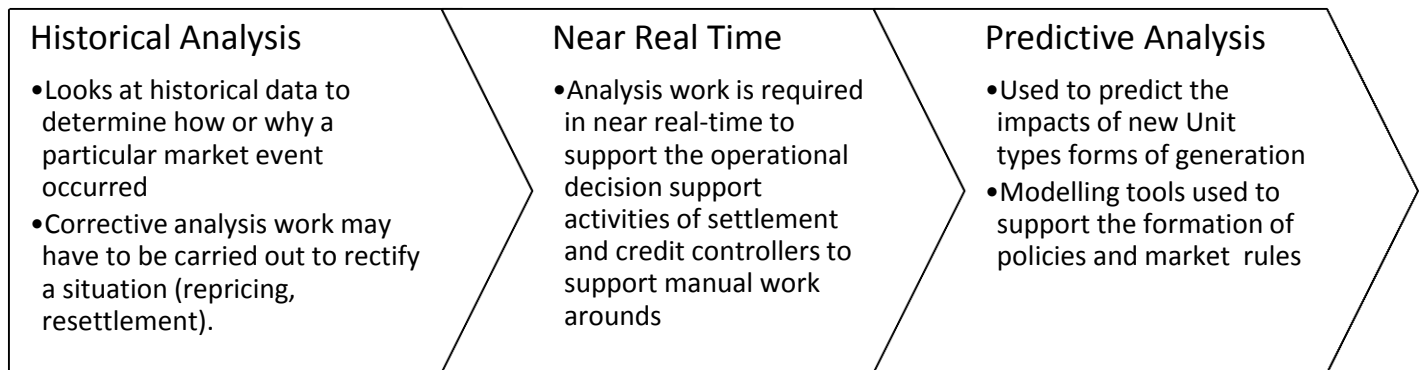
The various query types for which participants are seeking answers for. The following query types require specialist analysis support:

- Cash Collateral
- General Settlement Queries
- Market Analysis
- Market Rules
- Reports
- Settlement
- Formal Settlement queries
- Disputes

Benefits

A self-service analytics tool which support the range of time sensitive and complex decision making required. Significant investment is required to deliver this capability at a standard that enables prudent market and system operation.

Analytical tools can be pre-programmed to flag market anomalies that can in turn monitor market events and possibly allow staff to take action to prevent harmful market events from occurring. Different analytical tools are required to analyse data in different timeframes.

Historical Analysis	Near Real Time	Predictive Analysis
•Looks at historical data to determine how or why a particular market event occurred •Corrective analysis work may have to be carried out to rectify a situation (repricing, resettlement).	•Analysis work is required in near real-time to support the operational decision support activities of settlement and credit controllers to support manual work arounds	•Used to predict the impacts of new Unit types forms of generation •Modelling tools used to support the formation of policies and market rules

Market modelling tools are required to predict how a change in service design can impact the market. More reactive analysis is also required to support the swift response to complex participant queries.

The following highlights this challenge in respect to the current SEM:
- 80-fold increase in data compared to the previous SEM market.
- 7,000 daily data exchanges across numerous interfaces.
- 408 market schedules each day, covering LTS, RTC and RTD.
- Data to support monitoring and analytics for the SEM is accessible via 698 separate savecase files per day (up from 6 in the previous SEM).
- The full set of input-output data to analyse/trouble-shoot a day of trading is obtainable via 56,000 CSV files that are manually exportable to Excel after separate loading of 698 save-cases.

Most of these are not needed, but the number underscores the challenge of data preparation for complex analysis.

- Minimum visualisation to oversee a 5-minute iteration of the market schedule could require 30-mins for data extraction, loading and chart production in Excel. While some visual capabilities are built into applications, these do not enable the complex visual relationships needed to test cause and effect, such as visual linkages between low forecasts and atypical unit commitment.

- If data is available via databases in an analytics environment, there will be 370 tables from the ABB system, for which there is no data catalogue or information on table architecture. The database design enables a raw data drop from ABB, without the range of control tables and standardised column headers that are needed to facilitate fast and efficient querying.

