SEM Capital Investment

Market System 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. This document reflects the feedback received from the regulatory authorities and stakeholders via public consultation.

Table of Contents

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.

Following industry consultation, which ran from 4 September 2020 to 15 October 2020, SEMO has identified six (6) 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.

Five projects were removed from the MSDP as part of the post-consultation review process and RA feedback under SEM-21-006. These are the Market Monitoring Systems, Participant Urgent Communications, Website Development, Compliance Management and Market Analysis Tools projects. More information on this decision, and feedback received from stakeholders during the consultation, is detailed in the MSDP Post-Consultation Report on the SEMO website.

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 six 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.

Post Consultation Note: There has been some changes to the projects outlined in the MSDP when compared to those included in the consultation. The projects outlined in this MSDP report for 2019-2021 have been updated to reflect those included as part of the SEM Committee's decision paper SEM-21-006 on SEMO's Capital Expenditure 2018 – 2021.

1. Introduction

SONI and EirGrid, in their capacity as licenced Market Operators, are required to produce a Market System 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 six (6) 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

[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.

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 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 had 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.

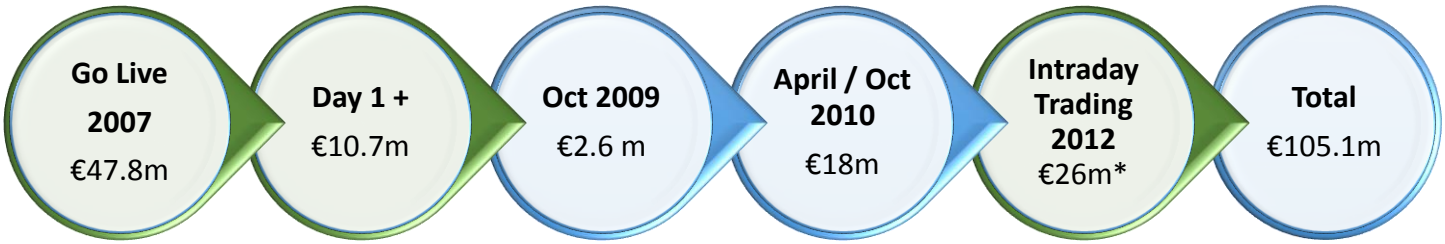


Figure 1- SEM Capital Investment – Project Implementation through to 2012[2]

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

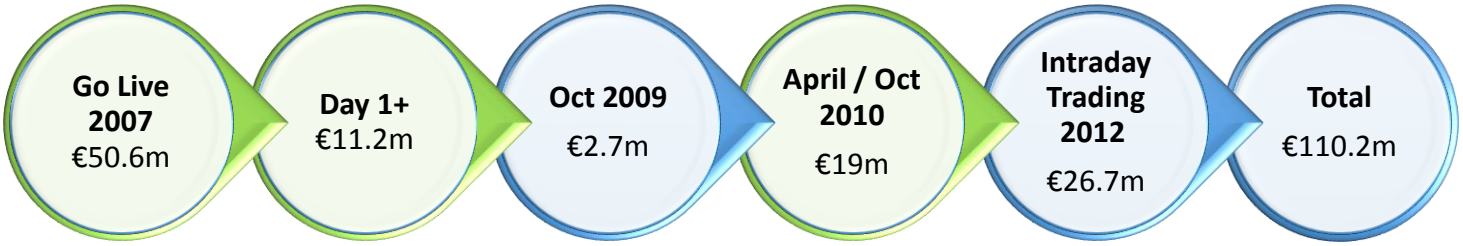


Figure 2 – SEM Capital Investment - Project Implementation through to 2012 in 2019 terms

[2] 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

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 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.

