Localism Act 2011

Acquisition of Land Act 1981

Inquiry into:

THE SOUTH TEES DEVELOPMENT CORPORATION

(LAND AT THE FORMER REDCAR STEELWORKS, REDCAR)

COMPULSORY PURCHASE ORDER 2019

Rebuttal Proof of Evidence

of

David Allison

On behalf of the South Tees Development Corporation

In response to the proofs of evidence submitted on behalf of:

SSI and the Thai Banks

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Appendices

1 INTRODUCTION

1.1 I am David Allison, I am the Chief Executive of the South Tees Development Corporation (STDC) and the South Tees Site Company Ltd (STSC).

1.2 This Rebuttal Proof of Evidence ("Rebuttal") has been prepared following consideration of the issues raised by SSI in their evidence in respect of the South Tees Development Corporation (Land at the Former Redcar Steel Works, Redcar) Compulsory Purchase Order 2019. Rebuttal of issues raised by other Objectors in their evidence is responded to by other STDC colleagues and expert witnesses.

Reference is made to aspects of the evidence on behalf of SSI and the Thai Banks ("SSI") from:

(a) Mr Duncan Neil Parr (DNP) of Rapleys LLP
(b) Mr Peter Roberts (PR), DWD
(c) Mr Simon Melhuish-Hancock (SMH), UK General Counsel for SSI

1.3 This Rebuttal is not intended to be an exhaustive response to every contention made in the evidence listed above in paragraph 1.2 or indeed, in other evidence. It deals only with certain points where it is considered appropriate and helpful to respond in writing. Where specific points have not been dealt with, this does not mean that these points are accepted and they may be dealt with further at the Inquiry.

1.4 My Rebuttal should be read in conjunction with all of the evidence and Rebuttal statements submitted on behalf of STDC. Several issues raised by objectors give rise to related responses from myself, Mr John McNicholas, Mr Anthony Greally, Mr Michael King and Mr Guy Gilfilan. We have endeavoured to avoid duplication, and this Rebuttal is to be read alongside these documents.

2 ALTERNATIVE PROPOSALS FOR DEVELOPMENT BY SSI

2.1 DNP in para 6.2 of his Proof of Evidence states that SSI will 'deliver STDC's objective' and PR in para 6.19 of his Proof of Evidence states 'These proposals would bring development forward in a shorter timeframe and without interference from the Development Corporation'.

2.2 These statements demonstrate that SSI is taking a blinkered approach which fails to recognise the integrated, cohesive nature of the overall STDC Master Plan, its emphasis on sustainable, high quality employment within a circular, advanced manufacturing environment powered by clean energy with strong linkage to the wider Tees Valley Local Industrial Strategy and Strategic Economic Plan.

2.3 STDC in addition to physical and economic regeneration recognises the importance of social regeneration, the emphasis on the skills agenda and the need to integrate with other key stakeholders regarding the delivery of innovation in order to achieve its strategic objectives. SSI is silent on these points.

2.4 Appendix 1 provides details of a new Cleantech £20m innovation fund recently announced by TVCA to support in large part the creation of a new innovation facility that will focus on clean growth, hydrogen and the circular economy. This illustrates the benefits of a joined up, holistic approach to developing the STDC Area rather than the piecemeal approach suggested by SSI which fails to deliver the necessary synergies.

2.5 DNP in para 6.5 discusses SSI's proposed Scheme A and states that SSI 'has been in active discussions with Jingye regarding an aspiration'. It is worth noting that Jingye have yet to acquire British Steel or their assets at Scunthorpe or Lackenby and that future aspirations are conjecture at this juncture.

2.6 Given the very late and superficial nature of SSI and the Thai Banks engagement on alternative commercial development on the SSI land, coupled with their very limited site due diligence, both PR and SMH's Proofs of Evidence demonstrate a lack of understanding of the scale and scope of work associated with ensuring that aged assets are compliant with current environmental and operational standards and that industrial infrastructure is fit for purpose to support redevelopment and subsequent beneficial operation.

2.7 The extensive detailed work carried out by STDC to fully appreciate the issues associated with regenerating the STDC Area, including potentially re-using aged assets where appropriate within the SSI land, is illustrated in the attached appendices, which are explained as follows.

2.8 First, Appendix 2 is the UK Power Network Services Energy Network Assessment Project Summary, which was commissioned by STDC to ascertain the condition of the High Voltage electrical distribution system across the STDC area which is critical to existing and future potential site occupants. DNP in his Proof of Evidence, para 6.2, states that SSI 'would deliver STDC's objectives', yet no consideration has been given to supporting infrastructure and related costs, such as the provision of power which is critical to industrial development.

2.9 The UKPNS report essentially concludes that most of the equipment is time expired and provides an indicative capital expenditure of £35,505,000 between 2020 and 2025 purely associated with the 66 KV network. The capital expenditure required to replace equipment over the next 20 years is expected to be in excess of £100,000,000. Further work is being commissioned to determine the status and likely costs associated with the 11 KV distribution network. This very clearly demonstrates the challenges faced on the Order Lands and the need for STDC to appreciate these and to develop strategies to address them. Currently STDC is considering the operational models and procurement strategy that would enable this critical infrastructure to be updated and future proofed as required. SSI have given this no consideration.

2.10 Secondly, I note that DNP, PR and SMH refer to restarting iron and steel making on the Order lands, e.g. DNP para 6.8 and PR in para 8.20. However, the level of due diligence SSI ha undertaken appears to have been minimal. DNP states that 'I am instructed that there is no need for additional development to take place'. The source of DNP's instructions, whoever that is, is incorrect. This is not correct. STDC has commissioned two independent reports from the highly respected Materials Processing Institute (MPI):

- Appendix 3 - Economic Assessment of the Restarting of Iron and Steel Making Using the Facilities Previously Operated by SSI UK Limited

- Appendix 4 - Economic Assessment of the Restarting of Steel Making using Electric Arc Furnaces on the Facilities Previously Operated by SSI UK Limited.

2.11 Both of these appendices conclude that the massive scale of capital expenditure required, £972,000,000 and £380,000,000 respectively, together with the cost base of subsequent operations, make it uneconomic and that neither proposal is commercially viable. STDC is supportive of introducing sustainable steel-making to South Tees but SSI neither proposes a suitable location nor a suitable means or process to do so. The SSI proposal is superficial and fundamentally misaligned with the Master Plan and would severely jeopardise delivery of STDC Area-wide regeneration.

2.12 There are other important reasons why the SSI proposals are unacceptable in terms of location and impact on the Master Plan's vision to regenerate the area, which are dealt with by other witnesses.

2.13 SMH in para 11.5 of his Proof of Evidence mentions Portnex and the potential re-starting of the Redcar Coke Ovens to suggest support for restarting coke-making. It is worth noting in rebuttal that this proposal was only supported due to the emphasis on by-product manufacture, rather than Coke production, and the production of methanol which would fit well in our desire to develop a circular economy. Methanol can then be converted to provide greener aviation fuel for example. SSI's proposals, insofar as information is provided about those proposals, do not support this strategy.

3 SSI OPTION OVER LAND ACQUIRED BY STDC

3.1 In PR's Proof of Evidence para 7.16 the inference is that STDC are free to develop the land acquired from Tata in February 2019. This is incorrect.

3.2 When Tata sold part of the site and assets to SSi in March 2011, it conferred upon SSI an option of the same date allowing SSI to acquire certain Tata land. The option is set out in clause 3 of an agreement dated 24 March 2011 made between (1) Tata Steel UK Limited (2) Sahaviriya Steel Industries UK Limited and (3) Sahaviriya Steel Industries Public Limited Company (SSI Option).

3.3 The SSI Option has been protected at HM Land Registry by the registration of restrictions against the relevant titles. The effect of these restrictions is to block STDC from being registered as proprietor of the relevant parts of the site unless either the restrictions are removed or a certificate is produced by SSI in each case to satisfy the terms of the restrictions. To date, SSI have refused.

3.4 The result of SSI retaining these legal options over parcels of the land STDC acquired from Tata is that development or enabling works are prevented until April 2023 at the earliest on a significant proportion of this land. See the drawing at Appendix 5 for further details.

4 SOUTH TEES SITE COMPANY ACTIVITIES

4.1 In para 7.30 and 7.43 of PR's Proof of Evidence he mistakenly confuses the activities of the South Tees Site Company (STSC) with that of the South Tees Development Corporation (STDC).

4.2 As explained in my Proof of Evidence, para 2.6, STSC is a wholly owned subsidiary of BEIS, who operate and keep the site safe and secure under a management agreement with the Official Receiver. STSC therefore, contrary to the statement made by PR, does have permission to undertake these activities. Further, BEIS has committed £49m to remove the on-site hazardous material and hence reduce the safety, health and environmental challenges as well as the STSC running costs currently being funded by the UK Tax payer. This is entirely separate from the activities of STDC and the funding associated with the development of the Order Lands moving forward. Hence the financial assertions of PR in para 7.43 are incorrect.

5 MEETING OF MARCH 2019 WITH SSI

5.1 In rebuttal of the points made by SMH in his Proof of Evidence paras 6.16 and 6.17 I would make the following comments below.

5.2 At the meeting of March 2019 between STDC and SSI/Thai Banks, which I attended, STDC had fully expected to discuss the outcome of the due diligence carried out by SSI/Thai Banks in January 2019 given that the meeting had been delayed to provide sufficient time for conclusions to be formed. Up to this point STDC had provided substantial information in support of their offer, with no counter offer being received from SSI/Thai Banks.

5.3 Contrary to STDC's expectation, and much to our disbelief and considerable frustration, Mishcon de Reya on behalf of SSI / Thai Banks proposed an agenda for the meeting which yet again focused on the details and perceived short comings in the STDC proposals rather than seeking to take forward negotiations. This led to Mr Steve Gibson, Non-Executive Director of STDC, to express his considerable frustration and to reject the proposed agenda. He did not shout or 'throw' the agenda at the Thai Banks representatives. Given the unwillingness of SSI or the Thai Banks to outline their requirements or to offer an alternative proposal and hence with no prospect of any strategic progress, STDC felt they had no alternative other than to bring the meeting to a premature conclusion.

