Report on	NIE - Consultation on Facilitation Of Energy Storage Services (FESS)
Date of Meeting	5th July 2021
Reporting Officer	Mark Kelso, Director of Public Health & Infrastructure

Is this report restricted for confidential business? If 'Yes', confirm below the exempt information category relied upon	Yes	
	No	X

1.0	**Purpose of Report**
1.1	The purpose of this report is to provide Members with information on the recent consultation launched by Northern Ireland Electricity (NIE) on the Facilitation Of Energy Storage Services. The consultation was launched on 4th June and must be responded to Friday 16th July 202.
2.0	**Background**
	<u>**Background to the Consultation Document**</u>
2.1	NIE have indicated that the increased connection of generation and low carbon technologies on the distribution network has presented significant challenges to NIE Networks. They are experiencing thermal constraints due to power flows at times of peak demand, voltage constraints due to renewable generation, and an unpredictability of load and generation due to the intermittent nature of renewable generation and Low Carbon Technologies (LCT).
2.2	Energy storage can absorb energy at times of high generation and low demand, and release energy at times of peak demand. Customers offering Energy Storage Services (ESS) therefore have the potential of deferring network reinforcement and accommodating the connection of further demand or generation which would otherwise be constrained by thermal capacity. Energy Storage Services (ESS) can also play in the System Services market helping to balance demand and generation.
2.3	The NIE FESS project will set the framework to enable the integration of customer owned Energy Storage Services (ESS) to the Northern Ireland network. The consultation seeks to identify potential barriers and the mechanisms that may need to be put in place to facilitate the deployment of energy storage on the network and identify opportunities where Energy Storage Services (ESS) could provide wider customer benefits.

3.0	Main Report
	NIE - FESS Consultation – The Challenges
3.1	Along with many network operators across the globe, Northern Ireland Electricity (NIE) Networks is facing challenges with the increased penetration of intermittent renewable generation, as well as changes in customer behaviour in response to the uptake of Low Carbon Technologies (LCT).
3.2	For NIE Networks these changes are manifesting themselves as constraint challenges on the distribution network – largely thermal constraints, but also challenges around maintaining voltages within statutory limits. NIE Networks recognises that electricity storage can be a means of alleviating network constraints and facilitating the connection of distributed generation and other Low Carbon Technologies (LCT).
3.3	The aims of the NIE Facilitation of Energy Storage Services (FESS) project are to: • Overcome barriers which may exist to electricity storage deployment in Northern Ireland • Explore the potential for NIE Networks to procure network services from storage, and • Make the necessary changes and recommendations to facilitate this deployment.
3.4	The NIE - FESS project has been running since May 2020. Activities to date include: • A technology assessment for electricity storage • A market evaluation survey to gauge the current levels and appetite for participation in energy storage markets and gather feedback on barriers to storage in Northern Ireland (NI) • Network constraints analysis and assessment of storage benefits against conventional reinforcement • Development of potential Use Cases for distribution connected storage in NI • Identification of barriers to deployment of storage in Northern Ireland. The FESS project is currently developing solutions to the barriers identified to storage in Northern Ireland (NI) that are within the remit of NIE Networks; this is the focus of the consultation paper.
	Draft Response to the Consultation Document
3.5	Members will note a copy of the Consultation Document is attached at Appendix 1. The Document is highly technical in nature and has not been drafted with a view to being either user friendly or totally transparent in what NIE are seeking to progress through this process. The general context of the document assumes that the reader has a detailed understanding of the NIE supply and distribution systems and the means by which that supply is provided.

3.6 By way of context Northern Ireland (NI) has sought to promote the Green Energy Agenda and is proposing a minimum of 70% of all energy generation through renewable means by 2030. The very nature of the Green Agenda creates difficulties for the NIE supply network in that the power generation from renewables in the Upper Sperrins and West of the Province is a significant distance from other areas of concentrated population and demand. This creates significant technical issues in maintaining a balance in the power supply grid across NI which it is believed has driven the process and demand for Energy Storage Services. Mid Ulster District Council are committed to supporting the wider climate change agenda and promoting green energy as part of the wider low carbon economy. A number of factors arise from the Consultation Document and in no particular order are identified as follows:

1. **Protection of the NIE supply Network**

   As outlined the proliferation of wind farms particularly in the Upper Sperrins and West of the Province, while meeting NIEs green energy targets has created its own particular problems in the balance across the NI power supply grid. It is noteworthy that new entrants with wind turbine or solar farms have been required to pay sizeable costs to NIE to divert the power input to a less congested section of the power supply and distribution network. It should be noted that despite levying these costs to individual contributors the overall cost of NIE supply to the consumer remains one of the highest per unit rating in the UK if not in Europe despite us having in excess of 50% renewable energy supply i.e. no direct generation costs being incurred by the provider.

   It is recognised that the network requires reinforcement and strengthening as new demands arise, and industry and commerce demand more supply, as part of a growing economy and that storage systems of various size and nature will become a more common feature. However, the use of storage systems should not be seen as a mechanism for not providing new distribution lines or increased capacity across the distribution network by NIE themselves. As a statutory utility NIE should in the first instance secure and strengthen the network as part of their normal business.

2. **Cost of Provision**

   It is noted in the Consultation Document that no reference is made to how these enhancements and reinforcements of the network supply will be costed or paid for. Reference is made to the technological mechanisms by which the need for an energy storage service may be identified but no indication is given of who will be paying for the provision of same. The development of large scale wind farms across NI was promoted by Government and encouraged and continues to be incentivised by the use of ROC payments. NIE should ensure that the cost of provision of any storage system network is addressed within existing structural costs and in the first instance should be levied at those large owners of wind farms who are already benefitting from a subsidised system along with any unit cost they attract by supplying power to the grid. The promotion of sustainable development and addressing the requirements of the Green Economy should not be used as a vehicle for attributing further costs to the individual domestic or commercial customer.

3. **Location of specific requirements**

The Consultation Document makes no reference as to where the Energy Storage Systems will be required to be deployed despite detailed analysis carried out by the NIE FESS team (as referenced in paragraph 2.4 in Appendix 1). It would appear that the total lack of transparency in this conversation should be addressed as a matter of some urgency. In responding to this consultation Council should formally request a presentation from NIE senior management on current NIE pressures and the mechanisms by which they will plan to address same over forthcoming years.

The Consultation Document would benefit greatly from having regional and sub-regional maps identifying areas of pressure on the network and any constraints that may have arisen. It would also help with the prioritisation of where such systems may be required in the next 3-5 years to ensure continuity of supply.

The increased emphasis being placed on the use of electric powered vehicles and government promotion of electric heat pumps to divert customers away from carbon based transport and heating systems will place an increased burden on the supply network and on the potential costs arising from same.

The Consultation Document makes no reference to the potential use of Energy Storage Services as a means of reducing operational costs for both domestic and commercial users. It is well noted that the energy costs during night-time hours are significantly less than those during peak business hours and as such more users may wish to explore the technological options which may be presented by the use of Energy Storage Services. Unfortunately the Consultation Document does not explore this or set out any mechanisms by which customers potentially could make use of such arrangements.

4. **Planning and Environmental Constraints**

The technology which has been referenced for Energy Storage Services has seen rapid development in recent years and the UK Government estimates technologies like battery storage systems which support the integration of more low carbon heat and transport technologies could save the UK Energy Network up to £40 billion by 2050 and assist in reducing people’s energy bills.

	The UK energy provider AIG (see Appendix 2) goes on to make reference to the fact that there are 3 principle technologies being looked at presently for energy storage, these include: • Compressed Air - storage systems • Mechanical Gravity - storage systems • Flow Batteries The most common mechanism now being widely looked at is the technological systems focused around Battery Energy Storage Systems. There are currently 5 types of Battery Energy Storage Systems in place : • Lithium-ion which are widely used across consumer devices and electronics • Lead acid – these are the traditional rechargeable batteries used in vehicles • Sodium Sulphur – used in some renewable sources such as solar or wind • Zinc Bromine – uses includes solar and wind • Flow Batteries – large rechargeable fuel cells similar in principle to Lead acid type batteries. The Consultation Document makes no reference to the mechanisms by which these systems are assessed and scrutinised or rolled out as part of this FESS consultation. It should be noted that some concerns have been raised regarding the use of large battery storage systems and the issues arising from same in the event of fire or damage to same. It is also noted that the planned roll out of these systems will require detailed analysis at the planning stage and as such will require full detailed assessments on how they can be safely managed and utilised. To this end Council would wish to receive further information from NIE on the technologies which it is purporting to promote as part of the consultation on FESS and the mechanisms by which any potential environmental or safety concerns can be addressed.
3.7	If Members are in general agreement with the comments in this report, the consultation response will be sent to NIE and its Management Board. The full Consultation Document and associated information guides are attached.
4.0	**Other Considerations**
4.1	**Financial, Human Resources & Risk Implications**
	Financial: N/a
	Human: N/a
	Risk Management: N/a

4.2	**Screening & Impact Assessments**
	Equality & Good Relations Implications: N/a
	Rural Needs Implications: N/a
5.0	**Recommendation(s)**
5.1	That members note the content of this paper and agree the draft consultation response to NIE for the ‘ Facilitation of Energy Storage Services ‘ and request a presentation from NIE Senior Officers on the current network and issues arising at a future meeting.
6.0	**Documents Attached & References**
6.1 6.2 6.3	Appendix 1 – Facilitation Of Energy Storage Services (FESS) Consultation Appendix 2 – AIG Lithium Energy Storage System Appendix 3 – National Grid – what is battery storage

FACILITATION OF ENERGY STORAGE SERVICES (FESS)

Consultation

04/06/2021

Contents

1. EXECUTIVE SUMMARY

The Facilitation of Energy Storage Services (FESS) project is seeking to identify and remove any barriers that exist to customers deploying energy storage devices on the Northern Ireland distribution network. This consultation paper is the second stakeholder engagement exercise that NIE Networks is undertaking as part of the project. The market survey, undertaken in summer 2020, was the first stakeholder engagement activity, which sought to gather wider feedback from parties engaged with electricity storage technologies. The results of the market survey were taken into account when undertaking subsequent activities in the FESS project around identifying barriers to distribution connected storage in Northern Ireland (NI) and proposing solutions to those barriers.