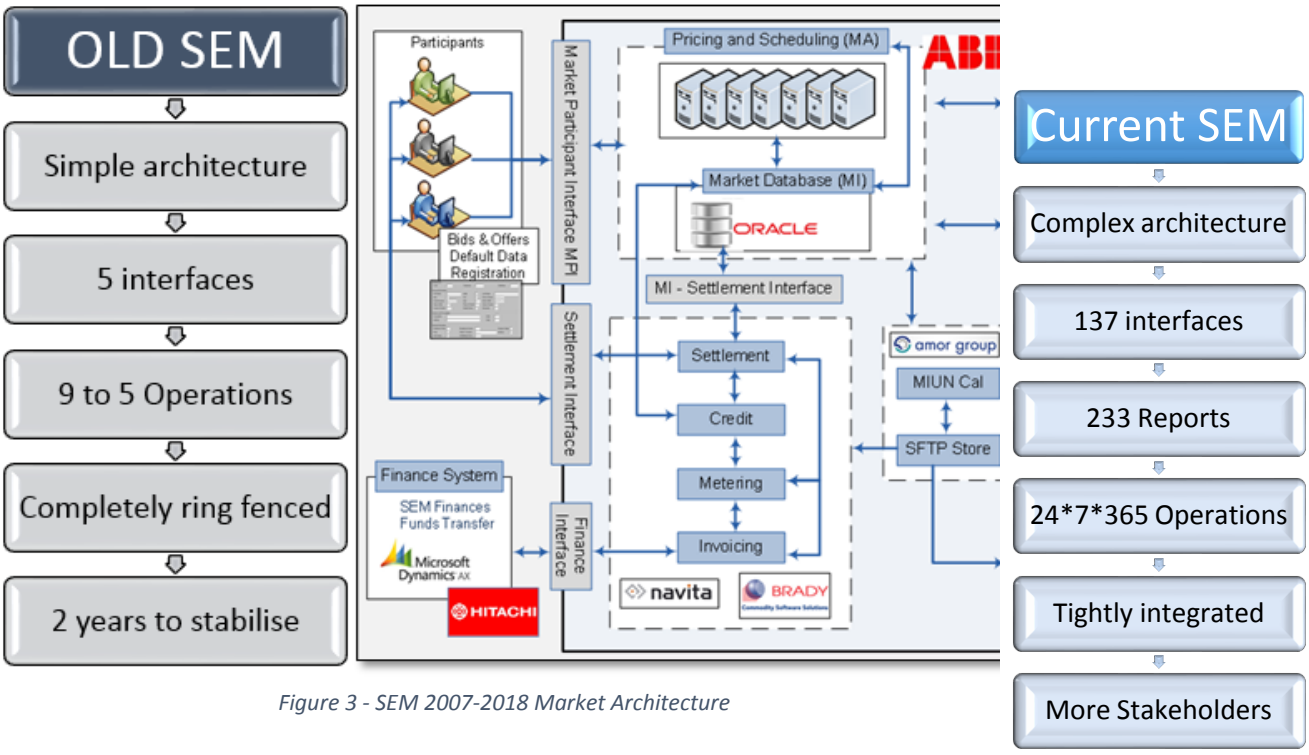


Figure 3 - SEM 2007-2018 Market Architecture

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.