David Allison
CEO
STDC and STSC

Appendix 1 – New £20m fund unveiled to boost cleantech innovation in Tees Valley

Tees Valley Mayor Ben Houchen has revealed a near £20m project which aims to support infrastructure projects being carried out by research and innovation centres in the region.

New £20m fund unveiled to boost cleantech innovation in Tees Valley

A new multi-million pound fund designed to boost the innovation of clean industries and products in Tees Valley has been unveiled.

Tees Valley Mayor Ben Houchen has revealed a near £20m project which aims to support infrastructure projects being carried out by research and innovation centres in the region.

The projects include a new bioscience incubator at Central Park in Darlington, as well as the creation of a new innovation facility that will focus on clean growth, hydrogen and the circular economy offering office and project space for companies locating onto the South Tees Development Corporation site, incubator and large-scale demonstration facilities.

The funding will also be used to support Mayor Houchen's commitment to delivering hydrogen fuelling stations, as well as supporting training and other activities around the digital sector.

Mayor Houchen commented: "There is some truly amazing ground-breaking work going on right here in Teesside, Darlington and Hartlepool, with our highly skilled workers using their expertise in a range of sectors, from clean energy and next-generation manufacturing to bioscience and digital.

"These are the products and processes of the future and are key sectors we need to support, and we as a region are leading the way. This investment will help our first-class research and innovation centres expand their work and create jobs in the sectors we are championing.

"Creating the jobs of tomorrow means investing in the right technology today. I'm delighted that this funding will support a number of significant projects, helping to put us firmly on the map when it comes to clean industry and innovation."

South Tees Development Corporation

Energy Network Assessment

Project Summary

January 2020

Document control

Revision	Description	Project Manager	Prepared by	Checked by	Issue date
1.0	Draft edition	Mike Holmes	Mike Holmes	Kieran Coughlan	16/12/2019
2.0	Version 2.0	Mike Holmes	Mike Holmes	Kieran Coughlan	28/01/2020

Sign off sheet

Authoriser	Company	Title	Signature	Approval date
Lee Maxwell	UK Power Networks Services	Head of Client Delivery		28/01/2020
Client authority	South Tees Development Corporation	Client authority		28/01/2020

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Glossary

Term	Definition
AC	Alternating Current
AMP	Asset Management Plan
ASC	Available Supply Capacity
AT	Auto-transformer
Avg.	Average
BAU	Business As Usual
BEIS	The Department for Business, Energy and Industrial Strategy
BSUoS	Balancing and Settlement Use of Energy
CAPEX	Capital Expenditure
CCL	Climate Change Levy
CfD	Contract for Difference
CHP	Combined Heat and Power
CM	Capacity Market
CO_2	Carbon Dioxide
CRC	Carbon Reduction Commitment
DC	Direct Current
DfT	Department for Transport
DNO	Distribution Network Operator
DUoS	Distribution Use of the System
EBITDA	Earnings before interest, taxes, depreciation and amortization
EfW	Energy from Waste
ESS	Energy Storage System
EV	Electric Vehicles
FES	Future Energy Scenarios
FFC	Fluid Filled Cables
FIT	Feed-In-Tariffs
GSP (s)	Grid Supply Point (s)
GWh	Giga-Watts-hour
HAWT	Horizontal Axis Wind Turbine
HH	Half-Hourly
HV	High Voltage

Term	Definition
IRR	Internal Rate of Return
IT	Isolation transformer
kW	Kilo-Watts (peak power)
kWh	Kilo-Watts-hour (energy consumption)
kWth	Kilo-Watts-thermal (peak)
LED	Light-Emitting Diode
LV	Low Voltage
MW	Mega-Watts (peak)
MWh	Mega-Watts-hour (demand)
NHH	Non-Half-Hourly
NPV	Net Present Value
Ofgem	The government regulator for gas and electricity markets in Great Britain
OPEX	Operating Expenditure
p.a	Per annum
PPA	Power Purchase Agreement
PV	Photovoltaics
RAG	Red Amber Green
RO	Renewable Obligation Levy
SLA	Service Level Agreement
SVC	Static VAR Compensators
TNUoS	Transmission Network Use of the System
WS	Work Stream (s)

Executive summary

Context

The South Tees Development Corporation (STDC) is the first Mayoral Development Corporation outside of Greater London and represents the biggest industrial regeneration opportunity in the UK today. STDC has been established to promote the economic growth and commercial development of Tees Valley by converting assets in the South Tees area into opportunities for business investment. The South Tees area covers approximately 4,500 acres of land to the south of the River Tees, in the Borough of Redcar and Cleveland, and includes the former SSI steelworks site as well as other industrial assets.

STDC have a vision focussed on investment in the community they are located in. Their vision is: “to see South Tees transformed into a hotbed of new industry and enterprise for Tees Valley that makes a substantial contribution to the sustained economic growth of the area and communities it serves, through the delivery of an exemplar, world-class industrial business park that is renowned as a destination for manufacturing excellence.”

STDC through the Energy & Utilities task and finish group have identified an opportunity to develop an energy ecosystem where the following principles could be applied:

- Net zero philosophy that occupants of the site will buy into;
- A community ethos for business users that encourages a co-operative approach to the deployment of energy generation and centrally optimised energy management for a whole site benefit;
- Whole system optimised by considering the sum of the parts to benefit all participants, with clear cost reflectivity;
- Move towards a circular economy by closing energy and material loops; and
- Planning and delivery using a multi vector – electricity, gas, hydrogen, heat and fibre approach.

This executive summary outlines the findings and recommendations from the energy network assessment which covered work streams relating to asset management, network development and energy generation on the South Tees site over the next five years (2020-2024). Individual work stream summaries can be found in each report.

General recommendations

Establish system operation and planning principles that would enable the development of a functioning microgrid:

- **Optimisation:** Establish a set of principles with tenants and developers for the operation and optimisation of all generation and demand on site. This includes optimisation of the technical and commercial operation of the site to the financial and sustainability benefit of end users (e.g. arbitrage of storage and other units) and ensure a balance of supply and demand to avoid over-investment in the network and a poorly optimised connection profile. This supports carbon neutrality of the site;
- **Planning:** Establish planning principles with tenants that encourages a co-operative approach to the deployment and of energy generation and a centrally optimised energy management approach. Consideration should also be given to ensuring that any

development on the site is undertaken in alignment with *"BS EN ISO 19650 – Organisation and digitisation of information about buildings and civil engineering works",* including building information modelling; and
- **Sustainability:** Establish a sustainability policy for the site that can be appropriately applicable to each tenant including expectations through targets, carbon output reporting and monitoring, and peak demand management. This may be captured in both the connection agreement and/or tenancy agreement.

Establish an 'Ecosystem of Energy' programme:
- **Programme development:** From our analysis, and due to the scale and size of the redevelopment, it is clear that a co-ordinated approach to energy system development is required. This approach will facilitate a routine reassessment of priorities and business cases. It is therefore recommended that an 'Ecosystem of energy' programme is developed and aligned to the energy principles of STDC;
- **Incentivise investment in energy opportunities:** This 'Ecosystem of Energy' programme would zone land and tender opportunities to help stimulate investment and partnership on the site. Consideration could be given to supporting investors through incentives where appropriate. Examples of investment that could be stimulated by zoning is energy storage;
- **Measurement, evaluation and research:** Included in the programme would be an approach for measurement, evaluation and research of energy on the site. Visibility of supply and demand across the site will be imperative in ensuring optimisation of all customer connections. This can be achieved through the use of smart metering and data collection and/or aggregation solutions. This will help stimulate further opportunities for value creation and optimisation on site to meet net zero objectives;
- **Innovation:** The programme could leverage a community of local expertise, seek to explore national innovation funding with the aim of ensuring the South Tees site becomes a benchmark for new energy systems both nationally and internationally; and
- **Tenant co-operative approach:** Establish an approach and cross company charter and steering committee from all tenants to ensure the energy principles for the site consider a co-operative approach to the benefit of all tenants.

Replacement and network development recommendations (CAPEX):

Establish a programme of replacement and network development projects and prioritise the delivery of these based on high-priority, prudent and beneficial categorisation:
- **High-priority projects**: Plan and invest in these as early as possible, these projects will enable the mobilisation of the programme. These projects require attention and could be driven by asset replacement priority and/or ensuring that STDC remain compliant with health & safety, environmental obligations and network performance. Or, there is an immediate requirement due to the certainty of a customer connection supported by funding. Before investing a recovery model will need to be developed to ensure any investment can be sustainably recovered by investors. Examples of projects of this category are:
    - Asset replacement of 66 kV fluid filled cables, attention on cables with reported leaks;
    - Asset replacement of Power Station 66 kV and Dock Road Indoor 66 kV substations;
    - Asset replacement of Riverside Pump House 11 kV, Holmebeck 11 kV, Coal Handling 11 kV and Estuary Water Pump House 11 kV substations; and

    - Project programme mobilisation and set-up of a project management office;

- **Prudent projects**: Plan to invest in these project in the 2020-2025 period. These projects categorised by the driver of asset replacement priority, an operational benefit, or there is a requirement to reinforce infrastructure or build new assets for a customer connection that could materialise. Examples of projects of this category are:
    - The replacement of the SCADA control room: and
    - Site enabling ground works and ground remedial works;

- **Beneficial projects**: Plan to invest in these projects if plans for the regeneration site continue to develop as planned. This could be dependent on asset replacement priority, an operational benefit and opportunity to improve efficiency. These projects could only be required if there is a requirement for a customer connection, however, there is a degree of uncertainty over the requirements and likelihood. Examples of projects of this category are:
    - New 66 kV substation in Cleveland North, driven by customer connections; and.
    - New network reinforcement projects only required under certain load scenarios.

Establish connection and design principles for the site to ensure consistent assessment of connections and avoid stranded investments:

- Define the design principles to ensure safety and security of supply is a priority. This could include the details on minimum security of supply standards relative to the size of the connection. It could include information on the options for operational and ownership boundaries that customers could adopt;
- Develop a connection methodology that defines the process for connecting customers to the network aligned to the GB ‘Distribution Code’. The policy should set out the service level that a connecting customer will receive when applying for a new connection, including connection lead times and quotation times. It should include the requirements to form and enter into a connection agreement; and
- Determine the connection charging methodology for customers and define how network enhancements beyond a standard connection will be appropriately proportioned and funded by customers.