- There is no analytics server or secure network platform that enables SEMO upload, cleanse, transform, analyse or store data.

9. Compliance Management

A Market Compliance System is required to track the levels of compliance of the Market Operator to the different activities to the various market codes and licenses. This will make audits more efficient as the Market Operator will be able to proactively demonstrate concerns/issues with adherence to the code and what remedial and long term auctions are being taken to resolve the non-compliances.

Regulatory Reference
The Market Operator requires a Compliance Management System to track the compliance levels of the Market Operator activities for the following range of regulatory obligations outlined in the following documentation:

> ## Market Operator Compliance Documentation
> •MO Licenses
> •Trading and Settlement Code
> •Capacity Market Code
> •Compliance to Agreed Procedures of both codes
> •SEMOpx Rules
> •REMIT and Transparency
> •EU codes and Packages (Energy Package, Winter package)
> •Legislation (Ireland, Northern Ireland and GB) e.g. changes to VAT etc.
> •Supporting EU Directives - security of network and information systems

Need Case
The Market Operator in both the Republic and Northern Ireland is obliged to comply with EU Codes and Directives along with licenses, SEMC and regulatory decisions along with Trading & Settlement and Grid codes. This requires that the Market Operator manages its compliance activities in a comprehensive and coordinated fashion. In order to deliver on these compliance goals the Market Operator needs to build a Compliance Management System to track the status and urgency of the various compliance issues and to be able to store comprehensive data and documentation and to be able demonstrate compliance with obligations.

Compliance
Compliance is the process used to achieve and monitor adherence to required organisational standards and applicable regulations. The Market Operator needs to develop an IT tool which acts as a single repository for all of Market operator's legislative, license and code obligations. This tool will provide a single, safe, secure environment to store and generate reporting on the Market Operators compliance obligations. This system will need to provide a full audit trail that is capable of tracking the status of compliance issues over time.

The Market Operator also needs to implement processes which ensure continuous compliance to all its obligations. Complying with a regulation involves two types of activities:

(i)   taking the actions required by the obligation and
(ii)   storing evidence which demonstrates to an auditor that the required actions have been taken.

If the Market Operator was in breach of any obligation then the compliance activities would become far more involved, as follows -

(i)   The nature of the non or partial compliance needs to be documented
(ii) The non or partial compliance needs to be assessed to determine what the impact is
(iii) Corrective actions need to be identified and agreed.
(iv) The corrective action then has to be implemented be it a work around, system change or Code change.
(v)   The corrective action needs to be assessed to determine if the corrective action has rectified the situation.

With this in mind SEMO need to develop a compliance application which can:
- store and track all compliance obligations in a single compliance register;
- provide a facility for the gathering of suitable evidence to demonstrate that the compliance obligation is met;
- to be able to record, assess and track the resolution non or partial compliances;
- to provide a compliance dashboard for the Market Operator to be able to determine the compliance levels across the various MO activities.