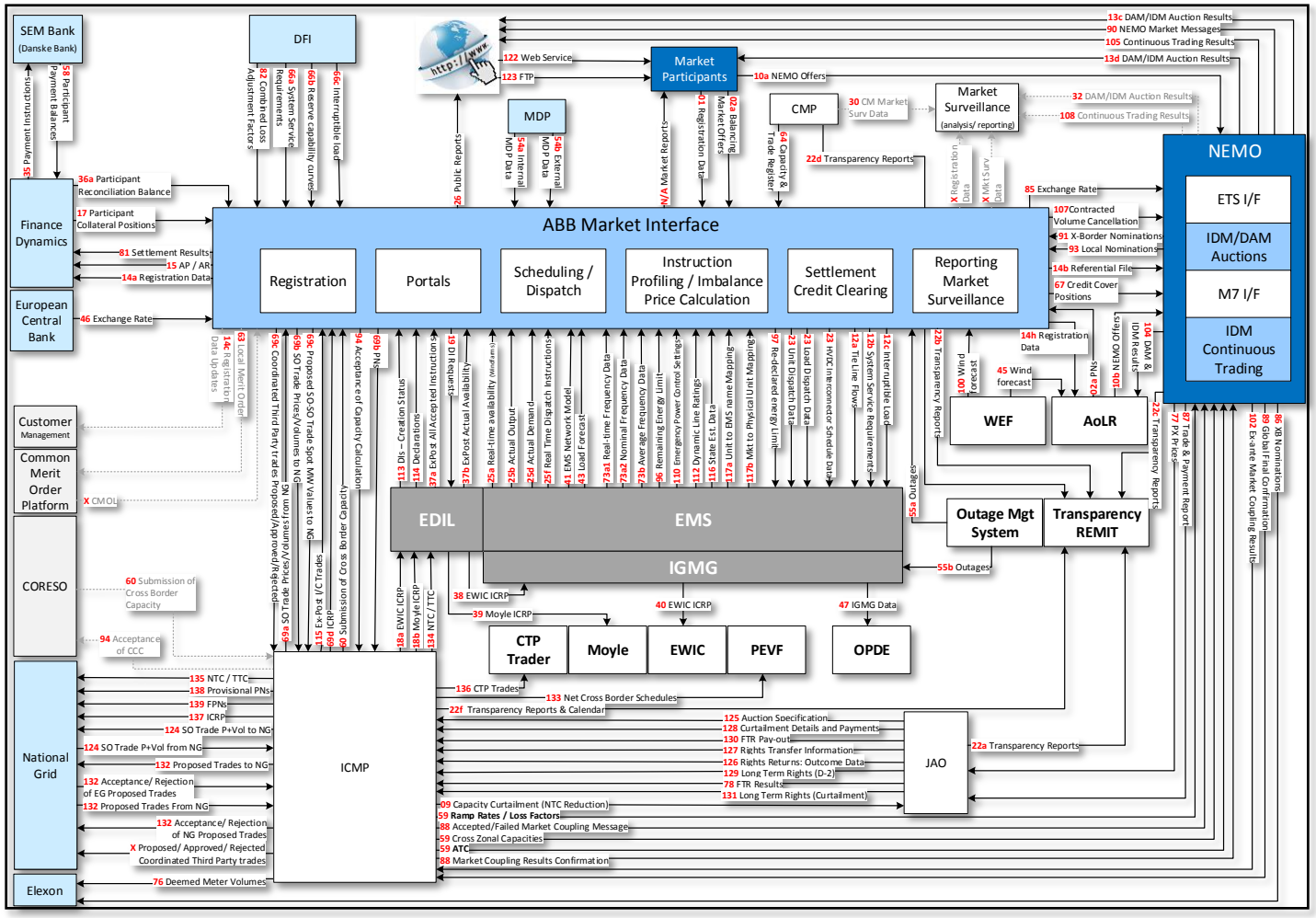


Figure 4 – Current SEM Application Architecture

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

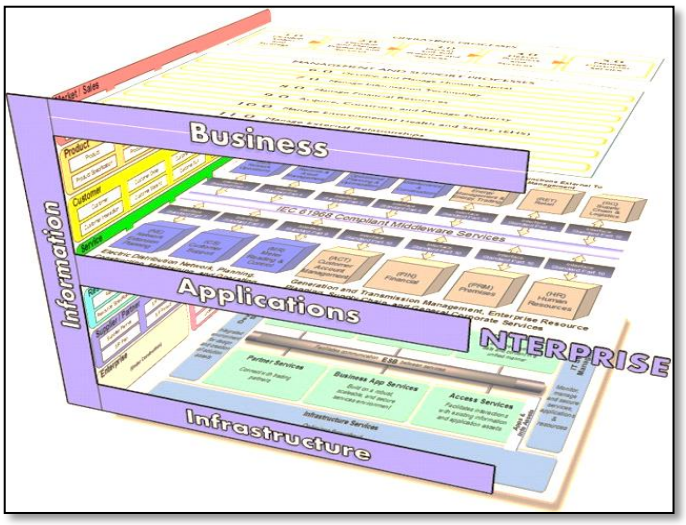
- To support delivery of continuous high quality market system releases
- To secure market critical third party vendor resources
- To support the market analysis needs in order to respond Regulatory Authority Market Monitoring Unit (MMU) queries in a timely fashion
- To support re-pricing and resettlement 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[3].

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)
Market System Infrastructure Capital	4. Market System Data Archiving
	5. Additional Market Environments
Market Service Resilience	6. MMS Performance Enhancements

Table 1- Capital Investment Areas and corresponding business cases

[3] 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

3. Business Cases

The following section contains the description of business cases for the six 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

Business
Applications
Infrastructure
Information

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.

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 augmentations required to existing functionality
- Additional business and Participant change requests that needed to be accommodated
- SEMC approved changes that were postponed until post Go-Live
- Multiple regulatory approved market modifications to that impact SEMO systems:
    - Trading & Settlement Code and Agreed Procedures
    - Capacity Market Code and Agreed Procedures which impact Settlement
    - SEMOpx modifications
    - Aggregator of Last Resort (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.

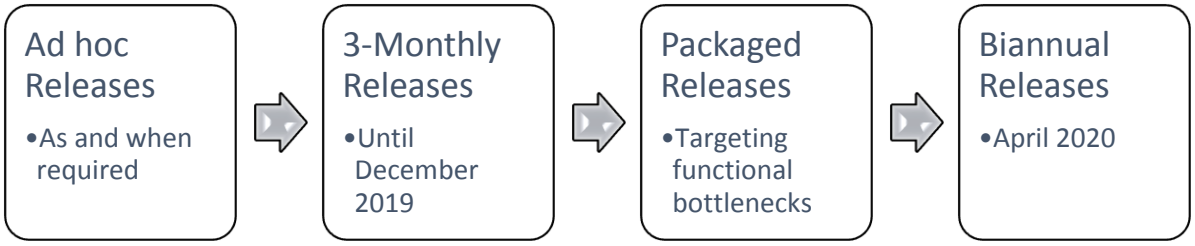


Figure 6 - Release Types and frequency

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.

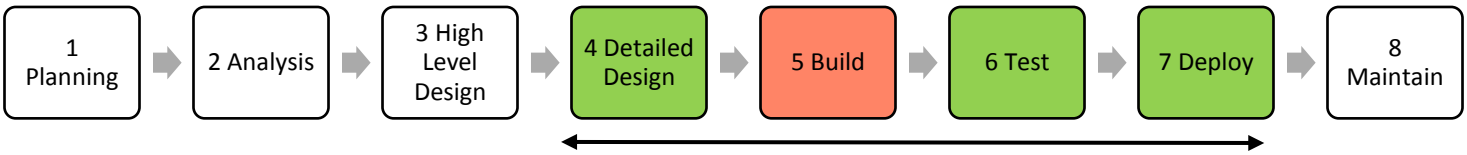


Figure 7 - Rapid Systems Development SDLC Lifecycle (6 to 10 weeks)

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.

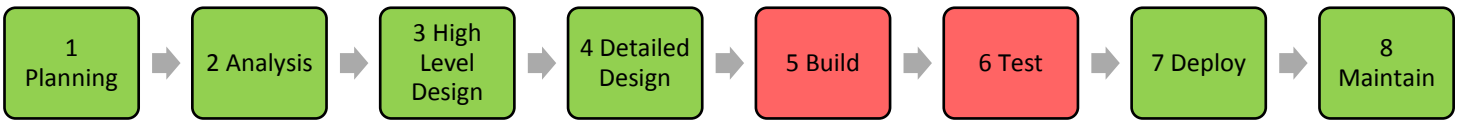


Figure 8 - Biannual Release Development SDLC Lifecycle (13 Months)

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.