Establish a programme management office for the delivery of capital programme:

- The recommended capital expenditure will required a dedicated programme management office (PMO). It is recommended that the scope, function and capabilities of the PMO for the delivery of the capex programme are established either via STDC directly or through a partner. Consideration should be given to the requirements of the office in terms of people, systems, data and connectivity and processes to mobilise the programme including establishment of a Building Information Modelling framework.

Ensure a co-ordinated cross vector utility and fibre approach:

- **Co-ordinated investment:** Assess the approach for planning of capital projects relating to heat, fibre and other utilities to ensure that investment is co-ordinated. Define utility corridors at the planning and design phase.

Operations and maintenance recommendations (OPEX)

Address issues in asset information management through the introduction of an enterprise management system:

- **Asset information and maintenance records:** A significant volume of data has been lost in recent years due to receivership. Some records remain, but there are gaps. Currently records of asset maintenance are captured in spreadsheets however over time it can become cumbersome to maintain such comprehensive data in this format. Introducing an Enterprise Asset Management system such as will allow STDC to move towards an industry standard system of handling maintenance data and enhance the maintenance process for the engineers; and
- **Implementation of 'ISO 55001':** Implementation of an asset management system aligned to 'ISO 55001' would bring STDC up to industry standard and provide an improved line of sight between corporate objectives, asset management planning, project delivery and network performance.

Improve standardisation, reporting and remedial activities in operations of the site:

- **Reporting:** While the assets appear to be managed and reported on effectively, establishing a framework for internal and external reporting would ensure that Environment Agency, 'ESQCR', Design and Construction standards are aligned with expectations. Examples of reporting that should be considered in this framework are reporting on oil losses and collection, gas storage and leaks (SF6), asbestos, storage of hazardous materials, pollution response plans and disposal of assets;
- **'ESQCR' compliance:** It was noted by STSC that there was an exemption from 'ESQCR'. It is recommended to undertake a full asset assessment against 'ESQCR' compliance and address any gaps that may exist;
- **Earthing:** Visual inspections indicated that earthing was not always visible leading to uncertainties on the integrity and design of the earthing. Priority should be given to a full survey of the earthing systems and ground potential rise risks across the site across the site;
- **Asbestos reporting:** As expected with the age of the network asbestos presence is prominent. A review of all asbestos reports should take place with additional surveys if necessary before any works on site shall commence;
- **Storage of hazardous materials:** Controls should be put in place to address the storage of hazardous materials such as SF6 gas cylinders; and
- **Protection settings:** No information was provided regarding the protection settings, standard of operation and overall calibration of the relay network. It is advised that a full survey is undertaken to gain an up to date view of the current protection settings with a plan to optimise the settings.

Develop, deliver and effectively record an annual work programme network asset management, development planning, inspection and maintenance:

- **Planning:** Establish an annual planning cycle for networks asset management and network development. Define planned network outage procedures to manage the continued development of the network; and
- **Maintenance:** Introduce an asset management system tool to create an accessible and intuitive database to record the assets and detail information. Adopt a maintenance and scheduling system tool. This can be embedded within the asset management tool, using the database and portal, to not only hold information on the assets; but also, schedule maintenance, issue projects to the work force, record notes, and track progress. Establish defect reporting mechanism, including consideration of employing National Equipment Defect Reporting System (NEDeRS) and reactive work.

Ensure continued electricity network environmental and safety compliance across the site:

- **Environment:** Develop a framework for ensuring environmental compliance management throughout the site, with attention to the management of fluid filled cable and SF_6 gas. Define the commitments to environmental protection and plans for minimising impacts across the site; and
- **Safety:** Develop and encourage safety compliance management. Ensure safety is the number one priority. Target an 'industry-leading' safety performance and roll-out safety best practices, to demonstrate a 'safety-first' culture. Learn from industry experts and apply proven strategies, systems and innovation.

Generation assessment recommendations

Make an investment decision or invite tenders for generation commercial projects that have been identified as having a business case and continue to monitor and review developing technologies:

- **Renewable generation:** Our analysis recommends that 44 MW of solar PV and 2 MW of wind be considered as the optimal generation solution to meet STDC's forecast demand profile over the forecast period to 2024. Consideration should be given to a phased roll out of the investment to align with growth in on-site customer demand and other generation projects;
- **Energy storage**: Energy storage presents a negative business case for STDC based on our analysis of current market opportunities. This results from a lack of excess energy from generation in addition to a lack of understanding of customer type on-site, in order to identify additional revenue streams. We recommend re-visiting energy storage as part of a periodic review as capex requirements are likely to fall with potential revenues likely to rise; and
- **Periodic review**: Ensure the energy generation strategy is reviewed periodically (at least every two years), encouraging the technologies to come to the site to support the co-ordinated development of the site.

Commercial Recommendations

Establish approach to deliver the capital and operational investment programme for the site both in the short term and long term:

- **Funding:** Funding either through government, or third parties will allow the STDC to meet start-up costs and support initial remedial activities (first five years). A governance structure will need to be established before services can be delivered in the proposed model. The up-front investment requirements and the ability of to recover their investment during the initial years of the site customers on site will need to be considered. Funding should be considered for support activities such as the procurement of the underlying service provider subcontracts, maintenance systems, IT system procurement and integration; and
- **Medium-long term:** identify preferred model for delivering the capital and operational expenditure programme in the longer term. Several options exist including insourcing, outsourcing (DBFOM), outsourcing (public and private), service provider model, and/or a hybrid option of all of the above.[see appendix for detail on each model**]. Establish an approach on exclusivity for the provision of electrical network services within the boundary of the site to provide assurance to investors and STDC that revenue can be recovered. This needs to be provided for under the terms and conditions of the governance processes and specifically approach with respect to exclusivity. The financial viability will depend on the exclusivity granted by the governance provided for on the site.

Establish revenue recovery model from end users:

- **Charging methodology:** To encourage investment by STDC or an investor, a revenue recovery model including an appropriate charging methodology is required, this must be attractive to investors and tenants alike. An agreed charging methodology will provide a level of ongoing profitability (ex-ante) that reflects the risks associate with service provision. This includes consideration of the counterparty risk related to users of the site and ability to recover revenue from this customers on an ex ante basis. The charging methodology principles and structure of service user charges will also provide appropriate pricing signals to the users of the microgrid and any centrally optimised generation. Establish principles for allocation of additional functionality costs where a 'user-pays' principal for additional capability requirements (eg additional connection, metering, or other requirements) is in place and ensure that no cross-subsidy occurs between core users and non-core users (ie users of value added services); and
- **Exclusivity/rights:** STDC or an investor will expect to have a contractual right to recover from its service users its own internal costs and the cost of the contracts of its service providers. It is recommended that exclusive commercial terms are established with all new tenants at the outset and also reviewed with existing tenants.

CAPEX Estimates

Within the 'Asset Portfolio Plan' (APP) we have supplied indicative cost estimations, supported by assumptions, for each of the projects identified in the work streams. These have been assembled based on comparable projects, which should facilitate optioneering and budgetary provisioning of the anticipated scheme. The detailed design and ascertainment of other factors during further development of the projects, could lead to variation from these costs. Similarly strategic procurement initiatives, value engineering and synergies in the programming of the scheme could also affect the cost outcomes. In addition to these cost estimates, where projects have less clearly defined parameters, only illustrative costs have been provided at this stage.

The Table 1 below we illustrate the indicative spend profile as detailed in the APP:

Table 1 - Illustration of CAPEX profile

2020	2021	2022	2023	2024	2025	Total
£7,541,431	£9,704,286	£8,910,598	£4,609,902	£3,691,276	£1,047,507	£35,505,000

Project collaboration

UK Power Networks Services would not have been able to deliver this project without the contributions and collaborative efforts made from staff of STSC. A shared cloud base data environment was set up to allow for the sharing of key data and information which both parties used effectively. STSC provided their input, support and supervision during all workshops, project meetings and site surveys.

1. Background

The South Tees sites has a large amount of existing electrical infrastructure that spreads across the vast span of the site forming a private network. The majority of the electrical network assets have had their ownership transferred to the STDC. The South Tees Site Company Ltd (STSC) is an interim government body appointed by Tees Valley Combined Authority (TVCA), established to be responsible for the safe, secure and cost-effective management of the former site. STSC deploys a ‘make it safe/keep it safe’ strategy, and is responsible for the transferred electrical infrastructure.

UK Power Network Services has been appointed by STDC to deliver a comprehensive assessment and evaluation of the existing electrical infrastructure. The appointment includes developing asset management plans to ensure that the sites electrical resilience and sustainable development can be delivered securely and safely. The plans for new infrastructure will attract new customers in the short term, whilst longer term plans for electrical infrastructure provision will serve the full needs of the proposed development and its future occupants.

2. Introduction

2.1. Project motivation and objectives

The South Tees electrical infrastructure assets include a combination of 66 kV, 11 kV and LV assets. Some of the HV and LV network assets have already been de-energised and removed. The South Tees site network benefits from having two Grid Supply Points (GSP) connected at 275 kV stepped down at Grangetown 66 kV and Corridor 66 kV station respectively. There are nine 66 kV stations, including the above GSP substations. The vast majority of the electrical infrastructure was installed between the years of 1950-1980 and the typical service lives for most of these electrical assets are 40 years.

STDC can encourage the development of the site and attract further investment by leveraging the existing electrical infrastructure as an attractive proposition. A direct connection to a private network that is connected to the transmission system, will be desirable to future occupants that may want to reduce their connection cost, use of system charges and have a more exclusive service of network operation. To ensure that the private network remains attractive it must be able deliver a reliable and secure electricity supply, comply with ‘Electricity Safety, Quality and Continuity Regulations’ (ESQCR), have established electrical safety rules and be sufficiently planned for sustainable growth. Part of keeping the STDC network secure is ensuring that the assets are in good condition, not overdue for retirement, compliant with standards, have no known defects or risks, and meet the desired rating requirements of the network.

The majority of the existing infrastructure has been maintained to a good standard, replaced and at times upgraded throughout its lifespan. However, age and condition needed to be reviewed across the existing asset base to identify which assets are fit for purpose, and which assets should be considered for replacement, refurbishment or removal.