This paper puts forward a more focused set of questions that aim to gauge stakeholders' opinion of the specific solutions put forward in the FESS programme of work and of the FESS project as a whole. NIE Networks invite interested parties to respond to this consultation, which will be open to respondents until 4pm on Friday 16th July 2021.

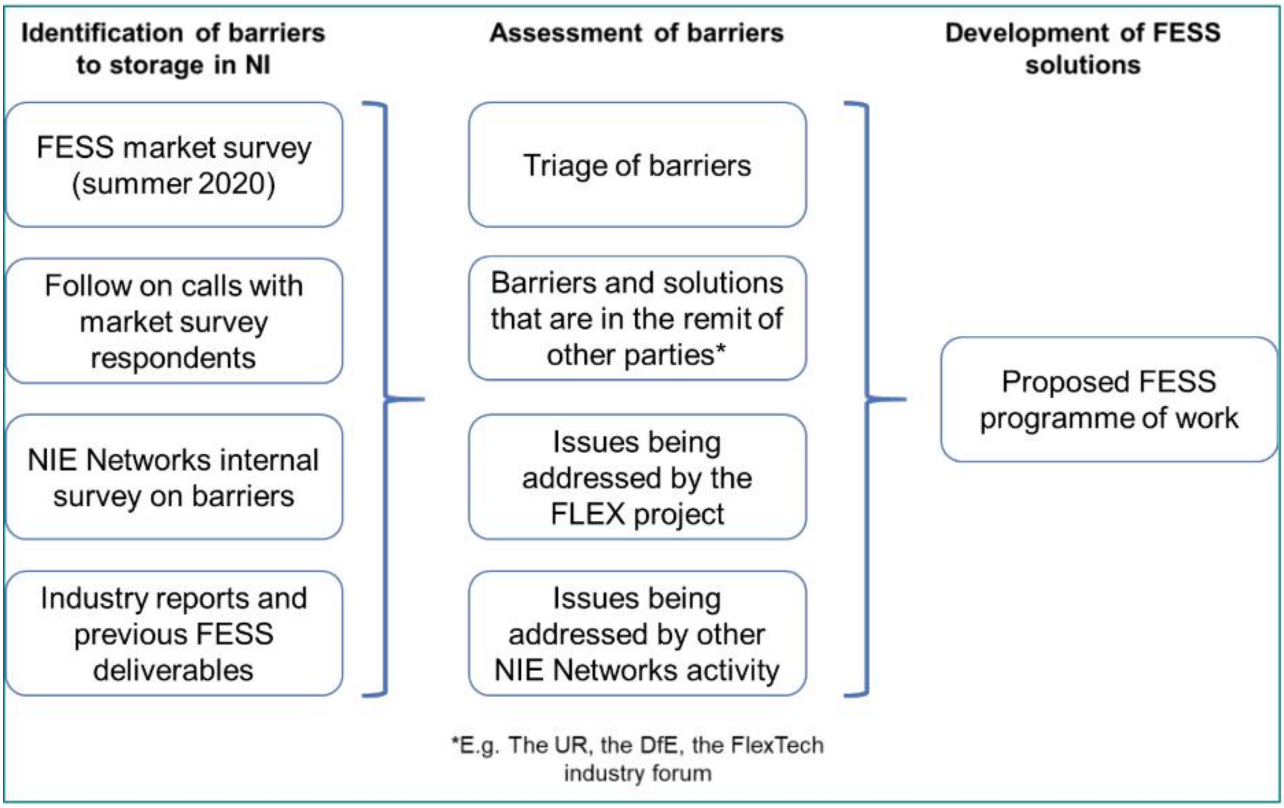
Electricity storage can be beneficial for network stability, for unlocking additional capacity on the network and for increasing the utilisation of renewable energy. The FESS project established potential use cases for electricity storage on the NIE Networks distribution network. Two broad categories of use cases for storage that are relevant for NIE Networks were identified:[1]

- Addressing network constraints - storage can address voltage, thermal and security of supply constraints that occur on the network due to high loads or excess generation.
- Facilitation of generator connections – storage can manage exports to within network limits and thus prevent costly reinforcement of the network.

A number of barriers to the deployment of electricity storage have been identified around industry codes and regulations, availability of information, commercial arrangements for procuring storage services and the grid connection and application process. However, not all the solutions to the identified barriers are within the remit of the FESS project and indeed NIE Networks. Some of the barriers fall within the remit of NIE Networks but are already within the scope of other internal projects and activity. Other solutions fall within the remit of government departments. Figure 1 shows the process used by the FESS project to identify barriers and subsequently progress solutions to the relevant barriers.

[1] Note that the use cases for storage identified for NIE Networks could not necessarily be implemented immediately, as the processes, charging arrangements etc. for procuring such services do not yet exist. The FESS use cases were about identifying ways in which distribution-connected customer owned storage could bring mutual benefit to both NIE Networks and customers.

FIGURE 1. PROCESS IN THE FESS PROJECT TO IDENTIFY BARRIERS AND SOLUTIONS



The solutions that are within the remit of NIE Networks but are not already part of business-as-usual activities or other projects form the proposed FESS programme of work. They involve:

- A review of the current structure of Use of System charges that are levied on storage facilities.
- Addressing barriers to connection. This includes drafting an internal policy document on storage connections and potentially considering prioritisation of storage connections where it could be beneficial to the distribution network.
- Improving provision of information for storage. This is likely to include a dedicated webpage for storage connections on the NIE Networks website. There will also be FESS stakeholder events later this year.
- Operational matters and other activities.

To respond to this consultation, please answer the questions in Section 4.5. Responses should be sent electronically to Josh.Watson@nienetworks.co.uk by 4pm on Friday 16th July 2021.

2. INTRODUCTION

2.1 Innovation at NIE Networks

NIE Networks is currently trialling six innovation projects in Northern Ireland. These are:

1. LV ANM - The Low Voltage Active Network Management (LV ANM) project will investigate how reconfiguring the network will provide additional capacity for Low Carbon Technologies (LCTs).
2. DRVC - By dynamically reducing network voltage, electrical demand can be reduced locally. The Demand Reduction through Voltage Conservation (DRVC) project will seek to manage network constraints.
3. FESS - The Facilitation of Energy Storage Services (FESS) will seek to identify and remove any barriers that exist to customers deploying energy storage devices such as batteries.
4. FLEX - This Demand Side Response (DSR) project will establish a DSO flexibility market.
5. SAM - Using real time thermal rating technology for plant and equipment, instead of a static nameplate rating approach, the Smart Asset Monitoring (SAM) project will seek to increase network headroom.
6. STATCOM - This project will actively manage network voltage through the installation of a static compensator on an 11kV circuit. This will accommodate further demand and micro-generation which would otherwise be constrained by voltage levels.

More information can be found on these projects on the NIE Networks website[2].

2.2 Background

Along with many network operators across the globe, Northern Ireland Electricity (NIE) Networks is facing challenges with the increased penetration of intermittent renewable generation, as well as changes in customer behaviour in response to the uptake of Low Carbon Technologies (LCT). For NIE Networks these changes are manifesting themselves as constraint challenges on the distribution network – largely thermal constraints, but also challenges around maintaining voltages within statutory limits. NIE Networks recognises that electricity storage can be a means of alleviating network constraints and facilitating the connection of distributed generation and other LCTs. The aims of the Facilitation of Energy Storage Services (FESS) project are to overcome barriers which may exist to electricity storage deployment in Northern Ireland, to explore the potential for NIE Networks to procure network services from storage, and to ultimately make changes and recommendations to enable this to happen.

The FESS project has been running since May 2020. Activities to date include:

- A technology assessment for electricity storage
- A market evaluation survey to gauge the current levels and appetite for participation in energy storage markets and gather feedback on barriers to storage in Northern Ireland (NI)
- Network constraints analysis and assessment of storage benefits against conventional reinforcement
- Development of potential Use Cases for distribution connected storage in NI
- Identification of barriers to deployment of storage in Northern Ireland

The FESS project is currently developing solutions to the barriers identified to storage in Northern Ireland (NI) that are within the remit of NIE Networks; this is the focus of this consultation paper.

[2] https://www.nienetworks.co.uk/future-networks/level2/our-innovation-projects

The remaining FESS activities are:

- Implementation of proposed solutions (following consultation feedback)
- Project dissemination events and close down report

2.3 Benefits of Electricity Storage

Electricity storage has the capability to provide a number of grid and network system services, including frequency response, voltage control, congestion relief, load shifting, reserve and black start. The potential benefits of electricity storage include:

- Contributing to the deployment of renewable generation to meet renewable energy targets in an efficient way;[3]
- Lower total cost of system services compared with fossil fuel generation;
- Lower emissions associated with system services compared with fossil fuel generation;
- Reduced curtailment of renewable generation;
- Provision of network services (e.g. reduce peak demand) to defer network reinforcement;
- Provision of balancing services – storage has relatively rapid response times; and
- Support to network reliability.

According to a study completed by Piclo[4] in April 2020, network savings are maximised by widescale deployment of distributed storage. A large, distributed asset base is required to maximise the benefits of flexibility, especially on the LV network.[5]

2.4 Purpose of this paper

The purpose of this consultation paper is to summarise:

- The Use Cases that have been identified by the FESS project and the barriers identified to storage in NI
- The proposed programme of work of the FESS project
- Other storage related activity in NI that is taking place outside of the FESS project

Responses to this consultation will be reviewed and considered for the implementation of solutions in the FESS project to address barriers to distribution connected storage. This will be followed by a stakeholder event for the storage community and other interested parties.

3. SUMMARY OF FESS ACTIVITY

3.1 Potential use of electricity storage connected to NIE Network’s system

Following the early activities of a technology assessment and market survey the FESS project developed potential use cases for distribution connected storage. These can be broadly categorised as addressing constraints on the network and facilitating the connection of generation.

[3] Energy Storage Ireland; Our Energy Storage Future: Recommendations for an All-Island Storage Roadmap; December 2019
[4] https://piclo.energy/publications/Central+Distr+Storage.pdf
[5] Low Voltage is defined in the NIE Networks Distribution Code as “A voltage not exceeding 250 volts”.