Deliverables

The project delivered the following releases as detailed in the table below. There were four specific releases during the period 15 Oct 2019, 3 Dec 2019,28 April 2020 and 3 November 2020. A further 2 releases areplanned for June 2021 and Q4 2021.

Release	Number of Defects	Change Request	Date of Deployment
D MMS (1.1.9) MMS (1.1.9.1)	51 5	• CR 73 Removal of Make-Whole Payments for biased quantities and negative imbalance revenue • CR 77: Amendment to No Load Cost equation to correct TSC error (and vs or), also requires Modification to TSC	15 Oct 2019 & 03 Dec 2019
E MMS(1.1.10) CR94 (1.1.10.2) MMS (1.1.10.1) MMS(1.1.10.3)	41 2 20 1	• CR-094_Automatic Export Of Scheduling Outputs • CR-076_Amendment to Uninstructed Imbalance Charge (CUNIMB) to correct for negative price scenarios	28-Apr-20
F To be advised around deployment by ABB	94	• CR 120 Exclusion of Dispatchable Priority Dispatch Unit Prices from Pricing • Setting System Operator Flags to zero for the purposes of Settlement • Application of Loss Factors for Interconnectors in Settlement • DSU State Aid Compliance Interim Approach	03 Nov 2020
G	TBA		Schedule June 2021
H	TBA		Q4 2021

Benefits

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

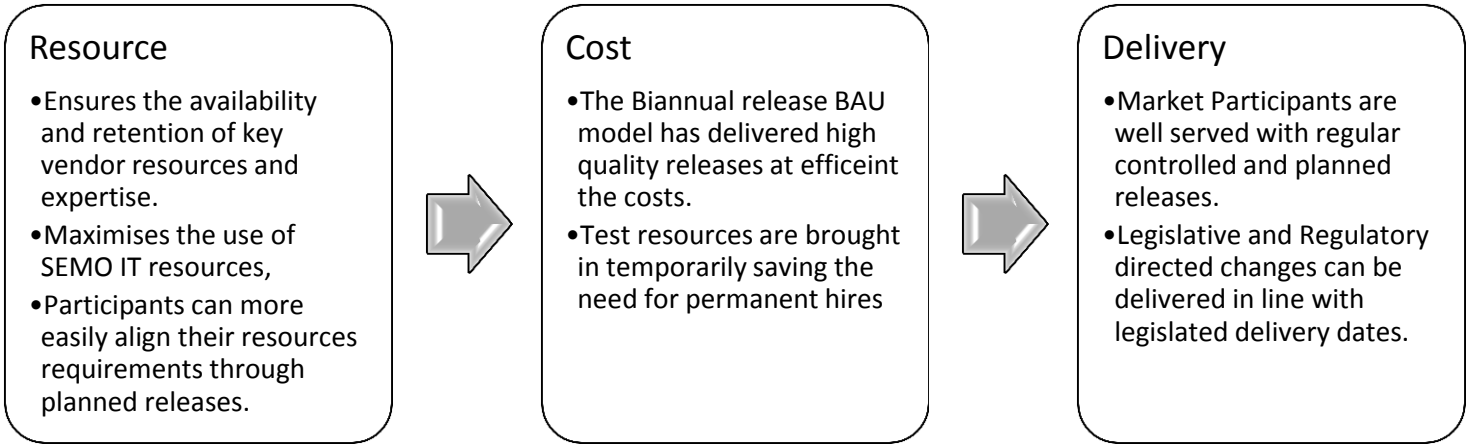


Figure 9 - Business benefits of Vendor Support & moving to a Regular Release Strategy

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:

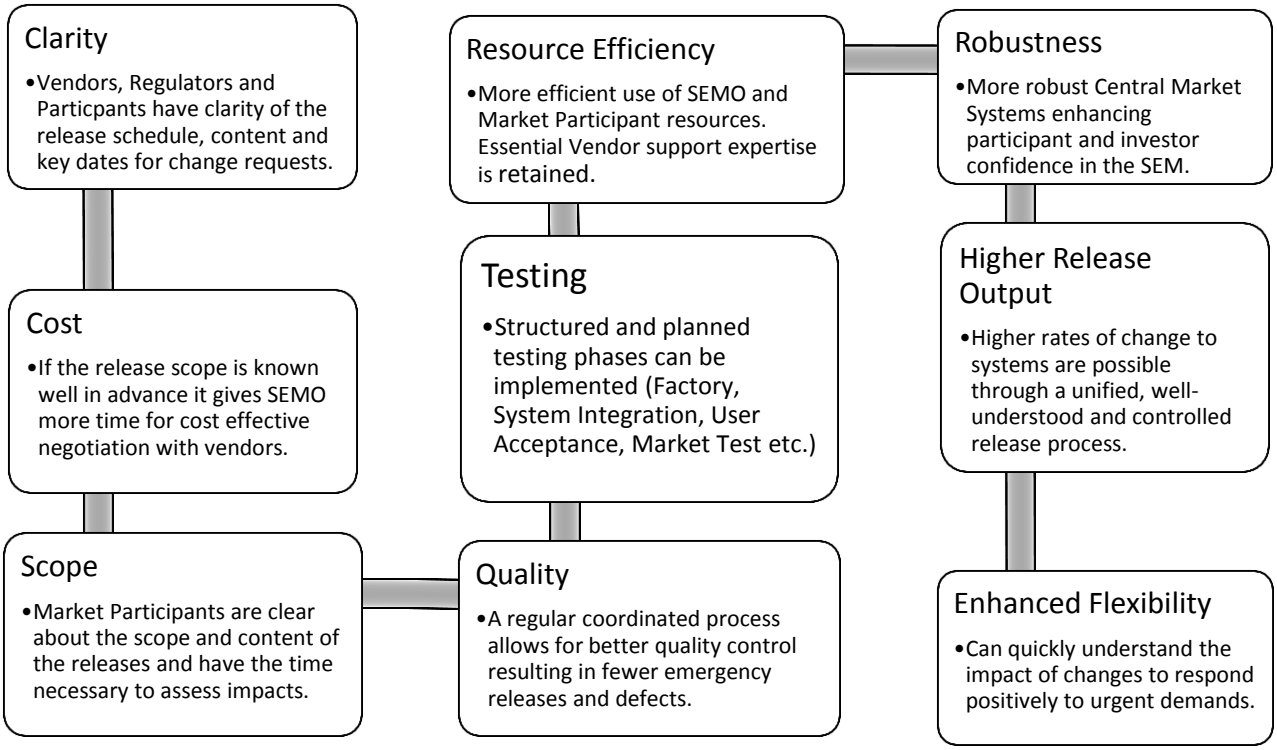


Figure 10 - The benefits of a stable and consistent vendor release strategy

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:

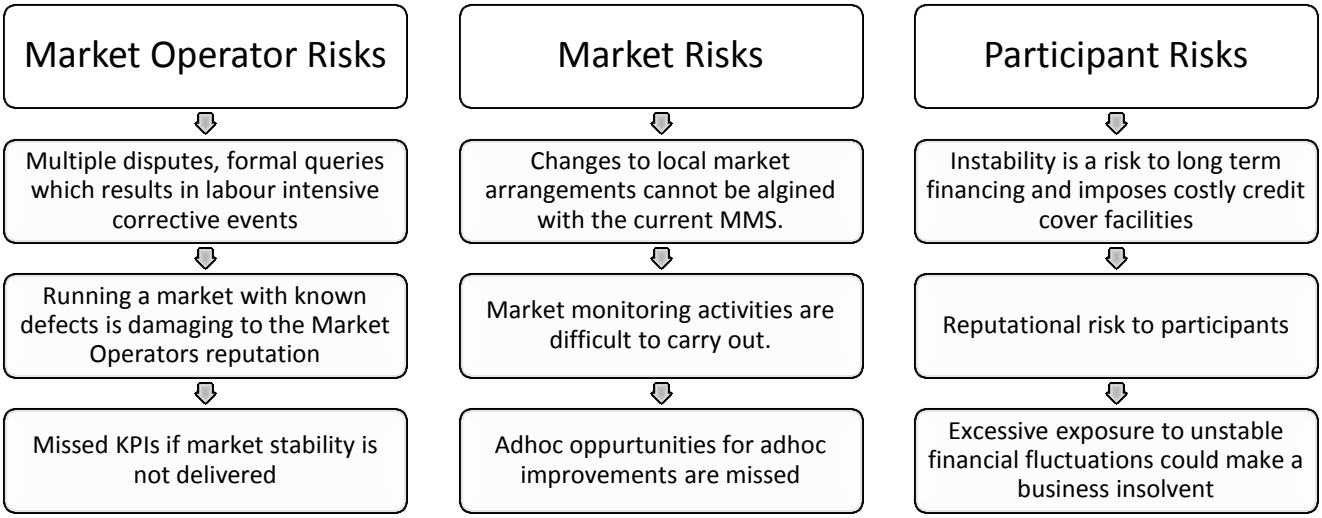


Figure 11 - Risks to the various parties of not having releases

2. Release Support Capital

Business

Applications

Infrastructure

Information

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.

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.

Deliverables 2018-2020

The project supported the following releases as detailed in the table below. Note that there were additional CSB (Counterparty Settlement Billing) defects but these have not been included as they are covered by the Settlement Support and Resettlement project. There were four specific releases during the period 15 Oct 2019, 3 Dec 2019,28 April 2020 and 3 November 2020.

Release	Number of Defects	Change Request	Date of Deployment

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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.