Reviewing the existing asset base supports STDC in planning. Recent discussions with interested parties, potential investors and the development of the master regeneration plan, have allowed for indicative plans to be developed suggesting the amount of load and generation growth that could be realised across various zones on site. There is recognition that to ensure that new occupants can land their own sites, it is key that a secure connection point can be made available within close proximity and that capacity is available to deliver the rating of the new connecting load.

The objective of the energy network assessment is to provide STDC with greater visibility of their current network assets and provide a plan for the replacement of the aging assets. The asset replacement plan is phased alongside a network development plan and the overall programme for the site development for the next five years.

The new STDC regeneration master plan creates an opportunity to also assess low carbon energy generation technologies. STDC requires an energy strategy that addresses the ability to provide sufficient energy to on site occupants, the capability and capacity to export to the grid, alongside an assessment of the associated carbon targets. To meet this objective the project executed an assessment of the generation capability and capacity within the regeneration region. A techno-economic assessment of potential generation and storage technologies has been carried out and recommendations made.

2.2. Project overview

To achieve the objectives of the project it has been divided into three separate work streams, providing clarity over the scope of the deliverables and outputs. Whilst each work stream has its own scope and clear objective, the delivery of the work has taken a coordinated approach, to ensure that each work stream has been delivered in conjunction with the others.

The overview of the scope of the three works streams is represented in Figure 1 below:

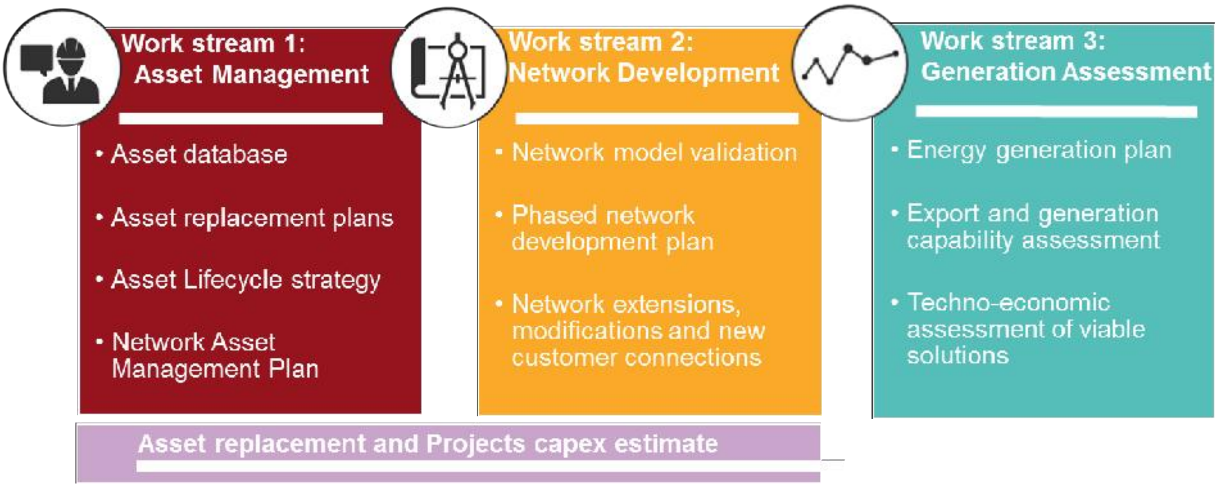

Figure 1 - Work stream scope overview

The scope of each work stream has been delivered and articulated in the following outputs:

Work stream 1: Asset Management:

- 'Asset Database + Asset Replacement Plan';
- 'Asset Management Plan' (AMP); and
- 'Asset Lifecycle Strategy'.

Work stream 2: Network Development:

- 'Network Development Report'.

Work stream 3: Generation Assessment:

- 'Generation Assessment Report'.

Asset Portfolio Plan (APP):

The 'APP' is a combined plan of projects recommended from work stream 1 and work stream 2. Each project has been estimated for capex spend and programmed within the 2020-2025 period.

In Figure 2 below we illustrate the relationship between each of the outputs of the three work streams:

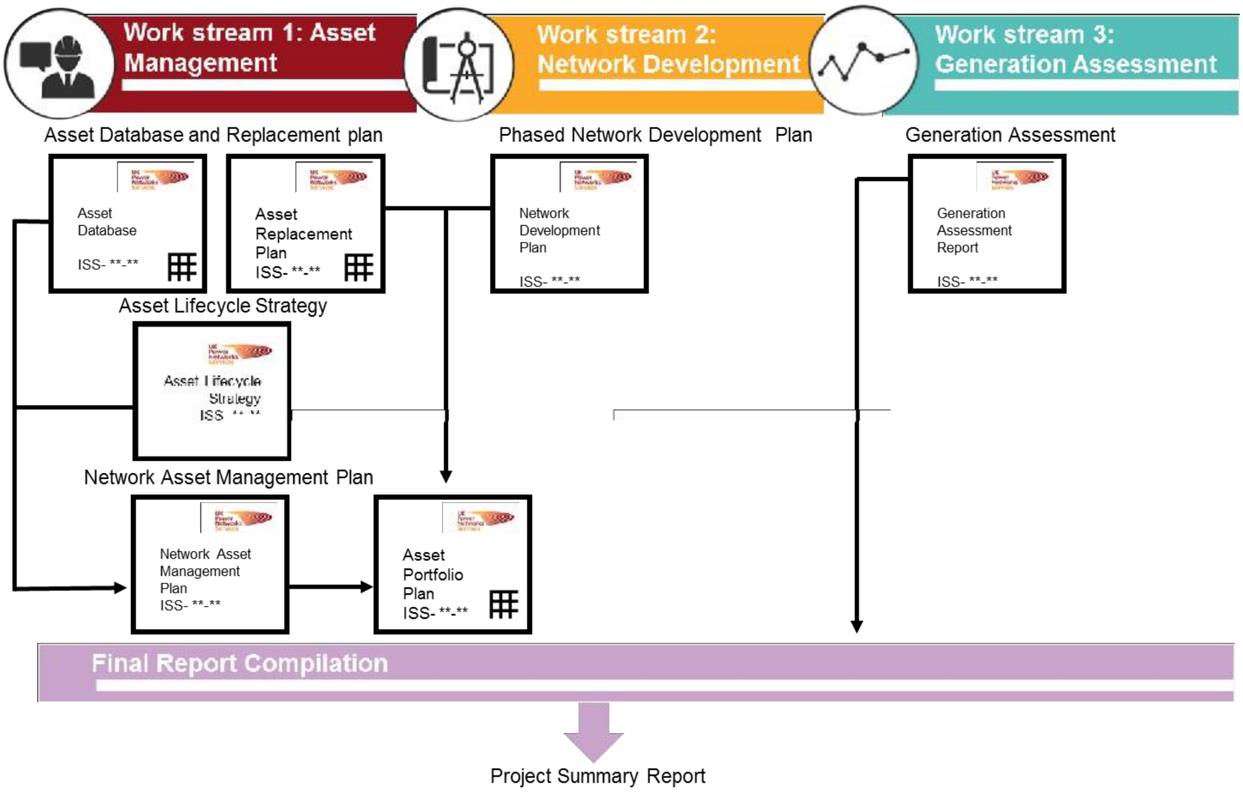

Figure 2 - Work stream outputs

3. Summary of work streams

3.1. Work stream 1: Asset Management

This section summarises work stream 1: Asset Management.

The objective of work stream 1 is to assess the existing asset database, survey the site assets and develop recommended asset replacement projects for STDC to address.

3.1.1. Scope

In order for the electricity network assets at the South Tees site to continue to operate in a reliable manner it is important for STSC to establish an asset management system. The system includes an asset management plan which assists in the development of asset strategy to maintain a safe, reliable and robust electricity network.

Work stream 1 reviews the physical electrical assets and systems owned by STDC, operated and maintained by the STSC on the 66 kV network. The scope includes assets belonging to nine 66 kV substations and four of the 11 kV substations.

This work stream reviews, surveys and suggests replacement projects that fall within 2020-2024 period for the following assets on the STDC network:

- 66 kV Switchgear;
- 66/11 kV Transformers;
- 66 kV Underground Cables;
- Battery Systems;
- Protection Control and SCADA;
- 11kV Switchgear;
- 11/0.415 kV Transformers; and
- Substation related civils.

3.1.2. Exclusions and assumptions

As discussed in 3.1.1 the majority of the 11 kV network is excluded from the scope of this work stream. However, four 11 kV substations were included within the asset review, these were specifically selected by STSC as they feed current site customers. For the purpose of work stream 1 these selected substations and their feeding network have been reviewed on an age and condition basis, with recommendations on investment given within the outputs of the work stream. Other related items that have not been included within the full review and outputs of the work stream include:

- Substation security upgrades (beyond fencing);
- 'ESQCR' compliance improvement details;
- Cable bridges, trenches, pits, ducts, other related civil infrastructure;
- Site-wide replacement of earth network for existing substations;
- 66/11 kV transformers at Beam Mill and REF Mill 66 kV substations are 3rd party assets. Ownership would be up to the point of the disconnectors on the busbars;
- 66 kV SCADA system: this was reviewed on a high level and although a recommendation for the replacement/upgrade of the system has been made a detailed. For a detailed replacement plan a separate survey of the system would be required;
- National Grid owned assets: Analysis was only up to the boundary points, these being the disconnectors on the busbars of Corridor and Grangetown 66 kV substations;
- Load related reinforcement projects on the 11 kV network;
- 11 kV cables: Complete cable records for the 11 kV system was not available therefore 11 kV cables were excluded from any proposed projects; and
- 11 kV protection: SCADA/Telecoms/Relays of the 11 kV system was excluded as part of the scope of works. As per the 66 kV SCADA system. A comprehensive separate survey of the system would be required.

3.1.3. Approach

Providing STDC with an updated review of network assets and asset management system requires a number of sources of information and data to begin. With the assistance of contributors from STSC, we have collaborated to build a new asset database. Using data from the existing database we compiled a new database. We attended site to conduct surveys at each substation, with support and site escorts from the STSC team. The survey information and data captured were checked and populated into the new database.