Obligation Recording and Evidence Gathering

Below are a number of steps that are part of the overall management and reporting system that needs to be delivered to support these compliance activities. Compliance has a time element which can make the identified obligation on a daily, weekly, monthly, yearly or a once off activity.
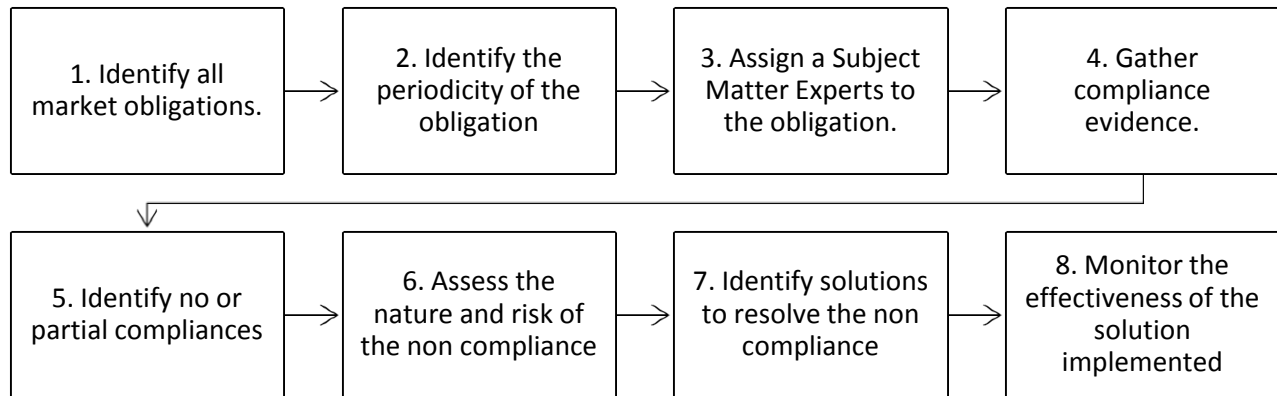
Figure 21 - Compliance Management & Report Steps

Benefits

The Compliance System will support the compliance process that will provide evidence of compliance with all relevant Electricity Laws and License Requirements that place an obligation or requirement on the Market Operator. The system will also a provide evidence of compliance with the obligations relating to Regulatory Codes (Capacity Market and Trading & Settlement Code). The benefits of a Compliance management system include:

Compliance Business benefits
• Gives Internal and External reassurance that the various codes and licenses are being complied with.
• Helps support the numerous audits that the Market Operator is regularly engaged in
• Provides a comprehensive library and audit trail of obligation evidence
• Helps improve the internal governance for managing and resolving partial or non-compliances
• Provides assurance to the wider industry that non or partial complainces are being actively managed and delivered

Consistent compliance delivery	⯈	Clear, regular reporting of compliance	⯈	Tracking of non-compliance resolution	⯈	Increased group awareness	⯈	External reporting to Regulators	⯈	Supports the internal audit function
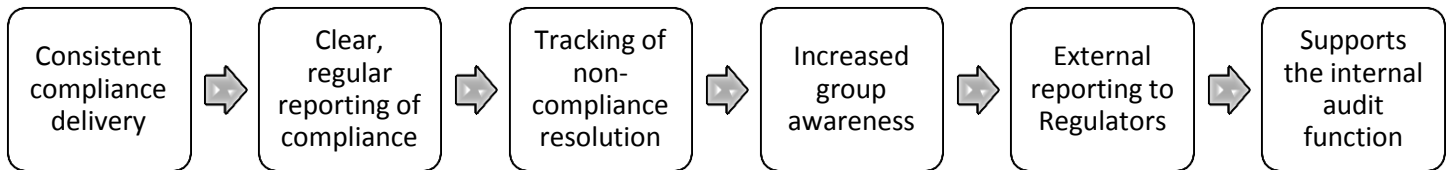
Risk Analysis

Adherence to all aspects of the various code requirements is a significant challenge for the Market Operator. This to some extent is to be expected in the early stages of a new market. In some cases systems don't fully align with the codes or rules in the codes aren't necessarily performing as intended. Potential solutions could require the Code to be modified to support the original intention and/ or the systems to be redesigned to fully reflect the market rules. In both these scenarios the Market Operator needs to manage these issues through work-arounds, Code amendments and/or design changes.

Addressing Non/Partial Compliances

Identification of non or partial compliance is important as it provides awareness or identifies exposure points within the Market Operator business. These instances of non-compliance present an element of risk to which the business may have been unaware of prior to the evidence gathering phase. The evidence gathering phase will capture information about the non-compliance. Non compliances can generally be cleared by:

- Amending a Code or License
- Documenting a process that previously did not exist
- Creating a manual work around or check that resolves the non-compliance
- Designing or redesigning an IT system that resolves the non-compliance issue.