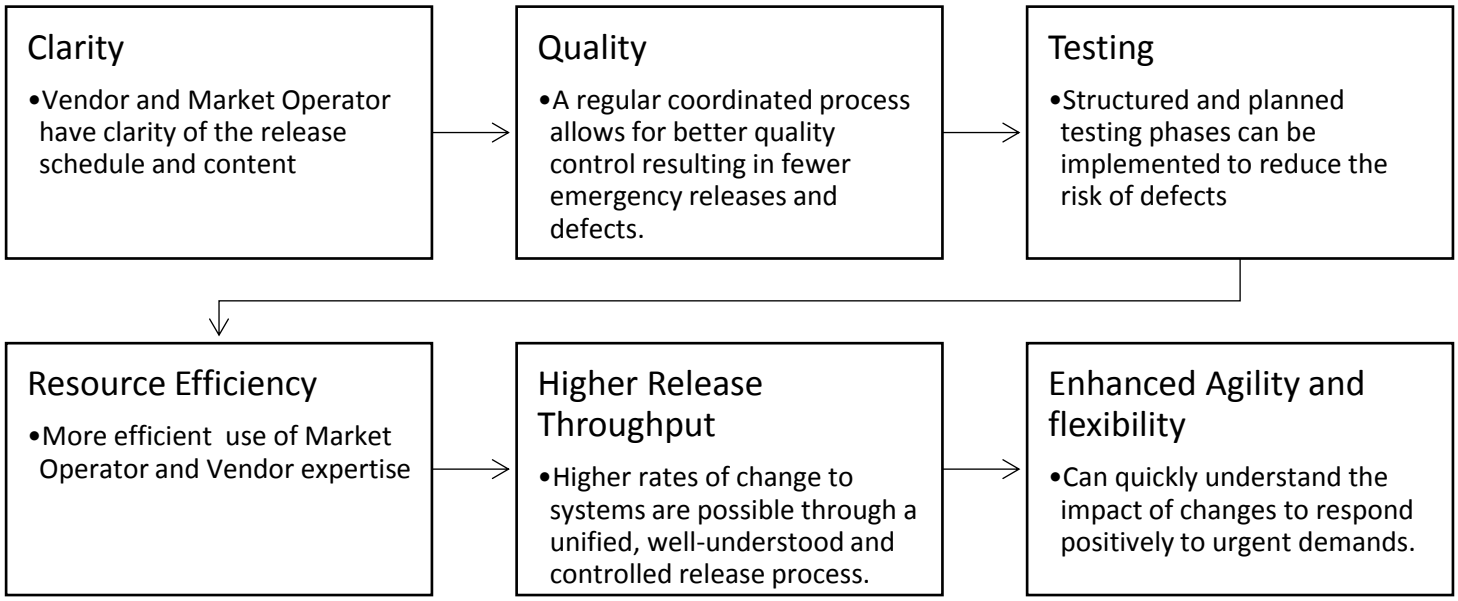


Figure 12 - Change Management

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.

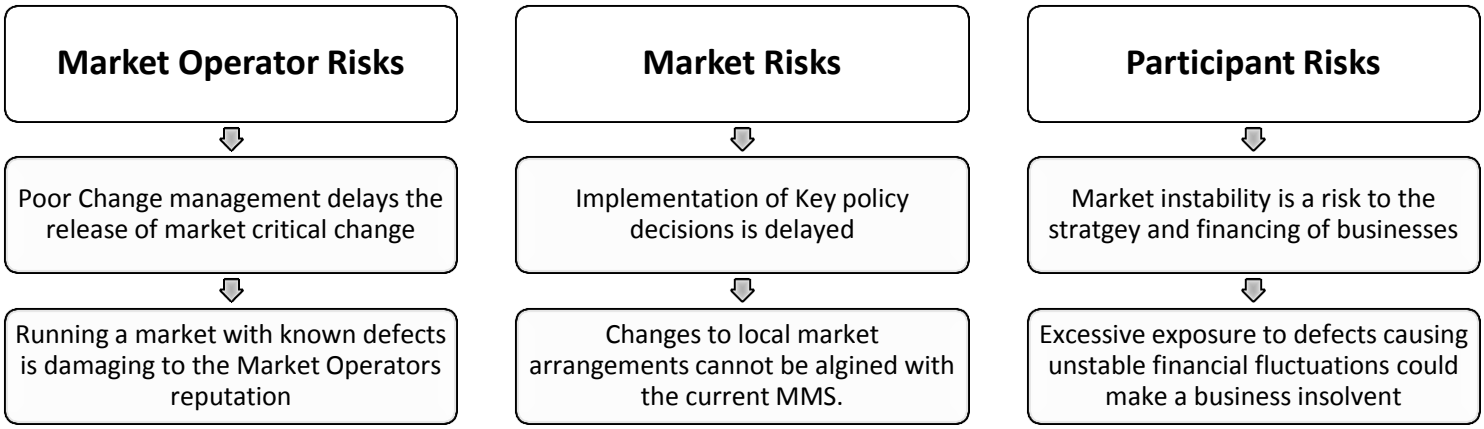


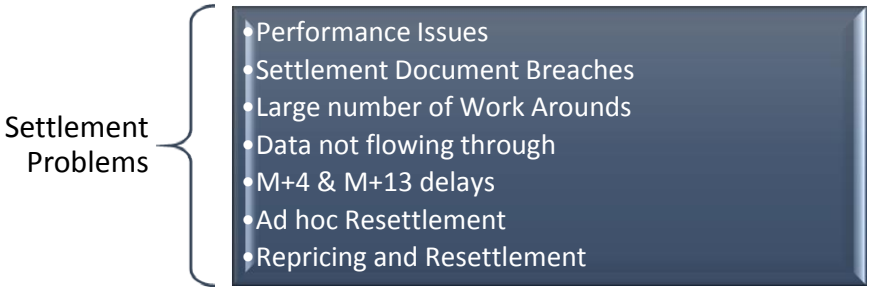
Figure 13 - Risks by type

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

Business
Applications
Infrastructure
Information

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 were on a trajectory to resolution, the following issues were still being experienced after Go-Live:



Initial Settlement Problems

There was a number of complex manual work-arounds in place which were impacting settlement timelines. Settlement activities which should have been a 9 to 5 activity required extended working days and significant weekend work. SEMO was and still is dependent on key internal resources and retained I-SEM Project and external vendor resources to support the settlement activities.

Re-Settlement

As set out above there had been challenges in delivering Initial Settlement services. This in turn meant that the capability to deliver the required M+4, M+13 and ad-hoc resettlements activities were severely impacted. A dedicated M+4 settlements team was put in place to deliver M+4 scheduled settlements pending defect fixes. Analysis work was required to resettle a large number of participants with component charges over a period of significant defects and the ongoing defects required 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 had never experienced this level and scale of Disputes and Formal Queries with 96 Disputes and 480 Formal Queries to 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 was insufficient to properly investigate and analyse disputes and formal queries. General Queries also added to the Settlement staff workload which was stretched significantly beyond its capability to deliver.

Settlement Statements

The focus had been on getting Settlement statements issued, as a result, it was necessary for the settlement team to develop, document and implement manual checks in the work procedures. These

were and continue to be onerous and time consuming tasks 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 were required (and still are in a small number of cases) 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 were required to support staff.

Settlement Releases

There were defects within all aspects of the system MMS and CSB that required workarounds and manual intervention. These workarounds are labour intensive. Additional resources were 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

The additional time limited project support provided the following benefits:

- Abillity to produce accurate timelines 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
- Made Settlements Operations more efficient through the automation of manual steps and targeted investment toward settlement bottlenecks and known settlement exceptions
- Facilitated the transfer of essential knowledge from the Project Team to internal subject matter experts
- Additional environments allows improved 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.

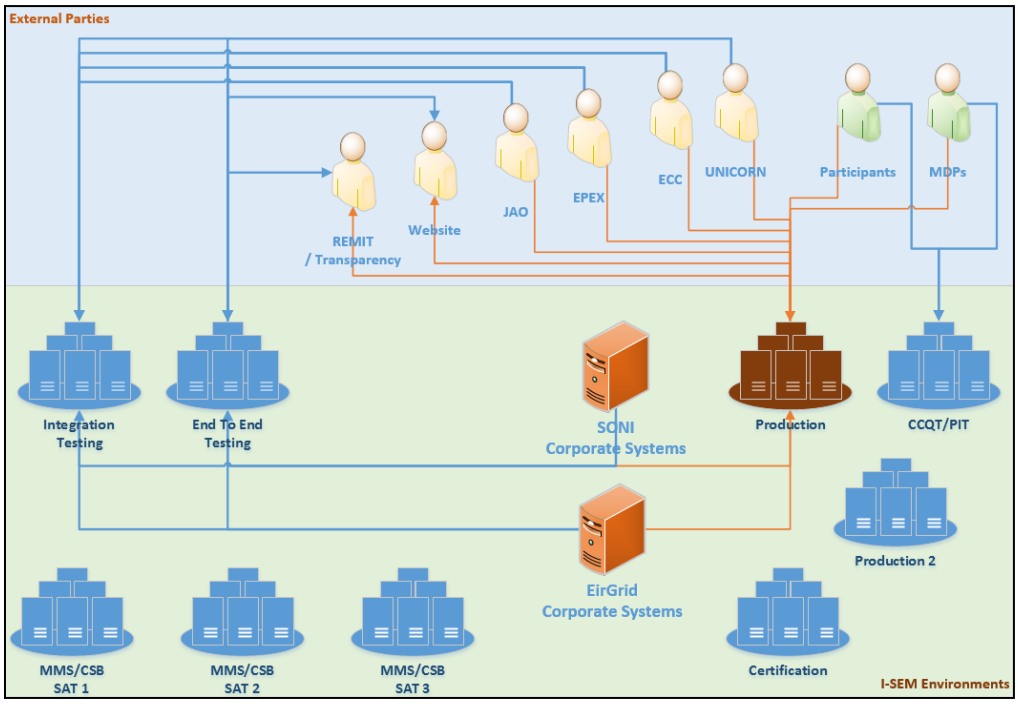


Figure 14 - MMS/CSB Environments

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.
    - 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:
    - 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.
    - Participant training

- **P2 Environment**
    - 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.
    - 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. MMS Performance Enhancements

Business
Applications
Infrastructure
Information

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.

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.