We reviewed each recorded asset on each line of the database, using the survey information and records that could be obtained from STSC. We assessed whether an item needs to be replaced, refurbished, maintained, or decommission based on criteria, the approach is detailed within the Asset Management Plan. Where an asset requires an intervention, the criticality and year for intervention is assigned to the asset, this informs and populates the asset replacement plan. We use the asset replacement plan to provide a profile of projects throughout the 2020-2024 period, and transfer the relevant project information into the 'APP'. We detail the key findings of review within the 'AMP', alongside the 'Asset Replacement Plan'.

Using the database and the 'AMP' we provide recommendations on how to optimise the lifecycle of each of these asset classes, to prolong their reliability, life and sustainability on the network. This is detailed in the 'Asset Lifecycle Strategy' report.

3.1.4. Outputs

The work stream 1 outputs are summarised below:

'Asset Database and Asset Replacement Plan': A combined database pooled from the existing asset register, on site information and survey data. The database consists of instances of data gaps where information could not be retrieved or found on a particular asset. Further reviews of assets and updates of the database will be required for STSC to update these data gaps. The replacement plan is a model of each asset that requires an intervention within the 2020-2024 period.

'Asset Management Plan': A report that provides STDC with tools to apply a systematic approach to asset management. The 'AMP' provides information about the assets including functionality of each asset, the approach to inspection and maintenance, asset failure risk, integrity issues and how the assets should be disposed.

'Asset Lifecycle Strategy': A report providing information on each asset class. It details the approach to ensure that STDC can maintain the lifetime costs of an asset to a minimum, but at the same time optimising the performance of the assets. It considers compliance with safety and regulatory policies and legislation.

Whilst not part of work stream 1 outputs the 'Asset Portfolio Plan' (APP) has been developed using the outputs of this work stream and is detailed in 3.4.

3.1.5. Findings and recommendations

Capital requirements

A visual inspection of the nine 66kV substations was conducted by a team of UK Power Networks Services engineers. Additionally we received support from STSC staff including asset data (where available), and maintenance data (where available). Our general findings are provided by asset class below based on the information obtained.

Due to the nature of the site and the loss of information over the years, it should be noted that some information was unavailable, and in some cases network models did not fully reflect the system reviewed. The recommendations provided in this document are based on site visits (visual inspection of some assets) and the information that has been made available to us by STSC. Information that was not provided include:

- Inspection and maintenance methodologies that STSC have applied;
- Fully detailed inspection and maintenance reports;
- Records of oil and gas leaks;
- Failure rates;
- Full cable asset register including cable routes;
- Full oil sample results – Switchgear, Transformers, Cables;
- 11kV network diagrams; and
- Age/Manufacture date of all assets.

All projects should be justified on a case by case basis as development on the site commences.

Switchgear 66kV

It was found that the 66kV switchgear was in a reasonable condition but is beyond design life and expected asset life in most cases.

The asset condition observed, as well as the asset age at Dock Road and Power Station substations has driven the forecast requirement for replacement within the next 5 years.

In addition to this, two substations have been identified for decommissioning as part of network optimisation:

- The close proximity of Beam Mill and REF Mill substations relative to each other will facilitate the diversion of Beam Mill transformers across to REF Mill substation leaving Beam Mill for decommission
- As per Beam Mill, the close proximity of Kinkerdale and Grangetown substations relative to each other will allow for decommissioning of Kinkerdale.

Consideration should be given to a phased replacement of the remaining substations over the next ten years as they are age expired.

Underground Cables 66kV

Fluid leaks are present on three circuits totalling approximately 7km. While in the current low load conditions, these do not present an issue in terms of resilience. However as demand increases on site it is expected that reliability and leaks will worsen.

All regulated distribution networks in the UK currently have a programme for the replacement of fluid filled cables.

Commencing the replacement of 66kV Fluid Filled Cables is recommended over the next five years. This timing of this should be aligned with diversions and site utility corridor developments to minimise costs.

It should be noted that cable tunnels and troughs conditions appeared poor. A further survey is required to determine the extent of works required to renew these structures along future cable/utility routes.

Transformers 66/11kV

The 66/11kV transformers, of which there are fourteen under STDC ownership, are all in need of remedial works to improve asset condition and extend asset life as signs of rusting, corrosion and oil leaks are present. In particular the transformer sub-components have deteriorated at a greater rate than the main transformer units and hence by replacing these parts the lifecycle of the asset may be extended.

- Replace transformer cooling systems – new radiators/fins, fans and pumps;
- Replace the control kiosks/gear;
- Replace the LNERs;
- Refurbish tap changers; and
- Refurbish transformers units.

This will ensure the continued safe running of the transformers over the next ten years before the main transformer units will need to be replaced.

Switchgear 11kV

In addition to the 66kV network, four of the customer connected 11kV substations were inspected. The 11kV switchgear were found to be obsolete as no manufacturer support or spare parts available. In general the population of 11kV switchgear was Brush VSI type gear and in a poor condition.

It is recommended that these are replaced as part of a full substation replacement with containerised GIS 11kV substations.

Transformers 11/0.415kV

The 11kV/415V transformers that were assessed were past their expected asset life and in poor condition.

It is recommended that the transformers are included in the replacement plan with the corresponding substations:

- Holmebeck substation;
- Estuary Water Pump House substation;

- Riverside Pump House substation; and
- Coal handling substation.

Battery systems

Several of the battery and charger systems at the 66kV substations are in a poor state with loose wiring, corrosion and low levels of fluid in the wet cells.

These have been identified for replacement at the following 66kV substations:

- REF Mill;
- Coke Ore;
- Corridor; and
- Pellet Sinter.

Protection Control and SCADA

A high level overview of the Protection and SCADA systems was conducted during the main site inspection.

Visually it was not possible to adequately ascertain the condition of the protection relays as it forms part of a much larger system. However discussions on site with STSC staff and maintenance history data indicated that the relays and SCADA system are in working order. However we have no data regarding the protection settings, therefore under fault conditions thresholds on the relays are unknown and may not perform as required.

Additionally, through the proposed development and reconfiguration of the network over the next five to ten years these systems will naturally be replaced with the installation of new substations and the existing control room at Power Station will be retired with the building.

It is therefore recommended that a new SCADA system or an overhaul of the existing SCADA system is undertaken with a new control room established either on or off site.

Civil Assets

From a visual inspection, brick built substations were found to be in a generally good condition with minor defects such as loose slabs and brick work.

However, there were significant issues identified related to the structures of the transformer brick built blast walls. These were leaning in some instances. Remedial works will be required and STSC staff have noted that there is a programme in place and therefore no additional recommendations have been made.

There is already enhanced security with perimeter fencing around three of the nine 66kV substations that have been identified with a high security risk due to their locations on site. However, it is advised that palisade fencing could be installed around each 66kV substation and transformer areas to increase security.

Operational requirements

This section outlines additional risks and opportunities identified for STSC in the management of the assets at STDC which will form additional operational expenditure.

Asset Information management

It was evident that STSC have applied an adequate frequency of maintenance works in place with 4 yearly inspections of their 66kV substations but it was not known what these consisted of as maintenance methodologies were not provided.

However due to the vastness and age of the network, the network could benefit further if a comprehensive asset management system was put in place.

As it stands some of the main areas where improvements could be seen include:

- Asset data – There is a vast quantity of asset data available however most of this data is in a hardcopy format. If this was sorted and digitised onto IT systems it would greatly enhance and speed up the data acquisition process allowing data to be accessed quickly, securely and in a suitable format.
- Asset Maintenance – Currently records of asset maintenance are captured in spreadsheets however over time it can become cumbersome to maintain such comprehensive data in this format. Introducing an enterprise asset management (EAM) system such as SAP/Maximo/Ellipse will allow STSC to move towards an industry standard system of handling maintenance data and enhance the maintenance process for the engineers.
- Failure rate/issues monitoring- establish an approach for monitoring asset failures and issues on site. This will support improved asset stewardship in the longer term.

Implementation of an asset management system to the standard of ISO 55001 would bring STSC up to industry standard, providing a set of tools to increase network performance, resilience, optimise capital and operational expenditure all whilst achieving compliance.

Standardisation, reporting and remedial activities

This could be further improved upon in the following ways:

- ESQCR – perform a full ESQCR site survey to identify opportunities to further enhance safety on the network bringing the site closer to industry standards, bringing improvements for operators and customers. As compliance to ESQCR is a statutory requirement for distribution network operators; Labelling across the site should be included in this review;
- Reporting - reporting of gas (SF_6) and oil losses to the Environment Agency; and
- Inspection and maintenance standardisation – It was not clear what Inspection & Maintenance standards STSC follow other than frequency. It would be prudent to identify gaps and address through the development of new standards.
- Confined spaces – consideration of substation basement levels to be classed as confined spaces;
- Earthing – visual inspections indicated that earthing/bonding was not always visible leading to uncertainties on the integrity of the earthing nests. Priority should

be given to a full site wide survey of the earthing systems and designs. Following this a ground potential rise survey should be completed;

- Asbestos reporting – As expected with the age of the network asbestos presence is prominent. A review of all asbestos reports should take place with additional surveys if necessary before any works on site shall commence;
- Storage of hazardous materials – Controls should be put in place to address the storage of hazardous materials such as SF_6 gas cylinders; and
- Protection settings – no information was provided regarding the protection settings, standard of operation and overall calibration of the relay network. It is advised that a full survey is undertaken to gain an up to date view of the current protection settings with a plan to optimise the settings.

3.2. Work stream 2: Network Development

This section summarises the work stream 2: Network Development.

The objective of work stream 2 is to assess the existing network and develop recommended customer connection and reinforcement projects, for STDC to further investigate once more detailed information and confirmed plans are available.

3.2.1. Scope

Work stream 2 focuses on the assessment, replacement planning and development of the 66 kV energy network. The objective of this work stream was to:

- Analyse the future distributed generation and demand connections by general location and year of connection;
- Identify thermal and voltage constraints that may occur on the 66 kV network which will limit the ability of those connections to take place; and
- Assess options for reinforcement of the 66 kV network.

We have used the background scenarios provided by STDC as a framework to develop detailed scenarios for the growth in ‘distributed generation’ and demand. The scenarios were applied to the electrical model of the 66kV network to assess their impact on the network.