Logging tracking and recording of compliance work requires the design and build of compliance management system which can store, track and record the compliance levels within the Market Operator.

10. Website Development

The website needs to be developed to better cater for the data and reporting needs of participants. The Market Operator also needs to enhance its communication ability through regular website publications, stakeholder market updates and through the provision of a Dynamic Reporting capability.

Need Case

Further website functionality needs to be developed and delivered to support the reporting and data needs of the Market Participants, Regulators and the Market Monitoring activities. The current process of publishing of reports, data and information from the MMS to the website requires improvement. Investment in dynamic reporting is required as Participants and Regulatory Authorities have considerable data and information needs which are not being fully catered for.

Internally SEMO requires a website test environment to be able to test links and view content. Pre-Production environments are required to review changes, before they go-live on the website. Reporting needs improvement to ensure that reports contain accurate and timely information. Browser issues also need to be resolved to protect and secure the data being accessed.

Report Categories

- Auction Results
- Balancing Market Data
- Balancing Market Development
- Capacity Auctions
- Capacity Market Development
- Capacity Qualification
- Capacity Registration
- Capacity Settlement Parameters
- Continuous Trading Results
- Ex-Ante Market Development
- Forecast Data
- Inputs, Commercial and Technical Offer Data
- Market Methodologies and Processes
- Market Operator Performance
- Methodologies
- Operational Reports
- Registration
- Settlement Data

Proposed Solution

The Website will require the following investment stages:

1. Ensure that the data sources are delivering the data reports in a high quality timely manner.
2. Develop a dynamic querying and reporting capability.
3. Provide a bulk data download capability for all market stakeholders.
4. Conduct a usability review of the website and restructure how the information is displayed on the site. Improve page structures and page layout, including dashboards and better screen layouts.
5. Provide suitable web publishing environments to test the content and changes being uploaded.
6. Develop new reports to meet the business needs of participants.
7. Restructure the underlying data repository to fulfil the reporting needs of Participants. This will require a project to define the needs and create the required databases, and supporting infrastructure.
8. Develop "mobile apps" to support participants using smart phones and tablet devices. The app will deliver the website's existing Operational Indicators, Market Messages, Market Overviews,

and Market News. A second app could enable Participants to securely display personalized dashboards relating to their trading data.

Benefit

For a relatively small targeted investment the data needs and market decision support indicators could be developed which would support the real time decision support of market participants and other key stakeholders e.g. regulators. A more reactive and informed market should reduce prices as participants can compete using real-time data to ensure they have made informed decisions.

Without the necessary website investment participants will not have the information certainty to understand the scope of any real or perceived market risks. Data and information are essential in knowing how and when to react to market issues and exceptions.

11. Participant Urgent Communication

The *Trading and Settlement Code Agreed Procedure 7 Emergency Communications* imposes significant participant communication obligations to keep Market Participants informed about key market events and issues. The intention of an Urgent Participant Messaging solution is to provide a direct communications channel to Participants outside of the normal working day.

Business

Applications

Infrastructure

Information

Need Case

The purpose of this business case is to support the delivery of an Urgent Participant Messaging service out of office hours. During normal business hours (09:00-17:00) Market Participants are sent Market Messages by way of email to notify them of any significant events e.g. updates on planned outages etc.

Where similar events happen out of hours, a service was provided on a temporary basis by the I-SEM Project team. It may not be efficient or cost effective for project resources to provide this service on an enduring basis. However, without this project stopgap Market Messages would not have been issued and lead to a situation where Market Participants would not be fully informed about significant market events. For example, on March 26th the Balancing Market systems were taken down for a planned release. The Project team were contracted to provide a temporary Local Communication Failure service and communicated to Market Participants on the progress of the planned release. The business as usual market operations model does not support this out of hour's urgent communications capability.

The Ex-Ante Markets have 24x7 urgent messaging to inform participants where systems are not available etc. In other markets more comprehensive Urgent Participant Messaging services are available

> The Balancing Market operates on a 24x7 basis however, without the provision of an out of hours services Market Participants will effectively have no Urgent Communications for 75% of the week.