Note that the commercial and market arrangements for NIE Networks to procure these services do not exist currently. NIE Networks is exploring the procurement of flexibility services through its FLEX project.[6]

It is worth noting that these services are not unique to storage and could be provided by other customers. However, electricity storage is well-suited to provide these services and has therefore been investigated as part of the FESS project.

3.1.1 Addressing constraints on the network

Substation overload

The growth in electric vehicles and heat pumps could lead to overloads on substations and feeders. This constraint in capacity is likely to happen only during peak times. Electricity storage could be used to manage peak loads and keep the demand within the available capacity constraints, to defer or avoid network reinforcement.

EREC P2 Constraint

Engineering Recommendation (EREC) P2 is a distribution network planning standard, which sets out the minimum levels of security of supply for DNOs. NIE Networks currently uses EREC P2/6 (more on this in 4.3.2). EREC P2 uses a term “Group Demand”, which determines the minimum level of security of supply required for an area of the network. In situations where Group Demand has increased to such a level that security of supply requirements have increased, electricity storage could be connected to the primary substation or the feeder supplied by the primary substation to export to meet peak demand. The storage could discharge at times of peak demand so that the security of supply requirements are met.

Voltage constraints

Another role that electricity storage could play is in alleviating voltage constraints. Long rural feeders in particular may experience voltage constraints due to incremental growth in both generation and load. Generation is likely to cause high voltages and load is likely to cause low voltages. Storage facilities could be used to counteract voltage spikes and drops by exporting or drawing real and reactive power.

3.1.2 Facilitation of generator connections

EREC G99/NI Generation connections

In some cases the amount of generation a generator wishes to connect to a certain point in the network exceeds the network capacity to accept generation, for example due to generation export exceeding the thermal capacity of the substation. Storage could be used to manage the generation export. Storage would charge from the generation when there is no capacity to export to the network and discharge into the network when there is available capacity.

EREC G98/NI Generation connections (micro generation)

A high number of EREC G98/NI generation sources[7] connecting in one area has the potential to cause reverse power or thermal constraints at the secondary or primary substation. If reinforcement is required, the cost of the work will be borne by the NI customer through system charges, as these costs cannot be passed on to the individual G98/NI generation customer. A storage facility could charge to mitigate the constraint by increasing demand at times of peak generation or increasing overall minimum demand.

[6] https://www.nienetworks.co.uk/flexibility

[7] Generation up to and including 16 Amps per phase, i.e. up to 3.68 kW single-phase connected at 230 V or 11.04 kW three-phase connected at 400 V

Connection prioritisation for EREC G99/NI connections

Where there is more than one applicant for a connection at a given location, a connection queue is formed. Storage has the potential to unlock additional capacity for other generators wishing to connect. If such opportunity is identified in a connection queue, storage could be prioritised (allowed to jump the queue) to allow other generators in the queue to connect without the need for reinforcement. This would require the introduction of flexibility in the current approach, which is a first-come first-served basis. This is discussed further in section 4.2.2.

3.2 Identification of barriers to storage

As a relatively new and developing technology, the connection of electricity storage in NI can face certain barriers. These can be categorised as barriers within and outside of the control of NIE Networks. While all barriers identified will be listed here, the focus of this consultation paper is on the barriers that are within the control of NIE Networks.

The barriers to storage were identified from a number of sources, including:

- The FESS market survey responses, and a number of follow up calls with representatives from organisations that participated in the survey and indicated that they were willing to be contacted.
- The experience of NIE Networks staff.
- Other FESS deliverables, including the FESS Technology Assessment and the FESS Use Cases activity.
- Industry reports, such as the Energy Storage Ireland (ESI) all-island storage roadmap.[8]

The barriers were grouped into a number of categories. While the focus of the FESS project is on addressing barriers to storage that are within the remit of NIE Networks, the opportunity was taken to summarise barriers to storage identified that are in the remit of other parties. These are summarised in Annex A.

The following sub-sections outline the barriers identified using the sources listed above. Potential solutions to all barriers identified are discussed in section 4. Note that once barriers were identified, the FESS project went through a process of assessing these barriers and determining a programme of work for developing solutions, as illustrated in Figure 1.

3.2.1 Industry codes and regulations

The industry codes and regulation barriers identified are summarised in the following table.

TABLE 1. BARRIERS TO STORAGE RELATING TO INDUSTRY CODES AND REGULATIONS

Issue	Barrier to storage
Regulatory definition of electricity storage within primary legislation and licences	Clarity and appropriateness of the application of certain charges to storage (e.g. the Climate Change Levy), as determined by whether or not storage is legally classed as a Generator. Clarity on the number of licences required (and associated fees) for storage that is co-located with generation.

[8] Energy Storage Ireland (ESI); Our energy storage future – recommendations for an all-island energy storage roadmap; December 2019

Lack of specific treatment of electricity storage in the industry codes	The treatment of storage is not always explicit in industry codes, and where storage is required to meet generation conditions, these are not always suitable for storage facilities. EREC G83 generation that was installed prior to 2014 with a capacity that exceeds 16 Amps per phase is not eligible for the EREC G99/NI procedure for integrated micro-generation and storage installations (previously known as the G59 storage fast track).
Charges to storage	The characteristics of storage mean it can behave as generation, demand or a network asset depending on the function it is carrying out at any one time. Tariffs that currently focus on recovering network costs from generation or demand only customers may not be appropriate for storage. The issue of double charging for storage was raised by two respondents to the FESS market survey and identified as an issue in the Energy Storage Ireland (ESI) all-island storage roadmap. The term “double charging” is used, as storage could be seen to be paying for the same network assets twice, through import and export Use of System (UoS) charges.
Other issues around regulations and codes	A lot of piecemeal changes to regulations for storage and flexibility, but without a clear and published vision of what the “end point” looks like can lead to high uncertainty. Restriction of preferential treatment of technologies (with regard to prioritising storage in the connection queue which could facilitate further generation connections). In one of the FESS Use Cases storage is used to avoid the need for reinforcement to meet the security of supply standard EREC P2. This would require the adoption by NIE Networks of EREC P2/7 (NIE Networks currently uses EREC P2/6), which allows for storage (and other service providers) to be considered in group demand calculations.

3.2.2 Information Transparency

The barriers to storage related to information transparency are summarised in the following table.

TABLE 2. BARRIERS TO STORAGE RELATING TO INFORMATION TRANSPARENCY

Issue	Barrier to storage
Network information	Developers rely on information provided by network operators to assess their options for connection. While much of the network information made available is relevant to storage, there is currently not an option providing information on connections for electricity storage on either the NIE Networks connections page or generations connections page.

Pace of policy changes	Stakeholders can find it difficult to keep up with policy changes in this area considering how fast the arena is changing.

3.2.3 Commercial arrangements

NIE Networks does not have an established mechanism for procuring storage services that can defer traditional reinforcement. The procurement of distribution network services from flexibility service providers is currently being explored as part of an NIE Networks innovation project, FLEX[9].

Such a mechanism for procuring storage services would need to consider the following:

- Publication of flexibility opportunities, so that potential participants could evaluate this in revenue stacking / cost recovery. Note that storage and flexibility services will not always be the lowest cost solution; there will be circumstances where the optimal solution is network reinforcement.
- Provision of clarity to storage operators about the specification of the services needed (e.g. expected frequency, magnitude, duration, time / season of the requirement).
- Ensuring that storage is not prevented from connecting in high demand areas where additional import capacity is not available at the time of peak demand, when that is the constraint the storage facility is aiming to resolve i.e. through a contract to export (or to not import) at the time of peak demand.
- Putting in place a mechanism to recuperate the cost of procuring storage services.
- Allowing storage operators to pursue other revenue streams and stack services.
- Ensuring there is clarity on any penalty clauses for failure of storage operators to provide a service.

3.2.4 Grid connection process

The grid connection process involves an exchange of information between NIE Networks and the developer. Stages include the submission of a connection application by the developer, and an assessment of the application and an offer of terms of connection by NIE Networks.

A number of barriers were identified to the process of network connection from internal and external stakeholders. The issues that were identified are summarised in the table below.

TABLE 3. BARRIERS TO STORAGE RELATED TO THE CONNECTION PROCESS

Issue	Barrier to storage
Connection process barriers	• Concerns around offer of terms for connection expiring before planning approval is obtained. • Limited network capacity for connection which can result in high grid connection costs. • A lack of recognition of the flexibility offered by behind the meter storage. • The over-install limit being 20%, which is a particular hindrance where storage is co-located with generation. • Desire for an easier procedure to co-locate storage with generation.

[9] https://www.nienetworks.co.uk/flexibility

	• Separate connection policies exist for generation and demand customers, but not for storage. • TSO / DNO links and interactions, particularly in relation to distribution connected storage that participates in the DS3 markets. • Further information that NIE Networks could make available e.g. on their website (particularly if NIE Networks proceeds with the procurement of network services following the FLEX project).
Technical and operational considerations	• How storage is presented/recorded in internal systems. • The treatment of storage during network outages. • How storage is forecast in future DSO operations (network capacity allocations). • How storage 'mode of operation' is recorded and managed.

4. PROPOSED SOLUTIONS

4.1 Potential Solutions

Potential solutions to the barriers identified are listed in the tables below. The solutions have been categorised as follows.

TABLE 4. CATEGORISATION OF POTENTIAL SOLUTIONS

Remit of potential solutions	Table	Further covered in this paper
NIE Networks	Table 5	Yes – focus of this consultation paper (section 4.2 and 4.3)
NIE Networks FLEX project	Table 6	No
The FlexTech industry forum[10]	Table 7	No
Others e.g. government departments	Table 8	No

[10] The FlexTech industry forum or FlexTech integration initiative has been set up to help to break down barriers for renewables integration and system flexibility, as Ireland works towards a 70% renewable energy target. FlexTech is co-ordinated by EirGrid and SONI, and supported by ESB Networks and NIE Networks. A number of working groups have been set up in the FlexTech initiative, including an energy storage working group.