3.2.2. Exclusions and assumptions

The full details of assumptions and exclusions are outlined in the ‘Network Development Report’. As aggregated demand values have been provided, and no point of connection specified, the loads have been modelled as lump sums connected to the nearest 66 kV substation in the geographical area. As with demand connections the generation is modelled as aggregated capacity values, with no point of connection specified, the generation connections have been modelled as lump values connected to the nearest 66 kV substation in the geographical area via an 11/66 kV step up transformer.

The studies under this scope of works focus on the 66 kV network; no assessment has been made of the 11 kV network.

No studies have been performed to assess the network requirements for the construction phase or temporary builder supplies. In many cases large developers, future occupants and there construction partners will be able to provide their own power generation for construction supplies. However, it is reasonable to assume that there will be requests to provide temporary power for construction, this should not be discounted in future planning of the network and its development.

Only load flow and fault level studies have been carried out, assessing steady-state voltages and power flows to ensure equipment is adequately rated and system voltages within tolerance.

No transient and dynamic stability studies have been undertaken to ensure generation and the network remain stable following circuit switching or a network fault and to predict any possible loss of synchronism. Nor has any other power quality studies been undertaken. No protection grading or coordination studies have been undertaken.

No earthing studies have been performed.

3.2.3. Approach

An existing model of the energy network built using ETAP was supplied by STDC. This model was validated, updated and correcting using existing site records and the survey information. Forecasted loads and future generation connections provided by STDC were reviewed and modelling scenarios established.

For each scenario the network model was used to analyse:

- The voltage at each bus;
- Voltage drop on each feeder;
- Power flow and losses in all branches and feeder circuits; and
- Three phase fault levels.

The outputs of the analysis in conjunction with the asset condition assessments were used to identify and recommend any reinforcement works to the 66 kV energy network.

3.2.4. Outputs and findings

The output document of work stream 2 is the ‘Network Development Report’. The project recommendations were included within the ‘APP’ as discussed in 3.4. The network was assessed in detail for seven yearly scenarios; 2020, 2021, 2022, 2023, 2024, 2025 and 2030. For each scenario the 66 kV network was assessed for thermal and voltage violations under normal operating conditions ‘System Intact’ and outage conditions ‘First Circuit Outage and Second Circuit Outage’. The ‘Network Development Report’ details the outcomes of analysis in full detail, and provides the recommended network modifications and reinforcements required to supply the future development in the given scenario. The following summarises the outputs of the analysis.

2020-2024 Network Summary

The 66 kV network is capable of supporting the forecasted demand up to year 2024 without further network reinforcement beyond that already achieved as part of the recommended programme of asset replacement.

From 2024 the network becomes heavily reliant on the availability of the on-site generation, with a generation plant outage resulting in overloading of the super grid transformers.

As a result of the increase in demand in 2024, network reinforcements are required to maintain security of supply and prevent overloading of the super grid transformer at Grangetown under outage conditions.

2025 Network Summary

In 2025, significant demand and generation is added to the network resulting in even further reliance on the availability of the on-site generation.

With group demand at Dock Road Indoor 66 kV Substation exceeding 60 MW, additional circuits are required between Grangetown 66 kV Substation and Dock Road Indoor 66 kV Substation to achieve security of supply compliance. Additional circuits are also required between Grangetown 66 kV Substation and Cleveland North 66 kV Substation and between Corridor 66 kV Substation and Ref Mill 66 kV Substation to overcome to thermal issues resulting from outages.

From 2025 under voltage issues are experienced on the 66 kV network under outage conditions, particularly in the event of an outage of the EFA or EFB generation plant.

2030 Network Summary

By 2030 the demand minus the contributions from the on-site generation exceeds the grid intake supply of 2 x 120 MVA by approximately 20 MVA when considering 100% generation output.

From 2030, under voltage issues are experienced on the 66 kV network under system intact conditions.

3.2.5. Recommendations

The recommendations from work stream 2 are the following:

- Our modelling shows that in 2024 the network becomes heavily reliant on the on-site generation and by 2030 the super grid transformers become overloaded. We have assumed a load profile for the demand and generation from the information available, it is recommended that further studies are undertaken once the demand and generation profiles are confirmed. Confirmation will initiate further validation of the modelling and initiate engagement with National Grid on capacity at the GSP. Consideration may also be given to the options of:
    - Load shedding in the event of a generating plant outage;
    - Reconfiguration of the network with additional SGTs in operation;
    - Replacing the existing Grid Intake Substations with new Intake Substations supplied under normal operation from the 600 MW Generation CPS and in the event of a Generation CPS blackout supplied by National Grid under reduced loading conditions; and
    - Automatic voltage regulation on the primary side of the SGT.
- At the time of this report, connection details and profile information was not available on the demand and distributed generation to be connected to the network; therefore, the network connections could not be modelled to the full extent. Therefore, it is recommended that further studies are undertaken when designing and developing the demand and generation connections, to avoid conditions such as system overload, over and under voltage, system frequency variations and reduced system power factors;

- It was noted from the network simulations that there are existing voltage issues on the 11 kV network. It is recommended that studies are undertaken on the 11 kV network to evaluate the impact of the demand and generation connections on the 11 kV network;
- It is recommended that transient and dynamic stability studies are undertaken when designing and developing the demand and generation connections to ensure that the generation and the network remain stable following circuit switching or a network fault and to predict any possible loss of synchronism; and
- It is recommended that protection studies are undertaken when designing and developing the demand and generation connections to ensure adequate protection of the network.

3.3. Work stream 3: Generation Assessment

This section summarises work stream 3: Generation Assessment.

The objective of work stream 3 is to develop a 'Generation Assessment' for STDC that addresses the 'energy trilemma' (security of supply, sustainability and affordability) and recommends tactical electricity generation initiatives to deliver these objectives.

3.3.1. Scope

The South Tees industrial 'Masterplan' covers an area of 4,500 acres. The plan includes the former SSI Steelworks site and surrounding land, Teesport, Bolckow Industrial Estate and South Tees Freight Park. The proposed 'Masterplan' is intending to re-generate the area. As a result of the re-generation, the energy demand will increase and this demand could be met in part by a number of distributed generation assets.

In work stream 3 we assessed the currently available generation technologies through a techno-economic analysis to provide STDC with the optimal choice and sizing of technologies to best meet the demand of the site over the next five years. The technologies considered include:

- Solar PV;
- Onshore wind;
- Offshore wind;
- Tidal run-of-river;
- Tidal (sea);
- Battery storage;
- CHP;
- Energy from waste; and
- Anaerobic digestion.

Additionally, in the 'Energy Generation Assessment' report, we have assessed the global, national and local energy policies to understand their impact on STDC and also assessed the available commercial model alternatives for RE development to recommend the most beneficial option for STDC.

3.3.2. Exclusions assumptions

The following exclusions and assumptions were identified, further details are provided in the 'Energy Generation Assessment' report and are summarised below:

- All work is limited to a five year timeframe (2020-2024);
- The peak demand and generation for the site over a 25 year period has been provided by STDC and used in the technology review as well as in the technical and financial modelling;
- The energy generation plan focuses on medium to large scale generation only (~above 5MW). Small scale generation within dedicated industrial plots (tenants) has not been included and should be considered on a case by case in parallel with the tenants;
- All proposed technologies are subject to detailed design, surveys, planning permissions and other relevant consents;
- Existing and planned demand and generation have been provided by STDC. When several options were given, the worst case option for generation has been assumed (when demand is lowest);
- This study is limited to a desktop analysis;
- All costs for the proposed technologies are estimated based on current market values (2019). Further detailed designs and procurement will define the final costs with more accuracy;
- Residual values for the proposed technologies are excluded;
- Heating supply strategy is excluded, this analysis is focused on electricity only;
- Grid connection capacity exploration and costs have been excluded due to being outside this project scope (scope changed since the original proposal due to limited information available);
- Point/s of connection for the proposed generation plant are excluded as these are highly likely to be at the 11kV network (11kV network is excluded from this project scope);
- A typical discount factor of 7% has been assumed for modelling cash flows;
- Customers (end users) connected directly to the private on-site distribution network are expected to avoid DUoS charges, but will be subject to an alternative distribution network charge to cover the cost of the private network; and
- Detailed energy trading for energy storage has been excluded due to current and future STDC energy tariffs being unknown and limited visibility on energy contract details.

3.3.3. Approach

Work stream 3 was carried out in five steps and the project methodology is described in Figure 3.

During Steps 2 and 3 in Figure 4 a wide range of technologies were initially considered and then consequently filtered down in a four phase process as illustrated in Figure 4. These four phases (A, B, C and D) have been divided in two main stages: the initial technology review (Stage 1) followed by the detailed technology review (Stage 2).

Solar PV, battery storage and on-shore wind were selected as the most suitable technologies to be explored in the technical and financial models.

Excess from on-site RE generation is minimal for the proposed plant and therefore battery storage was analysed in isolation operating in energy arbitrage mode (buying electricity for the grid when prices are low).