Information is a key element in every market. The fact the Market Operator has market sensitive information that is shared between 09:00 and 17:00 but not at other times may inadvertently impact certain participants who trade in the market outside of a limited working day (24% of the trading window).

Benefits

The proposal is to continue to provide the 24*7 communications using project resources. The principal benefits of this proposal are as follows:
- **Market Instability** – There is level of market instability and participants would significantly benefit from timely and relevant market information 24*7
- **Customer Satisfaction**: Market Participants are made aware at all market system issues in a timely manner so they can react by implementing their exception handling procedures.

- **Consistency**: As the Balancing Market is 24x7 it is expected that a consistent level of service should be provided for at all times.
- **Business Norms**: Urgent Participant Message systems for Market Participants are the norm in other 24x7 Balancing Markets across Europe
- **Regulatory Requirements:** There are a number of Agreed Procedures which require out of hours communication ability with Market Participants e.g. Agreed Procedure 7.
- **Stakeholder Cooperation -** Strengthening of co-operation with regulators and other stakeholders.

Risks

Some of the benefits of not providing a Participant Urgent Communications capability include:

Efficient simple secure	Urgent Participant Messaging
⬇	⬇
These messaging platforms offer an efficient, simple and secure way to disclose market information	The UPM platform can be used to notify the market about planned or unexpected changes to generation, consumption and transmission.
⬇	⬇
Provide seamless system integration of participant systems through stable APIs	Participants can view real-time notifications of events, disturbances and price impacts on short and long term markets.

In the absence of this service Participants and the market as a whole will not be able to react to adverse market signals and events which could in turn could have a significant monetary impact on their business operations.

Appendix: 1 Evolution of Capex Provisions and Approvals in SEM 2007-2013

2007/2008 Revenues

SEM Go Live

Recovery of incurred **Project Capex:**

- SEM Programme (Implementation)
- SMO Establishment
- Market Trial

No forward looking Capex Provision in allowances

During 2007/2008

MSDP covering SEM Day 1+ activites upto Jan. 2009 - Approved by SMEC

Capex Approved totalling €10.7m (2007 monies)

2008/2009 Revenues

As Day 1+ had started the RAs included the full value of the project in the SEMO RAB in setting the 2008/2009 revenues

2009/20010 Revenue

Release Capex and Predictable Capex totalling €1.95m (2010 Monies) included in the decision

During 2009/2010

Additional Capex was approved by the SEMC for the SEMO Website project. c.€0.57m (2010 monies)

Resulting in the outturn Capex amount approved for 2009/2010 of €2.6m (2010 monies)

PC 2010-2013

Bi-Annual IT Market Release Support Capex; Predictable Business Capex; and Unpredictable Business Capex totalling €11.18m (2009 Monies) included in decision

Biannual IT Market Release capex (2010-2013)

While Bi-Annual IT Market Release Support Capex was included in the baseline provision. Bi-Annual Release Capex which allowed SEMO to deliver market modifications, non Trading and Settlement Code changes, system defects and operational efficiencies was determined as the scope for the releases became known.

During 2010-2013 c.€7m (2013 monies) of capex was provided for this purpose.

Intraday Trading (2012)

In 2012 SEMO's scope expanded to include Intraday Trading

The capex provision (to SEMO) for this project was €7.8m (2012 monies).

Appendix 2: Capital Requirement

The table below details the cost breakdown of the six Capital Investment areas outlined in Section 2.

Categories of Capital Requirement	Business Case Num.	Total
Application / System Development Capital	1	€8,185,267
Ongoing Project Support Capital	2, 3	€5,742,898
Market System Infrastructure Capital	4, 5	€1,400,413
Market Service Resilience	6, 7	€2,824,563
Market Operational Support Capital	8, 9	€975,000
Participant / Regulatory Support Capital	10, 11	€600,000
Total		**€19,728,141**

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