TABLE 5. SUMMARY OF POTENTIAL SOLUTIONS TO STORAGE BARRIERS IN NI UNDER THE REMIT OF NIE NETWORKS

Issue / Potential Solution	Remit
Consider whether a fast track storage process is possible for pre-2014 generation that is greater than 16 Amps per phase	NIE Networks
Review network charges for storage	The Utility Regulator (UR) and NIE Networks
Provide an overview of activity relevant for storage	NIE Networks
Consider prioritisation of storage / flexibility in connection queues	NIE Networks
Consider adopting EREC P2/8[11]	NIE Networks
Provide clarity for storage connections on the NIE Network's website connections page	NIE Networks
Use workshops and interactive events to engage with the storage community, and in future to communicate needs for services to developers	NIE Networks
Apply to the UR for approval for distribution reinforcement to create capacity in constrained areas	NIE Networks
Provide clarity on the options for discussions before submitting a formal application	NIE Networks
Consideration of storage solutions when generation application is rejected	NIE Networks
Review internal connection processes for storage (small and large scale) and consider developing a document or suite of documents for storage connection assessments.	NIE Networks
Review how storage is presented/recorded in systems (e.g. is a new storage symbol required in control systems)	NIE Networks
Review the treatment of storage during network outages	NIE Networks
Review how storage is forecast in future DSO operations (network capacity allocations)	NIE Networks
Review how storage 'mode of operation' is recorded and managed	NIE Networks

[11] Note that NIE Networks is planning to consult on adopting EREC P2/7 in 2021 – see section 4.3.2 for more information.

Table 6. Summary of potential solutions to storage barriers in NI being considered by the FLEX project

Issue / Potential Solution	Remit
Provide procurement documents for flexibility services	FLEX project
Indicate the location and details of network constraints (e.g. via a platform such as Piclo)	FLEX project
Transparent procurement processes	FLEX project
Consider the requirement for longer term contracts to improve the business model of storage projects	FLEX project

Table 7. Summary of potential solutions to storage barriers in NI under the remit of FlexTech

Issue / Potential Solution	Remit
Provide clarity on storage requirements in industry codes	FlexTech energy storage working group
Review the 20% over-install limit, particularly with reference to storage co-located with generation	FlexTech

Table 8. Summary of potential solutions to storage barriers in NI under the remit of government departments

Issue / Potential Solution	Remit
Provision for storage in legislation and licences	DfE for legislation – note that the Transposition of 2019 Electricity Directive Consultation[12] covered storage and the Energy Strategy will set the direction of travel on this. The UR has determined an approach to licences for storage, by granting electricity generation licences to storage facilities.[13]

[12] https://www.economy-ni.gov.uk/consultations/transposition-2019-electricity-recast-directive
[13] https://www.uregni.gov.uk/sites/uregni/files/media-files/Decision%20-%20Licence%20Grant%20-%20Drumkee%20Energy%20Ltd.pdf

Review network charges for storage	The UR is planning to consult on this issue. NIE Networks is reviewing internally.
Provide clarity on the interaction of storage (particularly co-located with generation) with other policies (e.g. renewable generation incentive schemes)	DfE
Make more information available on the economics of storage, e.g. develop case studies	Potentially the DfE, although may be more appropriate for wider industry.
Review and address resistance to storage projects due to perceived negative impact on the surrounding area, including health and safety concerns	DfI and the Health and Safety Executive Northern Ireland may have a role in providing guidance, developers have a role in undertaking pre-application stakeholder engagement.
Review planning arrangements for storage	DfI has released a Call for Evidence on implementation of the Planning Act,[14] to which NIE Networks will contribute. DfI has also announced an upcoming review of the strategic planning policy on renewable and low carbon energy.[15]
Review and address potential difficulties in accessing storage technologies at competitive prices	The government and policy makers are responsible for giving direction for the sector. However, it is important that a competitive market exists, which will be impacted by the supply chain, operational experience, demand, etc. Any concerns about competitive pricing can be taken to the Competition and Markets Authority.

The FESS project has engaged with the Utility Regulator (UR) and the Department for the Economy (DfE) and will continue to do so, to support progress on the above points (Table 8). Future engagement will include discussions on FESS project learnings, particularly on the barriers and potential solutions identified, and seek to further understand the UR / DfE plans in these areas. The DfE is currently consulting on policy options for the new energy strategy for NI, which refers to electricity storage as being a potential means of achieving network flexibility.[16]

4.2 Proposed FESS programme of work

THE NIE NETWORKS POTENTIAL SOLUTIONS IDENTIFIED IN

[14] DfE Call for Evidence: https://www.infrastructure-ni.gov.uk/consultations/review-implementation-planning-act-ni-2011-call-evidence
[15] https://www.infrastructure-ni.gov.uk/news/mallon-gives-green-light-renewable-energy-planning-review
[16] https://www.economy-ni.gov.uk/consultations/consultation-policy-options-new-energy-strategy-northern-ireland

TABLE 5 WERE DISCUSSED IN A WORKSHOP WITH NIE NETWORKS INTERNAL STAKEHOLDERS. NOT ALL OF THE SOLUTIONS WERE CONSIDERED SUITABLE TO BE DEVELOPED BY THE FESS PROJECT. THIS IS PRIMARILY BECAUSE THEY ARE BEING, OR WILL BE, ADDRESSED ELSEWHERE WITHIN NIE NETWORKS. THIS SECTION SUMMARISES THE PROPOSED PROGRAMME OF WORK FOR THE FESS PROJECT. THE SOLUTIONS IN

Table 5 that are not being addressed by the FESS project are discussed in section 4.3.

4.2.1 Review DUoS charges for storage

NIE Networks is conducting an internal review on tariff reform, reviewing distribution network use of system tariffs. The FESS project will liaise with staff involved and consider appropriate options (both interim and enduring) for electricity storage network charges. This will include a review of how electricity storage is charged for its use of the network in other jurisdictions. This will support NIE Networks in proposing an interim approach to network charges for storage, while wider reviews (i.e. by the UR) are taking place. It is noted that NIE Networks does not currently levy DUoS charges on export, i.e. storage will not, in any immediate approach to charging, be charged both import and export unit charges.

4.2.2 Consider prioritisation of storage in connection queues

One of the storage Use Cases identified in the FESS project proposed that NIE Networks could consider promoting flexibility providers, including storage projects, in the connection queue where the flexibility provider can create additional capacity that can be used to connect other applicants in the queue. This differs from the current process, whereby generators are connected on a first-come first-served basis and the connection queue is ordered based on the date of a complete application. The connection prioritisation approach is based on work from the Energy Networks Association (ENA) Open Networks project – see the summary box below for more information (Figure 2). Note that connection prioritisation on this basis is not allowed under NIE Networks current queuing principles.

FIGURE 2. OPEN NETWORKS DEVELOPMENT ON FLEXIBILITY IN CONNECTION QUEUES

Open Networks – Treatment of flexibility in connection queues

The ENA Open Networks project Queue Management Process Guide recognises that opportunities to implement flexible resources to address network constraints that underlie connection queues should be considered.[17] If projects can demonstrate that they would positively benefit the constraint on the network, they should be given preferential treatment by being moved up the queue (a high level example of this is given in the ENA Guide document). The alleviation of grid constraints caused by the connection of the flexible resource would thereafter defer reinforcement and allow further projects to connect. The detailed market mechanism required to allow for this has not yet been specified by the ENA, but network companies are encouraged to consider the opportunity to promote flexible resources in connection queues as a means to address queue constraints. The Guide notes that this sort of treatment would require a contractual agreement with a commitment that the flexible resource customer would act to alleviate the specific network constraint:

"Queue Management can result in flexible resources being promoted in connection queues on the basis that additional capacity is then enabled for other connectees. The processes described in this

[17] ENA Open Networks Project; Queue Management Process Guide; 15th April 2020; WS2 P2 (Work Stream 2, Product 2)

guide do not consider the detailed market mechanisms required to drive this behaviour in an economic and efficient manner, but opportunities for the promotion of flexible resources should be considered by network companies as a means to address the network constraints that underlie connection queues.

The promotion of flexible resources in the connection queue would require the contractual agreement of a suitable form of commitment or surety that the customer concerned will act to alleviate the specific network constraint. Such arrangements will depend on the particular circumstances that give rise to the connection queue including the nature of the network constraint, the timing of any agreed network reinforcement and the availability and location of other flexible resources."

Implementing this queue flexibility and prioritisation would be complex, and issues that would need to be considered include:

- An update would be required to the NIE Networks connection queue principles and connection process to allow for the prioritisation of applicants who can facilitate subsequent connection of other applicants in the queue. NIE Networks is currently required to ensure no preferential treatment is given to one connection over another. Consideration would need to be given to whether this approach to queue prioritisation contravenes any of NIE Network's licence conditions.
- There will be a contract duration issue to manage; the storage facility end of life is likely to come before the generation (e.g. wind turbine). A review may be required (e.g. after 7 – 12 years) to assess whether the requirement still stands.
- Clarity on any penalty clauses for failure of storage operators to provide a service, and a process in place for any longer-term issues, such as storage operators ceasing operations within the contract term.[18]
- Clear and available commercial arrangements (clear remuneration for storage service) e.g. do all subsequent applicants facilitated by the storage facility pay the storage for the required services?
- Agreed technical approach (e.g. fixed requirement to be reviewed at annual intervals or dynamic requirement based on real-time monitoring).
- Agreement (and costs) of monitoring the storage response and managing non-delivery of the response from both a commercial and technical perspective.
- Future increase in network capacity through wider system reinforcement – what impact does this have on the use and revenue of the storage facility? How is this risk addressed in commercial contracts?
- Sufficient network demand capacity to allow a suitable Maximum Import Capacity (MIC) for the storage to relieve the constraint.
- What information would need to be provided in advance to the connecting applicants in order to allow them to assess their options? What information needs to be provided to the storage facility to allow the stacking of services?
- Under current connection charging arrangements NIE Networks would see no financial benefit from connecting additional generation, which may prove challenging to the business case for NIE Networks

[18] The Open Networks standard Flexibility Services Agreement, for example, has clauses on insurance, termination and service failure.

to facilitate this service. It is worth noting that charging principles for all connections will be considered in a full connection charging review which will involve a full consultation process.