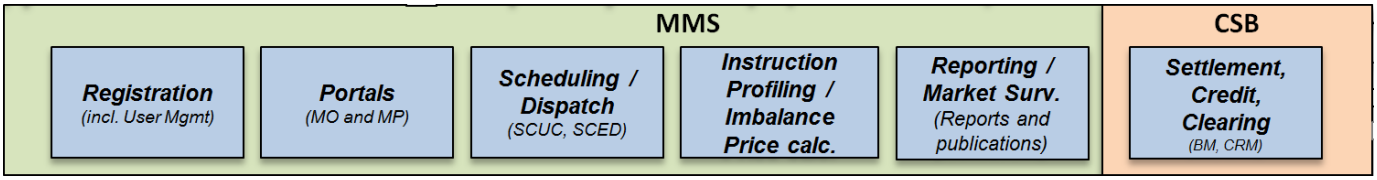


Figure 15 - MMS/CSB system

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

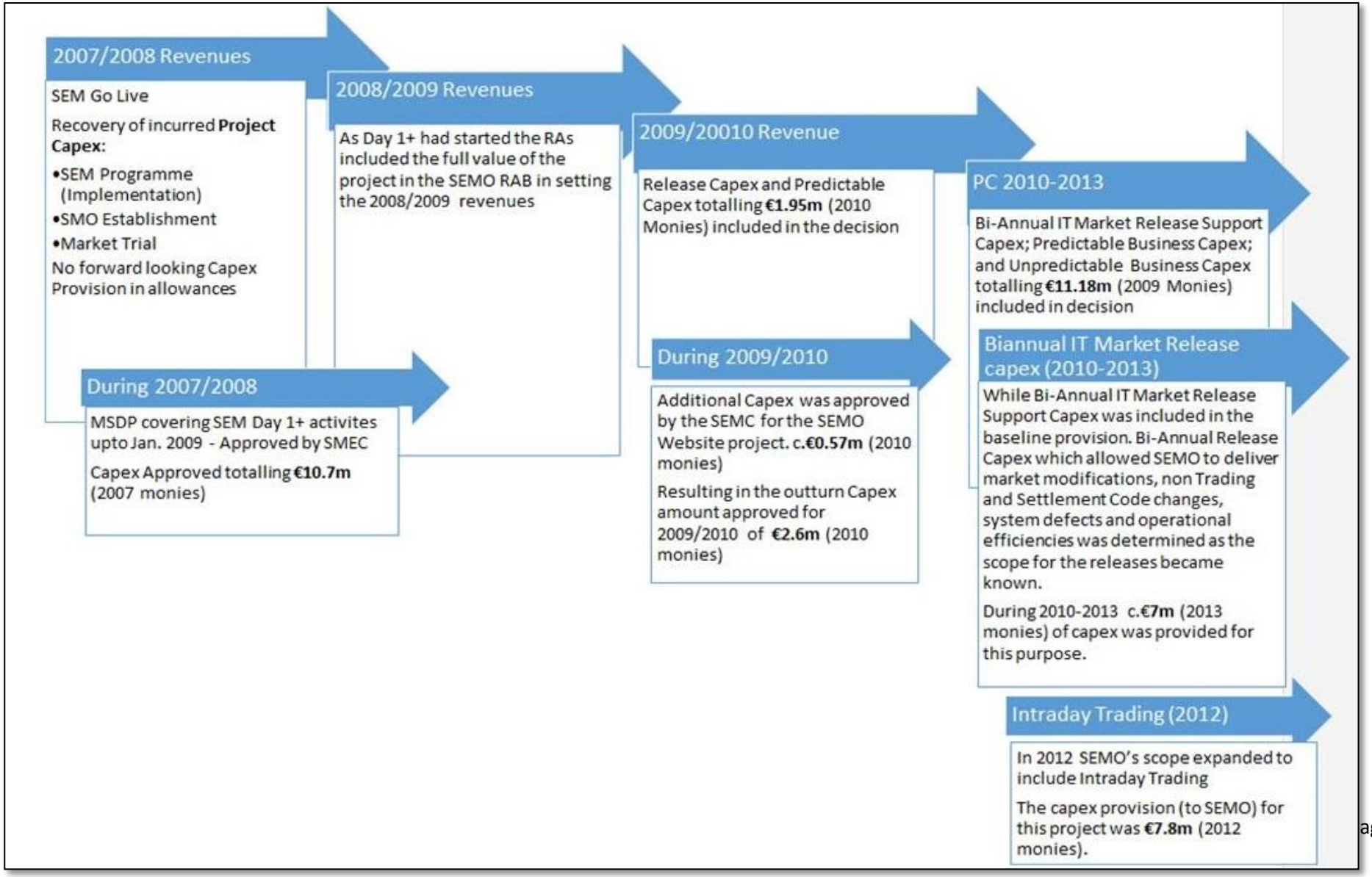
The MMS contains a number of key market functions including Registration, Scheduling / Dispatch, Instruction Profiling / Imbalance Price Calculation and Reporting.

- **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 16 -Scheduling Applications

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



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	€6,364,000
Ongoing Project Support Capital	2, 3	€4,086,000
Market System Infrastructure Capital	4, 5	€1,271,000
Market Service Resilience	6	€526,000
Total		**€12,247,000**

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