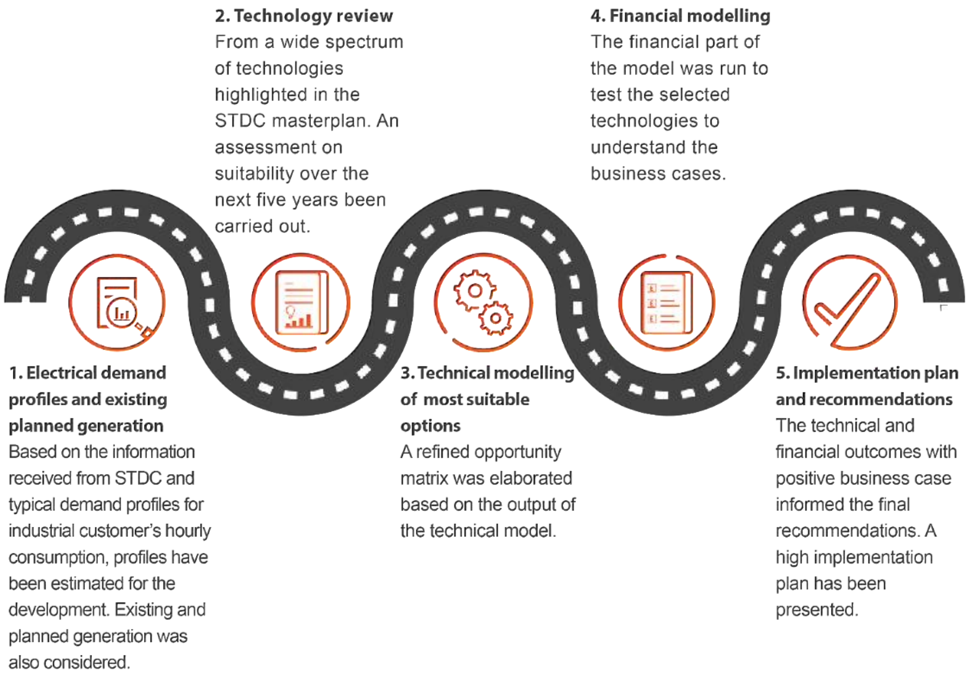

Figure 3 - Work stream 3 approach

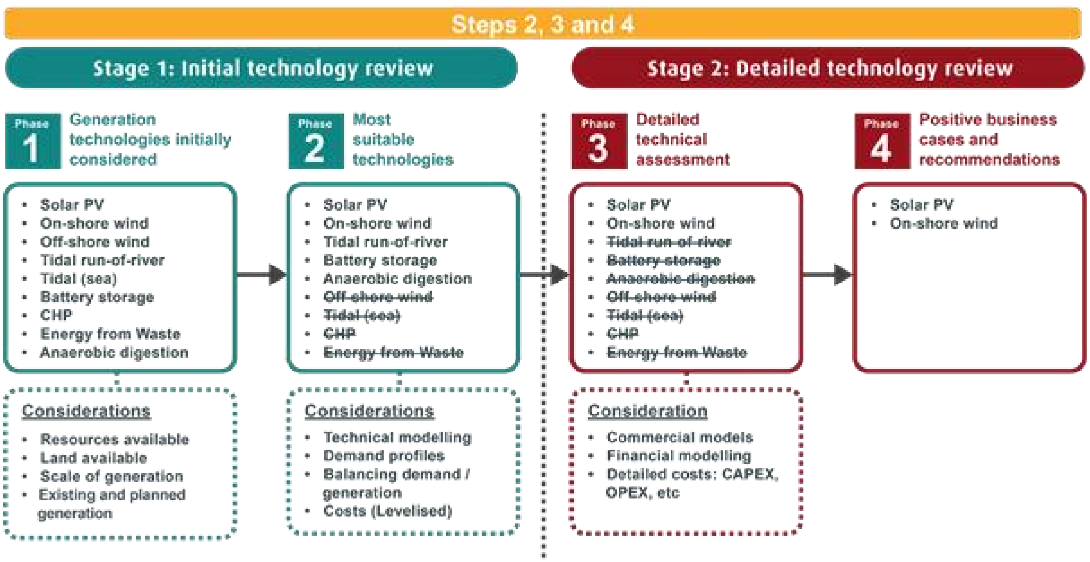

Figure 4 - Technology review

3.3.4. Key outputs and findings

Technical and financial analysis

The technical and financial analysis found that the optimal generation solution for the STDC site over the next five years recommends 44 MW of PV and 2 MW of Wind to be installed. All other technologies were discounted, the reasons for which are provided in the Energy Generation

Assessment report. The recommended on-site RE generation solution could generate up to 12.2% of the total energy required from the first year of operation - after discounting the energy generated by the existing or already proposed on-site power stations.

The business case for the proposed technologies is positive with an NPV of £15.7m and a discounted payback period of 13.6 years which is currently typical for this type of installation.

The financial outputs of the proposed solution are summarised in the 'Energy Generation Assessment' report and the cumulative discounted cash flows are shown in below in Figure 5 below.

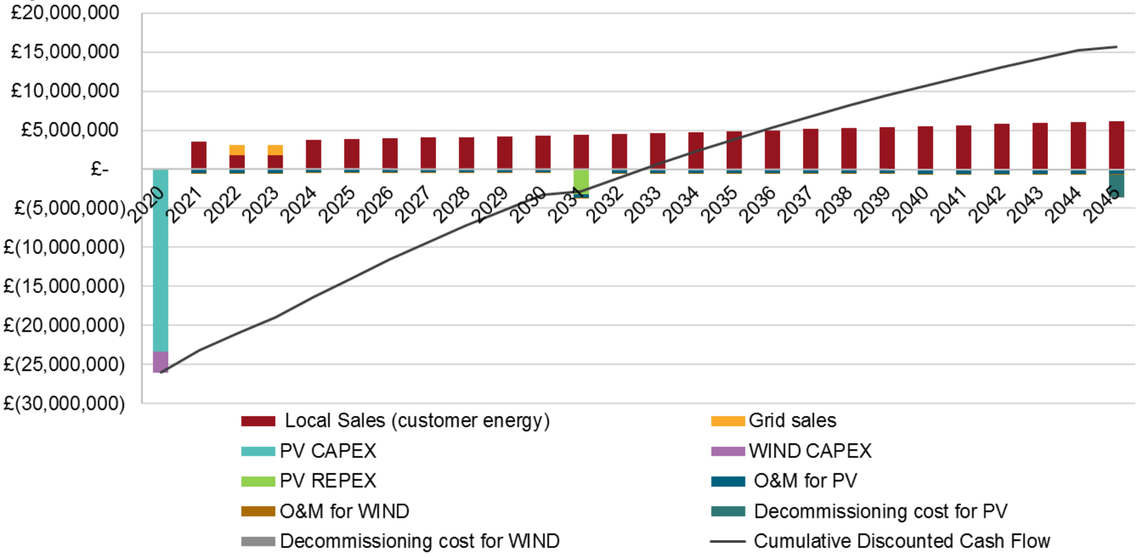

Figure 5

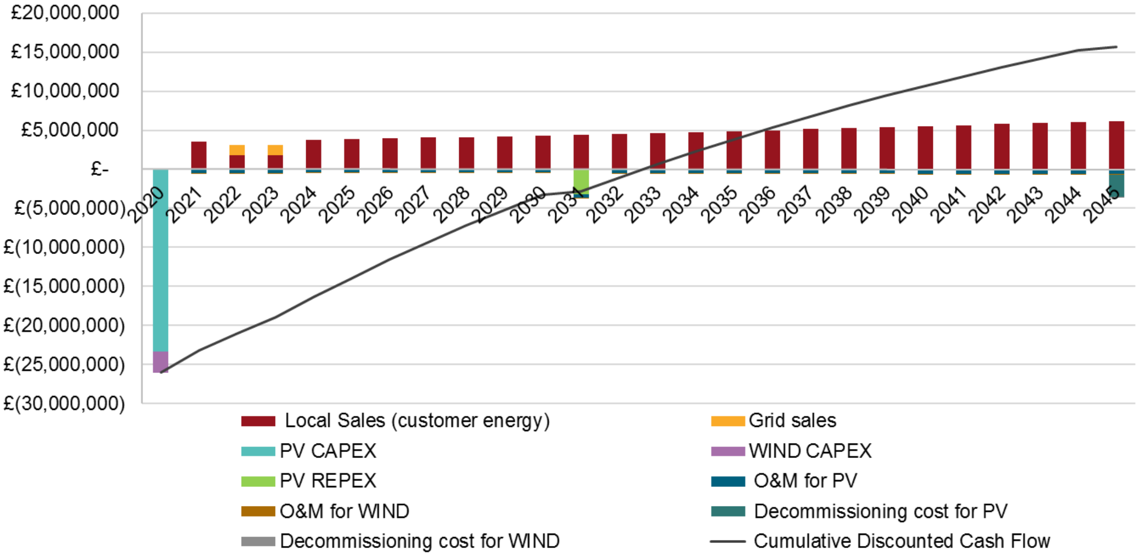

Figure 5 - Cumulative discounted cash flows @7% of the proposed solution

Due to the minimal RE excess, a high level financial analysis has been performed for the 15 MW / 15 MWh battery installation operating purely on energy arbitrage mode. The outcomes suggests that the potential battery would break even at year 10 which is the lifetime of the asset. It is therefore, not recommended to proceed with the installation of the battery at this stage without accounting for additional revenues which could add value to the investment (stacked revenue streams). However, it is recommended that the business case for battery storage is re-examined at a later stage of the development as it can bring additional benefits such as added resilience, network stability and enabling the implementation of a microgrid.

Implementation plan

A high level implementation plan 'roadmap' has been prepared for STDC, as shown in Figure 6. This plan provides STDC with a high level view of the required activities to deliver the recommended RE projects over the next five years.

Figure 6 - Implementation plan for the RE plant

Assessment of commercial models

In the 'Energy Generation Assessment' report, different commercial models have been explored to understand the business case for on-site generation for STDC. Our assessment suggests that the most beneficial commercial model for STDC would have STDC retain the ownership and control of the RE generation plant, and sell energy to local tenants via its private network (or private wire). This private wire arrangement is the most financially attractive way to develop large scale RE generation in the UK.

3.3.5. Recommendations

The following recommendations have been established from Work stream 3:

- The current national and local policy, legislation and environmental agenda is driving the green initiative's agenda at pace. There is a significant opportunity for STDC to facilitate the creation of a renewable energy (RE) hub with innovation at its core;
- Solar PV and wind energy are recommended as the most suitable technologies for on-site RE generation during the first five years of the proposed 'Masterplan' (2020-2024);
    - Two large scale ground mounted solar PV farms (21MW and 23MW), located to the east wing (Plot 2) and west wing (Plot 1) of the 'Masterplan' co-located with a 2MW wind turbine (in Plot 2) are recommended as the optimal technology options at this stage. The selected plots for RE generation are in line with South Tees Regeneration Master Plan;
    - There is a significant opportunity for STDC to own the proposed RE generation plant and sell electricity via a private wire to local industrial tenants. The business case presented for this arrangement is positive with an indicative IRR of 12.3% and NPV of £15.6m over 25 years; and
    - To maximise returns it is recommended that STDC defers the completion of the solar PV and wind plants to 2024, when sufficient load is expected to have been connected to the network in order to absorb 100% of the energy generated. Export could be an option in the interim, making however the business case less attractive. Alternatively the RE plant could be expandable and modular, and built over time in a phased manner to match the site's demand forecast.
- Early engagement and negotiation with the planning authorities, suppliers, RE developers, tenants and energy suppliers is highly recommended to increase certainty around the presented business case and identify any stakeholder risk at an early stage;
- Continuous review of the developed proposition and monitoring the market for other technologies such as battery storage, tidal run of river or anaerobic digestion can offer generation opportunities to explore further. For example, the business case for energy storage could flip positive if market conditions and STDC requirements align to allow for stacked revenue streams. For example, the business case for energy storage could flip positive if market conditions and STDC requirements align to allow for stacked revenue streams. Future reviews of available generation technologies and associated opportunities are recommended every two years to continually review the business case of the proposed projects, technology market re-assessment and the comparison with the demand and generation characteristics of the site; and
- Maintaining an accurate data set, maintaining the overall use plan for the plots and understanding of the existing and future loads and generation plants. This is key to informing strategic decisions around on-site generation and successful commercial models.