Consultation Q1. Do you think that NIE Networks should give further consideration to connection queue priority? i.e. Where flexible connections (e.g. storage) are given priority in a connection queue if they can facilitate the connection of other customers.

Consideration should also be given to ensuring that storage is not prevented from connecting in areas of high demand with limited import capacity, when storage is aiming to resolve that constraint.

NIE Networks currently offers secure import connections – i.e. a connection with a single Maximum Import Capacity (MIC), with no variation for time of day. Under these current arrangements, storage would be prevented from connecting in a demand constrained area with limited import capacity, even if the purpose of the storage is to export at peak time. This is because contractual arrangements are not in place to prevent the storage from importing at peak time.

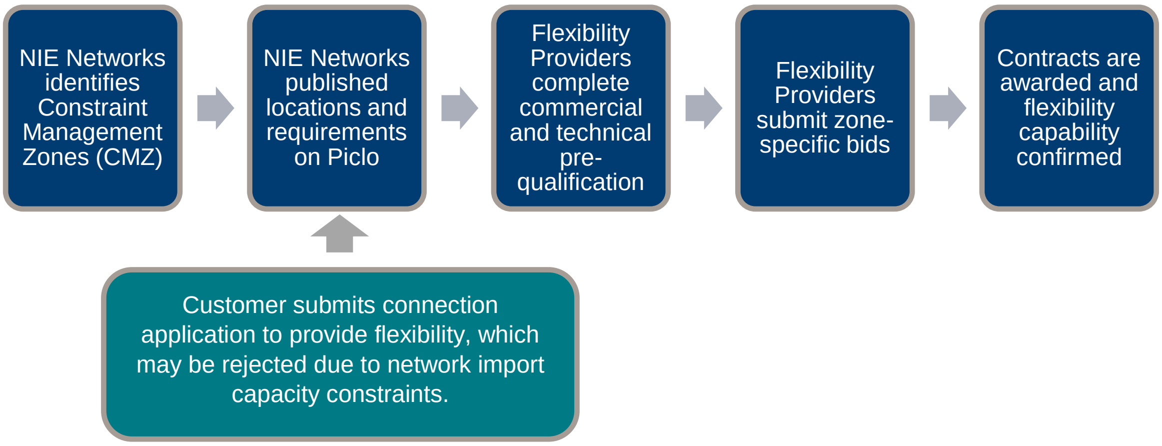
NIE Networks is currently considering whether it would be possible (and beneficial) to offer a "two-tier" or flexible MIC. This would, for example, allow connections to have a different MIC for day and night (to align with existing tariff times). There is a significant amount of complexity to move to such a two-tier approach, however, this would provide considerable benefits to customers who are able to be flexible with their time of use, such as those wishing to charge a fleet of electric vehicles overnight. This would also be beneficial for storage, by facilitating connections in areas where there is currently limited capacity to import at peak times, as storage could discharge at peak times to support the network at times of high demand and charge overnight. This approach would represent better utilisation of existing network capacity by incentivising use of the network at times of lower demand and reducing potential network reinforcement needs as the demand increase is limited to existing overnight headroom.

It is expected that this would be developed in a phased approach and would initially only be made available to 33kV (Extra High Voltage, EHV) and 11kV (High Voltage, HV) connected customers, with consideration to be given to implementing this for low voltage (LV) connections at a later stage. It is worth noting that the extension of this development to LV connections may be dependent upon the roll-out of smart meters to enhance metering capability.

Consultation Q2. Do you agree that NIE Networks should further consider offering a 'two-tier' MIC, allowing connections to have a different MIC for day and night?

The NIE Networks FLEX project is currently tendering for flexibility services. The FLEX tender pathway is illustrated below (Figure 3). This process is likely to be developed to take account of learning from the FLEX trials. The issue of connecting in a constrained area to provide flexibility is shown on the diagram in the customer (green) box.

FIGURE 3. FLEX TENDER PATHWAY TO PROVIDE FLEXIBILITY SERVICES TO NIE NETWORKS



Consultation Q3. Do you agree that NIE Networks should give consideration to facilitating the connection of storage (and other flexibility providers) in constrained areas (e.g. areas of high demand with limited import capacity) provided that the storage will act to resolve the network constraint?

4.2.3 Provide clarity for storage connections on the NIE Network's website

There is currently no dedicated page for storage connections on the NIE Networks website (Figure 4).

FIGURE 4. CURRENT CONNECTIONS PAGE ON NIE NETWORKS WEBSITE

The FESS project has reviewed GB and Ireland DNO websites for provision of information related to storage. From this review, the range of provisions for information on storage ranges from:

- No reference to storage
- No storage headings, but links to the storage fast track application form on the generation webpage
- Dedicated storage pages with further information, such as links to relevant application forms and guidance documents
- Best practice for provision of information to storage includes:
    - Guidance on likely connection voltage level for different storage capacities
    - Highlighting technical considerations that are likely to be the limiting factor for connection capacity (voltage step changes)
    - Overview of information required with application
    - Links to network capacity maps

The FESS project will draft proposed alterations to the connections web page, to be agreed with the NIE Networks Connections team. For example, this could include a dedicated storage page (with a clear link from the connections page) signposting the relevant forms and documents for storage projects (including V2G), and providing additional storage-specific guidance where appropriate.

Note that in terms of sharing information on the location of network constraints, the NIE Networks FLEX project is using the Piclo platform to advertise Flexibility Trial Zones for the FLEX project trial.

Consultation Q4. Do you agree that enhancement of the Connections webpages on the NIE Networks website to include storage would be of value?

4.2.4 Use workshops and interactive events to engage with the storage community

The FESS project will be hosting dissemination events to present the learning and outcomes of the project. These events can be used to canvas the appetite from storage stakeholders for future storage-focussed events.

Consultation Q5. Would further workshops for storage customers and ongoing engagement be of value? If so, can you give an indication of the types of topics that would be beneficial to cover?

4.2.5 Provide clarity on options for discussions before submitting a formal application

The development of an internal connection process for storage is discussed in 4.2.6. The FESS project will produce an external facing summary of the key points of this internal process, which could be included in a dedicated storage webpage on the NIE Networks website (4.2.3). This could also include clarification or guidance on the options that are available prior to submitting an application for discussions and studies.

4.2.6 Review internal connection processes for storage

NIE Networks has internal policy documents that set out the connection assessment and design process for generation and demand connections. While most of the stages in a storage connection assessment are covered in these, there are some storage specific issues that would be helpful to clarify. The FESS project is developing a storage connection policy document. Once this activity is complete, consideration will be given to identifying aspects that might be helpful to storage developers in the development of their projects and application form. This could form part of the website update content (4.2.3).

4.2.7 Operational matters

A number of internal topics regarding storage operation were identified for consideration. These include:

- Review how storage is presented/recorded in NIE Networks internal systems
- Review the treatment of storage during network outages
- Review how storage 'mode of operation' is recorded and managed
- Review how storage is forecast in future DSO operations (network capacity allocations)

While much of this is taking place under Business as Usual (BAU) activity, the FESS project will liaise with relevant NIE Networks staff to raise particular areas of consideration, so that any changes required for storage can then be taken forward by those individuals or teams. The FESS project will also review the suitability of Connection Agreements and prepare draft modifications for storage where necessary. The NI Standard Application Form will also be reviewed and, if necessary, modifications proposed, which could be shared with the relevant ENA working group.

Consultation Q6. Do you have any comments on the proposed FESS programme of work (section 4.2)? Is there anything missing from the FESS programme that is within the remit of NIE Networks and is not covered in section 4.3?

Consultation Q7. Do you have any comments about the FESS project as a whole?

4.3 Barriers being addressed by other NIE Networks activity

AS MENTIONED IN SECTION 4.1, A NUMBER OF THE NIE NETWORKS SOLUTIONS IDENTIFIED IN

Table 5 are already being addressed as BAU activity. The activity in these areas is summarised here.

4.3.1 Fast track storage process for pre-2014 generation

As noted in Table 1, EREC G99/NI contains a connection procedure for integrated micro-generation and storage installations (previously known as the G59 storage fast track). However, this does not cover EREC G83 generation that was installed prior to 2014 with a capacity that exceeds 16 Amps per phase, which is a barrier to those existing PV installations installing small storage devices. The limiting factor here is the 16 Amps per phase threshold in ESQCR(NI).

A potential solution to resolve this issue is for the customer to install an export limiting scheme, limiting export to 3.68 kW. However, this may not be an attractive solution to customers with generation capacity that exceeds this. The ENA is currently reviewing fast track modifications in GB, which may address this problem. The proposed modifications would increase the export limit to 32 Amps per phase; permission would be required from the DNO to proceed, but this should be provided within 10 days. NIE Networks will remain cognisant of this review work and progress any modifications outside of the remit of the FESS project.

4.3.2 Consider adopting EREC P2/8

NIE Networks currently uses EREC P2/6 as the security of supply standard (with supporting document EROP 130). Updates to these two documents (EREC P2/7 and EROP 130) were published in 2019. They were updated to take account of developments in Distributed Energy Resources (DER), including Demand Side Response (DSR) and storage. Prior to 2019 neither EREC P/6 nor EROP 130 took account of DSR or storage as contributing to security of supply.

In EREC P2/7:

- The definition of Group Demand, which determines the minimum level of security of supply required for an area of the network, has been amended to allow DNOs to take Latent Demand (below) into consideration; and
- A new definition, Latent Demand, has been added: "*Demand that would appear as an increase in Measured Demand if the DG was not operating, the DSR was not implemented or other means (eg time of use tariff, export from electricity storage devices) of suppressing the Measured Demand within the network (for which the Group Demand is being assessed) was not operating.*"

Following the publication of EREC P2/7, EROP 130 was amended to provide guidance to DNOs on assessing the contribution to security from electricity storage (among other things) that is contracted with the DNO to provide a security service. EROP 130 contains guidance and examples on determining Group Demand for contracted and non-contracted electricity storage.

NIE Networks is planning to consult on adopting EREC P2/8 in Q3 2021. There are no changes from EREC P2/7 to P2/8 that impact storage.

4.3.3 Network constraints

The issue of limited capacity for grid connections was raised numerous times in the FESS market survey. Limitations can be in the distribution network and/or the transmission network, and this is a particular issue in certain geographic areas (e.g. north and west of NI). A specific issue for storage which was raised by industry is the limited availability of symmetrical connections, where import and export capacities match. This could diminish the ability of storage facilities to participate in the wholesale market for energy arbitrage activity. For example, if a storage facility had a 20 MW Maximum Export Capacity (MEC) and a 5 MW Maximum Import Capacity (MIC), this could limit the ability of the storage to charge quickly at times of low or negative electricity price.

The issue of limited grid capacity is not specific to electricity storage and comes as a result of significant progress in connecting renewable generation. In 2010 The Department of Enterprise, Trade and Industry (DETI) issued an ambitious target for Northern Ireland, that by 2020, 40% of the electricity consumed in the country would be generated by renewable resources[19]. NIE Networks played a key role in facilitating this change and by the summer of 2019 the target had been exceeded, with 44.9% of electricity consumption in Northern Ireland generated from renewable sources located in Northern Ireland, a figure which had risen to 47.7% by September 2020, with 84.5% of the total renewable electricity generated being from wind. When the level of connected renewable generation is viewed in the context that Northern Ireland experiences a summer minimum electrical demand of approximately 0.5GW and a winter maximum of around 1.8GW, it is easy to appreciate the challenge of such a proliferation of connected renewables. In practice, this means that during times of minimum electrical demand in the summer, the capacity of connected (or committed to connect) renewable generation can be up to 400% that of the electrical demand on the system.

Over the period 2010 – 2013, NIE Networks introduced a "cluster methodology". The cluster methodology improves access to the network for remote renewable generation by extending the 110 kV transmission system, in the form of a 110/33 kV substation (referred to as a cluster substation), to a point more central to a group of renewable generation projects. This has been very successful in facilitating the connection of renewable generation. The cluster methodology currently only allows generation connections; it excludes demand (including storage). NIE Networks has issued a Call for Evidence on reviewing the cluster methodology, which includes widening the remit to demand connections.[20]

[19] https://www.economy-ni.gov.uk/sites/default/files/publications/deti/sef%202010.pdf
[20] NIE Networks; Cluster Methodology Review – Call for Evidence; 05 October 2020 https://www.nienetworks.co.uk/documents/regulatory-documents/cluster-methodology-review-cfe.aspx

NIE Networks together with the TSO have worked with industry to progress connection policy and steps have been taken to enable the connection of generators 5 MW and above to the distribution system with non-firm market access. Connection Offers with non-firm market access are reflective of the transmission capacity or lack thereof, available to the generator. Issuing a connection offer with non-firm market access does not create more capacity or address the need for reinforcement; rather it allows generators to connect in anticipation of network reinforcement. We continue to work together to address connection policy for generators of less than 5 MW seeking to connect (and export) to the distribution system.

A SONI and NIE Networks Joint Working Group (JWG) produced a common electricity roadmap for NI to inform the DfE consultations on developing an energy strategy.[21] As part of one of five thematic working groups, this one focussing on power, the JWG roadmap contains an assessment of network development needs and associated costs for different 2030 renewable energy targets (60%, 70% and 80%), for both transmission and distribution systems. The roadmap notes that an increase in flexible technologies, including storage, is needed for increased renewable energy targets.

4.3.4 Consideration of storage solutions when generation application is rejected

One suggestion raised in the FESS market survey was that storage solutions could be recommended when a generation application is rejected. However, given that NIE Networks has a technology-agnostic role, it is not considered appropriate to nominate one generation technology (i.e. storage) over another. The preferred route would be to point towards other options e.g. zero export or limited export connections. Customers also have the option of requesting feasibility studies for a connection prior to submitting an application.

4.4 Overview of activity relevant to storage

One of the potential solutions identified was the development of a long-term vision for addressing storage barriers in order to avoid a piecemeal approach to changes.

Whilst the development of a long-term vision for storage in NI should be addressed by the DfE in developing the energy strategy, NIE Networks has a role to ensure that the industry codes and processes facilitate the connection of storage fairly. NIE Network's view on procuring network services from storage and other flexibility service providers is not fully formed yet, as it will be shaped by the results and learning of the FLEX project. However, the FESS project has summarised the activity within NIE Networks and elsewhere that could impact storage connections. This activity is summarised in Figure 5.

[21] SONI and NIE Networks; Insight Paper: Energy Scenarios to Inform Developing Energy Strategy in Northern Ireland; 10 December 2020

FIGURE 5. SUMMARY OF ACTIVITY RELEVANT TO STORAGE

		Feb				Mar					Apr				May					Jun				Jul				Aug					Sep				Oct				Nov					Dec	
Barrier/Solution	**Remit**	01/02/2021	08/02/2021	15/02/2021	22/02/2021	01/03/2021	08/03/2021	15/03/2021	22/03/2021	29/03/2021	05/04/2021	12/04/2021	19/04/2021	26/04/2021	03/05/2021	10/05/2021	17/05/2021	24/05/2021	31/05/2021	07/06/2021	14/06/2021	21/06/2021	28/06/2021	05/07/2021	12/07/2021	19/07/2021	26/07/2021	02/08/2021	09/08/2021	16/08/2021	23/08/2021	30/08/2021	06/09/2021	13/09/2021	20/09/2021	27/09/2021	04/10/2021	11/10/2021	18/10/2021	25/10/2021	01/11/2021	08/11/2021	15/11/2021	22/11/2021	29/11/2021	06/12/2021	13/12/2021
FESS project: Briefing note on UoS charges for storage	NIE Networks																																														
NIE Networks consultation on adopting EREC P2/8	NIE Networks																																														
FESS project: Draft proposals for modifications to the NIE Networks connections webpage for storage	NIE Networks																																														
FESS project: Storage stakeholder events	NIE Networks																																														
NIE Networks implementation of Maximum Import Capacity (MIC) / Chargeable Service Capacity (CSC) charges review	NIE Networks																																														
Two-tier Maximum Import Capacity (MIC) review	NIE Networks																																			Implementation likely to be in 2022											
FESS project: Produce customer-facing summary of key points of connection process for storage	NIE Networks																																														
FESS project: Review and document internal connection process for storage	NIE Networks																																														
FESS project: Review how storage is presented / recorded in systems	NIE Networks																																														
FESS project: Review the treatment of storage during network outages	NIE Networks																																														
FESS project: Review how storage mode of operation is recorded and managed within NIE Networks	NIE Networks																																														
FESS project: Meetings with the UR / DfE	NIE Networks																																														

		Feb				Mar					Apr				May					Jun				Jul				Aug					Sep				Oct				Nov					Dec	
Barrier/Solution	**Remit**	**01/02/2021**	**08/02/2021**	**15/02/2021**	**22/02/2021**	**01/03/2021**	**08/03/2021**	**15/03/2021**	**22/03/2021**	**29/03/2021**	**05/04/2021**	**12/04/2021**	**19/04/2021**	**26/04/2021**	**03/05/2021**	**10/05/2021**	**17/05/2021**	**24/05/2021**	**31/05/2021**	**07/06/2021**	**14/06/2021**	**21/06/2021**	**28/06/2021**	**05/07/2021**	**12/07/2021**	**19/07/2021**	**26/07/2021**	**02/08/2021**	**09/08/2021**	**16/08/2021**	**23/08/2021**	**30/08/2021**	**06/09/2021**	**13/09/2021**	**20/09/2021**	**27/09/2021**	**04/10/2021**	**11/10/2021**	**18/10/2021**	**25/10/2021**	**01/11/2021**	**08/11/2021**	**15/11/2021**	**22/11/2021**	**29/11/2021**	**06/12/2021**	**13/12/2021**
FlexTech: Develop a strategy on Transmission and Distribution Code updates	FlexTech																																														
FlexTech: Review over install limits (20%) for Renewable Hybrid plants	FlexTech																																														
Tariff reform - Call for Evidence	UR																																														
DfE Energy Strategy - Consultation	DfE																																														
DfE Energy Strategy - Final Energy Strategy	DfE																																														
DfI Call for Evidence - Review of the implementation of the Planning Act	DfI																																														

4.5 Consultation questions

Q1. Do you think that NIE Networks should give further consideration to connection queue priority? i.e. Where flexible connections (e.g. storage) are given priority in a connection queue if they can facilitate the connection of other customers.

Q2. Do you agree that NIE Networks should further consider offering a 'two-tier' MIC, allowing connections to have a different MIC for day and night?

Q3. Do you agree that NIE Networks should give consideration to facilitating the connection of storage (and other flexibility providers) in constrained areas (e.g. areas of high demand with limited import capacity) provided that the storage will act to resolve the network constraint?

Q4. Do you agree that enhancement of the Connections webpages on the NIE Networks website to include storage would be of value?

Q5. Would further workshops for storage customers and ongoing engagement be of value? If so, can you give an indication of the types of topics that would be beneficial to cover?

Q6. Do you have any comments on the proposed FESS programme of work (section 4.2)? Is there anything missing from the FESS programme that is within the remit of NIE Networks and is not covered in section 4.3?

Q7. Do you have any comments about the FESS project as a whole?

5. NEXT STEPS AND HOW TO RESPOND

5.1 Next Steps

This consultation paper is the second step in engaging with storage stakeholders, the first being the FESS market survey. The paper has summarised the barriers to storage that were identified in this project, potential solutions and a proposed programme of work for developing solutions in the FESS project. Where solutions are being undertaken elsewhere in NIE Networks, or are not considered appropriate, this has been stated. NIE Networks is keen to ensure that interested stakeholders have an opportunity to comment on the FESS programme of work, as well as seeking responses on other specific points. Responses to this consultation paper will help to shape the FESS programme of work and will provide valuable feedback for NIE Networks on storage related activity that sits outside of the FESS project.

An indicative timeframe for this consultation is shown below.

TABLE 9. KEY MILESTONES AND PROPOSED DATES FOR THE FESS CONSULTATION

Key Milestones	Proposed Dates
Publication of consultation paper	Friday 4th June 2021
Consultation paper close	4pm on Friday 16th July 2021
Stakeholder workshops	September 2021 (tbd)

5.2 How to Respond

NIE Networks invites interested parties to respond to this Consultation Paper. Whilst NIE Networks welcomes all comments, responses are particularly welcome on the questions that are embedded within this document (section 4.5). Responses should be sent electronically to Josh.Watson@nienetworks.co.uk by 4pm on Friday 16th July 2021.

NIE Networks will handle all information in accordance with the NIE Networks Privacy Statement. (http://www.nienetworks.co.uk/privacy)

Please note that it is intended to publish all responses to this paper on the NIE Networks website (www.nienetworks.co.uk). Respondents who wish that their response remains confidential should highlight this when submitting the response.

NIE Networks may share responses with UR. Respondents should be aware that as UR is a public body and non-ministerial government department, the UR is required to comply with the Freedom of Information Act (FOIA)[22].

[22] The effect of FOIA may be that information contained in consultation responses that is shared with UR is required to be put into the public domain. Hence it is possible that all responses made to this consultation that may be shared with UR will be discoverable under FOIA, even if respondents ask for the responses to be treated as confidential. It is therefore important that respondents take account of this and in particular, if asking that the responses are treated as confidential.

ANNEX A: BARRIERS OUTSIDE OF NIE NETWORKS' CONTROL

The barriers that were identified to storage in NI that are considered to be outside of the remit of NIE Networks are summarised in the table below.

TABLE 10. BARRIERS TO STORAGE THAT ARE OUTSIDE NIE NETWORK'S REMIT

Issue	Barrier to storage
Connection process	Feedback from the FESS market survey included views that the connection application process is slow and is not uniform across the Single Electricity Market (SEM), which operates across NI and Ireland. The NIE Networks process is governed by timeframes as set out in the distribution licence. The issue of uniformity across the SEM is a consequence of the situation NIE Networks is in, wherein there is close regulatory alignment (in terms of technical requirements for the connection of generation to distribution networks) with GB, and close cooperation with EirGrid through the SEM.
Grid balancing products and markets: Lack of long-term frameworks that enhance business cases	To ensure a robust business case can be developed, storage operators need clarity and a level of certainty around the time horizons of the services they provide. Long-term frameworks and contracts for services provide a guarantee that certain revenue streams will be maintained for a significant proportion of the lifetime of the asset. The DS3 schedule of providing agreements is a process that happens every six months and could lead to several months of lost revenue if the agreement gate is missed.
Economics of electricity storage	There is little information available about the economics of storage facilities, which has been identified as a deterrent to storage market entry.
Planning and construction	Like other developments, battery storage facilities need to demonstrate that they will not have a significant adverse effect on the surrounding area to gain planning permission. Battery storage facilities are made up of containerised battery packs, inverters, HVAC units, and fire suppression technologies. Additionally, a substation could be present at the site. The site needs to be fenced off and an access track needs to be built. There can be resistance to storage projects in the planning process due to perceived negative impact on the surrounding area.
Difficulty in accessing finance	Electricity storage is still classed as a relatively novel technology. However, it is already transitioning away from government R&D funding, while the perceived uncertainty surrounding it poses an obstacle to obtaining conventional debt financing. This is reflected in the 7.3%

	hurdle rate proposed for storage projects by Europe Economics.[23] Within this gap, storage projects have a limited access to finance that is mainly sourced from venture capital or crowd funding.
Supply chain considerations	The global lithium-ion batteries supply chain has developed and continues to do so quickly to meet demand from the automotive industry and for grid scale and domestic electricity storage. Most of the manufacturing capacity is situated in China, Japan and South Korea, but there is significant capacity in the USA and Europe. The UK is already well positioned in this supply chain. It should be noted that supply chain companies need to be held to high technical, environmental and ethical standards. Batteries require several rare earth metals, some of which (e.g. cobalt) could be associated with exploitative working conditions and low environmental standards.

23 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/910814/Cost_of_Capital_Update_for_Electricity_Generation_Storage_and_Demand_Side_Response_Technologies.pdf

Appendix 2

Lithium-ion Battery Energy Storage Systems

The risks and how to manage them

AIG Energy Industry Group

A key emerging risk

The rapid rise of Battery Energy Storage Systems (BESS's) that utilize Lithium-ion (Li-ion) battery technology brings with it massive potential – but also a significant range of risks. At AIG, we believe this is one of the most important emerging risks today – and organisations that use this technology must balance the opportunities with the potential downsides.

The market for BESS technology and Li-ion batteries is growing very rapidly and demand is coming from a wide range of industries and users, many of which are not aware of the risks involved. Consumers are using Li-ion battery technology extensively in their everyday lives – in everything from smartphones to laptops and hybrid cars – and organisations are embracing BESS technology for everything from renewable energy storage to electric cars.

So are these systems safe?

Fire is a major risk, with a number of Li-ion battery-related incidents hitting the headlines in recent years, from exploding Samsung smartphones to electric car fires and even a Dreamliner catching fire at Heathrow, along with a Hawaiian BESS facility fire. One of the most concerning features of battery fires is that they can seemingly ignite or reignite days or weeks after they were thought to be extinguished.

In this report, we look at the development of BESS's, with particular emphasis on those supplied by Li-ion battery technology and consider the associated risks – as well as what organisations can do to minimise their exposures.

What are Battery Energy Storage Systems?

Battery Energy Storage Systems (BESS's) are a sub-set of Energy Storage Systems (ESS's). ESS is a general term for the ability of a system to store energy using thermal, electro-mechanical or electro-chemical solutions. A BESS utilizes an electro-chemical solution.

Essentially, all Energy Storage Systems capture energy and store it for use at a later time or date. Examples of these systems include pumped hydro, compressed air storage, mechanical flywheels, and BESS's. These systems complement intermittent sources of energy such as wind, tidal and solar power in an attempt to balance energy production and consumption.

Energy storage results in a reduction in peak electrical system demand and ESS owners are often compensated through regional grid market programs. Regulators also offer incentives (and in some cases mandates) to encourage participation.

Types of BESS

BESS's use electro-chemical solutions and include some of the following types of batteries:

- Lithium-ion – these offer good energy storage for their size and can be charged/discharged many times in their lifetime. They are used in a wide variety of consumer electronics such as smartphones, tablets, laptops, electronic cigarettes and digital cameras. They are also used in electric cars and some aircraft.
- Lead-acid – these are traditional rechargeable batteries and are inexpensive compared to newer types of batteries. Uses include protection and control systems, back-up power supplies, and grid energy storage.
- Sodium Sulphur – uses include storing energy from renewable sources such as solar or wind.
- Zinc bromine – uses include storing energy from renewable sources such as solar or wind.
- Flow – flow batteries are quite large and are generally used to store energy from renewable sources.

Why are BESS's gaining popularity?

All types of BESS offer pros and cons in terms of capacity, discharge duration, energy density, safety, environmental risk, and overall cost. However, BESS's utilizing Li-ion batteries are by far the most widely used system today. This is primarily due to their high energy density and steady decrease in cost.

Decreasing costs

A major factor in the rapid increase in the use of BESS Li-ion technology has been a 50% decrease in costs of energy storage over the last two years. While costs are still high compared to grid electricity, the cost of energy storage has actually been plummeting for the last 20 years.[1]

Storage systems can also decrease the need to invest in new conventional generation capacity, resulting in financial savings and reduced emissions from generating electricity. Using storage systems also means fewer and cheaper electricity transmission and distribution system upgrades are required.

Storage systems at the utility customer level can also result in significant savings to businesses through smart grid and Distributed Energy Resource (DER) initiatives, where cars, homes and businesses are potential storers, suppliers and users of electricity.

In a virtuous cycle, the growing market will lead to increased production of BESS's, which will lead to lower prices, which will increase the size of the market further.

Security of supply

Storage technologies are also popular because they improve energy security by optimising energy supply and demand, reducing the need to import electricity via interconnectors, and also reducing the need to continuously adjust generation unit output.

In addition, BESS's can provide system security by supplying energy during electricity outages, minimizing the disruption and costs associated with power cuts.

Another reason for the rising popularity of storage systems is that they can enable the integration of more renewables, such as solar, tidal and wind power, in the energy mix.

Financial incentives

Many governments and utility regulators are actively encouraging the development of battery storage systems with financial incentives, which is likely to lead to further growth.

[1] Power Engineering, 4/18/2017, "What you need to know about energy storage."

What are the risks involved?

While the use of batteries is nothing new, what is new is the size, complexity, energy density of the systems and the Li-ion battery chemistry involved – which can lead to significant fire risks.

These risks are exacerbated by the fact that many of the new users of BESS's are not energy specialists. Previously, these systems would have been used by companies that had an in-depth understanding of their uses and potential dangers. Today, a buyer of a BESS is just as likely to be a property developer, council or university, with limited understanding of the inherent hazards.

Thermal runaway

'Thermal runaway' – a cycle in which excessive heat keeps creating more heat – is the major risk for Li-ion battery technology. It can be caused by a battery having internal cell defects, mechanical failures/damage or overvoltage. These lead to high temperatures, gas build-up and potential explosive rupture of the battery cell, resulting in fire and/or explosion. Without disconnection, thermal runaway can also spread from one cell to the next, causing further damage.

In BESS's that utilize lead acid batteries, hydrogen evolution can result in explosive atmospheres unless proper ventilation methods are employed

Difficulty of fighting battery fires

Battery fires are often very intense and difficult to control. They can take days or even weeks to extinguish properly, and may seem fully extinguished when they are not.

They can also be very dangerous to fire fighters and other first responders because, in addition to the immediate fire and electricity risks, they may be dealing with toxic fumes, exposure to hazardous materials and building decontamination issues. Different types of batteries also react differently to fire, so firefighters must be knowledgeable about how they react and how to respond. Otherwise they may decide to contain the fire but leave it to burn itself out leading to the loss of the entire facility

Failure of control systems

Another issue can be failure of protection and control systems. For example, a Battery Management System (BMS) failure can lead to overcharging and an inability to monitor the operating environment, such as temperature or cell voltage.

Sensitivity of Li-ion batteries to mechanical damage and electrical transients

Contrary to existing conventional battery technology, Li-ion batteries are very sensitive to mechanical damage and electrical surges. This type of damage can result in internal battery short circuits which lead to internal battery heating, battery explosions and fires. The loss of an individual battery can rapidly cascade to surrounding batteries, resulting in a larger scale fire.

Case studies

BESS's employing Li-ion batteries and Li-ion batteries in general have been involved in a number of high-profile incidents in recent years.

Dreamliner fire

In 2013, a Dreamliner 787 at Heathrow caught fire after a short circuit in a battery-operated device caused a thermal runaway reaction. The fire caused significant damage in the cabin, partly because the device was located near insulation materials. The fire also resulted in damage to the fuselage.[2] The Heathrow incident was one of a number affecting the aircraft in 2013, problems that were said to have cost Boeing in excess of $600 million.[3]

Samsung Galaxy Note 7 recalled after devices explode

Samsung hit the headlines in 2016 when it recalled 2.5 million Galaxy Note 7 phones after complaints about overheating and phones exploding. In January 2017, Samsung confirmed that the cause of the problems had been the batteries.[4] Direct costs of the recall were estimated at the time at up to £4 billion, but it has been suggested that the long-term damage to the brand could be anything up to £20 billion.[5]

Chevrolet Volt catches fire three weeks after crash

In 2011, a Chevrolet Volt caught fire more than three weeks after a routine side-impact crash test damaged its battery pack. The fire prompted concerns over the safety of using lithium-ion batteries to power hybrids and electric cars.[6] In a subsequent test on electric cars, carried out by the Fire Protection Research Foundation[7] in 2013, fire fighters found they needed a very large volume of water to extinguish battery fires, which kept reigniting. In one example, a battery fire reignited, 22 hours after it was thought to have been extinguished.[8]

Hawaii wind farm has two fires in a year

In 2012, the Kahuku wind firm in Hawaii experienced two fires, which caused significant damage and were attributed to the capacitors being at fault. In the second fire, the fire fighters could not enter the building for several hours because it was unclear whether the batteries were emitting toxic fumes.[9]

[2] http://www.bbc.co.uk/news/business-33985615
[3] http://www.businessinsider.com/dreamliner-trouble-has-cost-boeing-600-million-2013-4
[4] http://www.bbc.co.uk/news/business-38714461
[5] https://www.theguardian.com/business/2016/oct/14/samsung-galaxy-note-7-smartphone-profits-warning
[6] https://www.reuters.com/article/us-gm-volt/u-s-probes-ev-batteries-after-chevy-volt-fire-idUSTRE7AA53H20111111
[7] The Fire Protection Research Foundation (FPRF) is an independent nonprofit whose mission is to plan, manage and communicate research in support of the US National Fire Protection Association (NFPA).
[8] http://www.nfpa.org/news-and-research/publications/nfpa-journal/2016/january-february-2016/features/ess/lithium-ion-conundrum
[9] https://www.greentechmedia.com/articles/read/battery-room-fire-at-kahuku-wind-energy-storage-farm#gs.yfr=ERQ

How can companies reduce their risks?

Some manufacturers and utility companies are working on developing guidelines regarding how best to protect Battery Energy Storage Systems and any buildings in which they are installed. However, many of the test results are confidential, so efforts are being made to encourage the sharing of this information.

For now, companies that want to use BESS's must assess their fire protection challenges and reduce their risks wherever possible.

Planning

As a starting point, it is useful to consider these questions:

- How should the BESS be constructed (e.g. using individual containers of batteries, physical separation of batteries, use of dedicated fire areas, fire protection systems etc.)?
- What testing should be conducted during commissioning?
- How do batteries of this chemistry/technology react in a fire?
- How would firefighters make sure this type of battery is fully extinguished?
- How would firefighters handle a damaged battery that is still charged with power?
- Have fire fighters been invited to site to perform a planning review?
- What are the risks to first responders and the public from exposure to toxic fumes, electricity and other hazards if a fire or other incident were to occur?
- What environmental hazards would be created when fire systems interact with failed batteries?

Construction

There are practical steps that organisations can take to minimise their risks when constructing a battery system:

- Use non-combustible materials.
- Check where the batteries were made/who the manufacturer is.
- Transport the batteries very carefully as they are fragile, despite their robust appearance.
- Carry out extensive testing to detect any faults.
- Ensure an effective Battery Management System is included in the design.

For external installations:

- Locate storage systems well away from critical buildings or equipment.
- Where spatial separation is not possible, provide exterior protection such as a passive thermal barrier, or active fire protection such as drenchers.
- Install battery and battery management systems/electrical switch gear in separate rooms.

For internal installations:

- Make sure that the battery system is separate from critical infrastructure.
- Put battery and battery management systems/electrical switch gear in separate rooms, with fire resistive construction (two hour fire rated) to adequately cut off the room from surrounding exposures.
- Provide fire-rated compartmentation and adequate separation between battery units.
- Provide adequate fire doors (>FR60) that are maintained in the closed position and equipped with automatic closure mechanisms. Where insulated metal panels (IMPs) are used, these should contain a mineral wool core and be installed in accordance with the terms of their approval. Only non-combustible IMPs should be installed.
- Ensure proper management of cable/service penetrations. Cable penetrations should be adequately sealed to meet the fire resistance of the compartment (two hour fire resistance rating). Heating, ventilation and air conditioning ducts should have fire dampers provided that automatically close on activation of the fire alarm. Establish a permit to access system to manage changes to service or cable penetrations under an audited system.

Commissioning

During the commissioning process:

- Check the batteries visually at points of loading.
- Repeat factory tests.
- Ensure that those installing the equipment are properly trained.
- Ensure maintenance and inspection schedules are set up.

Fire protection

Organisations should put automatic fire detection in place, with early warning smoke detection or very early warning highly sensitive smoke detection (using air sampling devices such as VESDA). The system design should include continuous remote monitoring.

As for active fire protection, testing and research is just beginning and there is no publicly available test data that proves any particular type of active fire protection can prevent or control thermal runaway. Therefore, there is no clear guidance for organisations about what kind of protection to put in place.

However, inert gas and foam suppression systems seem unable to control thermal runaway, so the two main options are likely to be automatic fire sprinklers and water mist.

In 2018, a Property Insurance Research Group[10] project in the US will look into sprinkler protection for BESS's. It will aim to determine sprinkler protection guidance and establish an appropriate sprinkler system design that applies to the majority of locations where a BESS may be found within a commercial facility.

[10]The Property Insurance Research Group (PIRG), comprising representatives of seven major insurance companies supports the actvities of the Fire Protection Research Foundation (FPRF), itself part of the US National Fire Protection Association (NFPA).

BESS technology is an area in which the technology – and the associated opportunities and risks – are constantly evolving. AIG's Energy Industry Practice Group, which focuses on key issues that could impact the energy industry, considers this a key risk and monitors it on an ongoing basis.

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For further information on the issues raised in this paper, or on AIG's Client Risk Solutions, you can also contact your local AIG Property Risk engineer or **CRS@AIG.com**

What is battery storage?

Battery storage technologies are essential to speeding up the replacement of fossil fuels with renewable energy. Battery storage systems will play an increasingly pivotal role between green energy supplies and responding to electricity demands.

Battery storage, or battery energy storage systems (BESS), are devices that enable energy from renewables, like **solar** and **wind**, to be stored and then released when customers need power most.

Lithium-ion batteries, which are used in mobile phones and **electric cars**, are currently the dominant storage technology for large scale plants to help electricity grids ensure a reliable supply of renewable energy.

Why is battery storage important and what are its benefits?

Battery storage technology has a key part to play in ensuring homes and businesses can be powered by **green energy** even when the sun isn't shining, or the wind has stopped blowing.

For example, the UK has the largest installed capacity of **offshore wind** in the world, but the ability to capture this energy and purposefully deploy it can increase the value of this clean energy; by increasing production and potentially reducing costs.

Every day engineers at National Grid and electricity grids worldwide must match supply with demand. Managing these peaks and troughs becomes more challenging when the target is to achieve **net zero** carbon production, by phasing out fossil fuel plants that have traditionally been used as a back-up to provide a reliable, steady supply of energy.

The UK government estimates technologies like battery storage systems – supporting the integration of more low-carbon power, heat and transport technologies – could save the UK energy system up to **£40 billion by 2050**, ultimately reducing people's energy bills.

In the US, Ken-Ichi Hino, Director of Energy at **National Grid Renewables**, the US renewable energy arm of National Grid Ventures, says: “Storage enables further renewable generation, both from an operational and reliability perspective. It’s also a key piece of our utility customers’ ongoing evolution and transition to renewables. We see significant opportunity for pairing energy storage with our solar projects moving forward.”

Battery storage facility, East Hampton, Long Island, NY

How exactly does a battery storage system work?

Battery energy storage systems are considerably more advanced than the batteries you keep in your kitchen drawer or insert in your children’s toys. A battery storage system can be charged by electricity generated from renewable energy, like wind and solar power.

Intelligent battery software uses algorithms to coordinate energy production and computerised control systems are used to decide when to keep the energy to provide reserves or release it to the grid. Energy is released from the battery storage system during times of peak demand, keeping costs down and electricity flowing.

This article is concerned with large-scale battery storage systems, but **domestic energy storage** systems work on the same principles.

What renewable energy storage systems are being developed?

Storage of renewable energy requires low-cost technologies that have long lives – charging and discharging thousands of times – are safe and can store enough energy cost effectively to match demand.

Lithium-ion batteries were developed by a British scientist in the 1970s and were first used commercially by Sony in 1991, for the company's handheld video recorder. While they're currently the most economically viable energy storage solution, there are a number of other technologies for battery storage currently being developed. These include:

- **Compressed air energy storage**: With these systems, generally located in large chambers, surplus power is used to compress air and then store it. When energy is needed, the compressed air is released and passes through an air turbine to generate electricity.
- **Mechanical gravity energy storage**: One example of this type of system is when energy is used to lift concrete blocks up a tower. When the energy is needed, the concrete blocks are lowered back down, generating electricity using the pull of gravity.
- **Flow batteries**: In these batteries, which are essentially rechargeable fuel cells, chemical energy is provided by two chemical components dissolved in liquids contained within the system and separated by a membrane.

Prescott Hartshorne, Director of Distributed Energy and Renewables for **National Grid Ventures**, says: "The next decade will be big for energy storage in general and for batteries in particular. It will be an important proving time for batteries and for other technologies."