3.4. Asset Portfolio Plan

3.4.1. Scope

In work stream 1 we provide an ‘Asset Replacement Plan’ that accompanies the ‘AMP’. This database provides STDC with profile for replacement projects within the 5 year period of 2020-2024. In work stream 2 we provide a road map for network development from 2020-2025, that considers the assets being replaced and provides the recommended projects for new customer connections and network reinforcements. To present the projects in a combined database we have developed the ‘Asset Portfolio Plan’ (APP).

The ‘APP’ provides a projects by projects plan, programmed on a yearly basis to be delivered in the period of 2020-2025. To enable STDC to forecast the investment required in this time period, we have provided an indicative estimate for each project. Where projects have less clearly defined parameters, only illustrative costs have been provided at this stage. The forecast can be used to determine an investment profile and assess which projects are necessary or least regrets investments.

3.4.2. Exclusions and assumptions

‘APP’ includes the projects identified within the scope of work stream 1 and work stream 2. This includes all assets reviewed on the 66 kV network under STDC control and just four 11 kV substations that are feeding existing customers. As stated previously the 11 kV network has not been considered in terms of load flow within the scope of work stream 2, the 11 kV assets that have been reviewed only on a condition and age basis, to advise on the recommended decision regarding replacement, refurbishment or maintain.

The ‘APP’ includes the following indicative estimates:

- Cable replacement programme of all 66 kV cables;
- 66 kV substations new builds and replacements where identified;
- The extension of 66 kV substations as identified;
- Decommissioning and removal of redundant substations; and
- Cable decommissioning (not including recovery).

The ‘APP’ includes the following illustrative estimates:

- Construction and temporary builder supplies;
- Site setup and mobilisation costs, including ‘Project Management Office’;
- Replacement of existing SCADA system;
- Ground remedial works; and
- Prelims and enabling ground works.

The ‘APP’ excludes any estimates for the following:

- Substation building repair;
- Substation security upgrades (beyond fencing);
- ‘ESQCR’ compliance mods;
- Operational expenditure that isn’t capitalised to projects;

- Cable bridges and other related civil infrastructure replacement;
- Load related reinforcement/connection projects on the 11 kV network;
- Site-wide protection coordination study;
- Site-wide earthing study and replacement of earth for existing substations; and
- Projects identified in work stream 3.

3.4.3. Outputs

The 'APP' provides a comprehensive view of forecasted spend on the private network between the years 2020-2025, within the boundaries of this project's scope. The estimated spend profile is presented within the 'APP' document and discussed below in section 4. Least regrets investments.

Within the outputs of work streams 1 and 2 suggested project years are provided for the asset replacement and new build projects. In some cases the 'APP' programmes projects in a different order, ensure the programme can be delivered efficiently and disruption from construction is minimised.

eg In the 'Network Development Report', section '6.6.5 Reinforcement works', it is recommended that two new 66 kV feeder cables are required between Grangetown 66 kV substation and Dock Road Indoor 66 kV substation to achieve security of supply compliance in 2025. However, in the 'Asset Replacement Plan' there is a project detailed for the asset replacement of the two existing cable circuits between Grangetown 66 kV substation and Dock Road Indoor 66 kV substation in 2020, project no. CABL-0002. Therefore, the two new circuits detailed in the 'Network Development Report' will be bundled into the same programme as the asset replacement project of the existing cables in 2020, as per CABLE-0002 and CABLE-1002 in the 'APP'.

Each project has been identified as a specific work type; 'mobilisation', 'NAMP', 'connection', or 'reinforcement'. These are defined below:

Mobilisation: Projects required to enable the programme and preliminary works for site setup, as well as the ongoing function of the project management office

NAMP: Projects identified by work stream 1, they include asset replacement, asset diversions, decommissioning and asset refurbishment.

Connection: Projects identified in work stream 2, which are anticipated requirements to be able to connect the new customers as per scenarios provided by STSC.

Reinforcement: Projects identified in work stream 2, these are wider network reinforcements that are only required as a consequence of the increased load in the scenarios provided by STSC, but are not directly linked to a single or group of customer connections or group of connections.

Figure 7 below illustrates the indicative estimate of spend on projects categorised by each work type for each year of the 2020-2025 programme. This programme has been developed based on technical requirements and without consideration of resource optimisation.

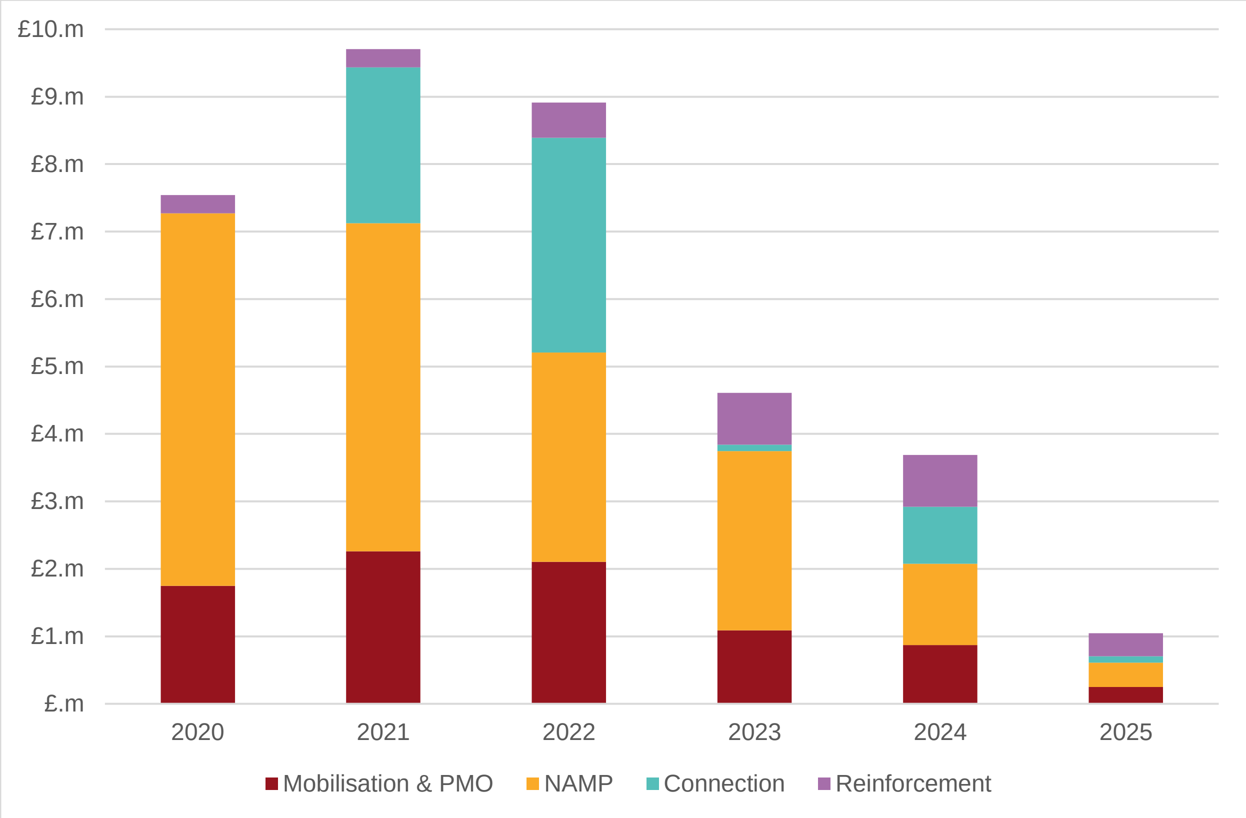

Figure 7 - Work type spend profile

4. Least regrets investments

4.1. Approach

When investing in any infrastructure the investment decision will always carry a degree of risk. In some instances where a decision is made to replace or refurbish an asset due to its condition, there could be a change in plan or site arrangements that would deem it redundant. In this case the asset is left stranded and the investment benefits would no longer exist. To avoid or reduce the risk of this happening an assessment across the STDC portfolio will identify the projects or investments of least regrets.

4.2. Investment risk assessment

To provide greater clarity over which projects or assets require investment as a necessity or those that could be differed, the investments can be categorised into separate investment risk categories. Within the 'APP' each project is identified as 'high-priority', 'prudent' or 'beneficial', these are defined below:

High-priority: Plan and invest in these as early as possible, these projects will enable the mobilisation of the programme. These projects require attention and could be driven by asset replacement priority and/or ensuring that STDC remain compliant with health & safety, environmental obligations and network performance. Or, there is an immediate requirement due to the certainty of a customer connection supported by funding. Before investing a recovery model will need to be developed to ensure any investment can be sustainably recovered by investors.

Prudent: Plan to invest in these project in the 2020-25 period. These projects categorised by the driver of asset replacement priority, an operational benefit, or there is a requirement to reinforce infrastructure or build new assets for a customer connection that could materialise.

Beneficial: Plan to invest in these projects if plans for the regeneration site continue to develop as planned. This could be dependent on asset replacement priority, an operational benefit and opportunity to improve efficiency. These projects could only be required if there is a requirement for a customer connection, however, there is a degree of uncertainty over the requirements and likelihood.

4.3. Investment Plan

Using the 'APP' and the categorisation of investment risk for each project we have forecasted the indicative estimate across the programme. Further detail on each project and the risk categorisation can be observed in the 'APP'.

Figure 8 provides an illustration of the indicative spend profile of investments, categorised by investment risk, over the 2020-2025 programme:

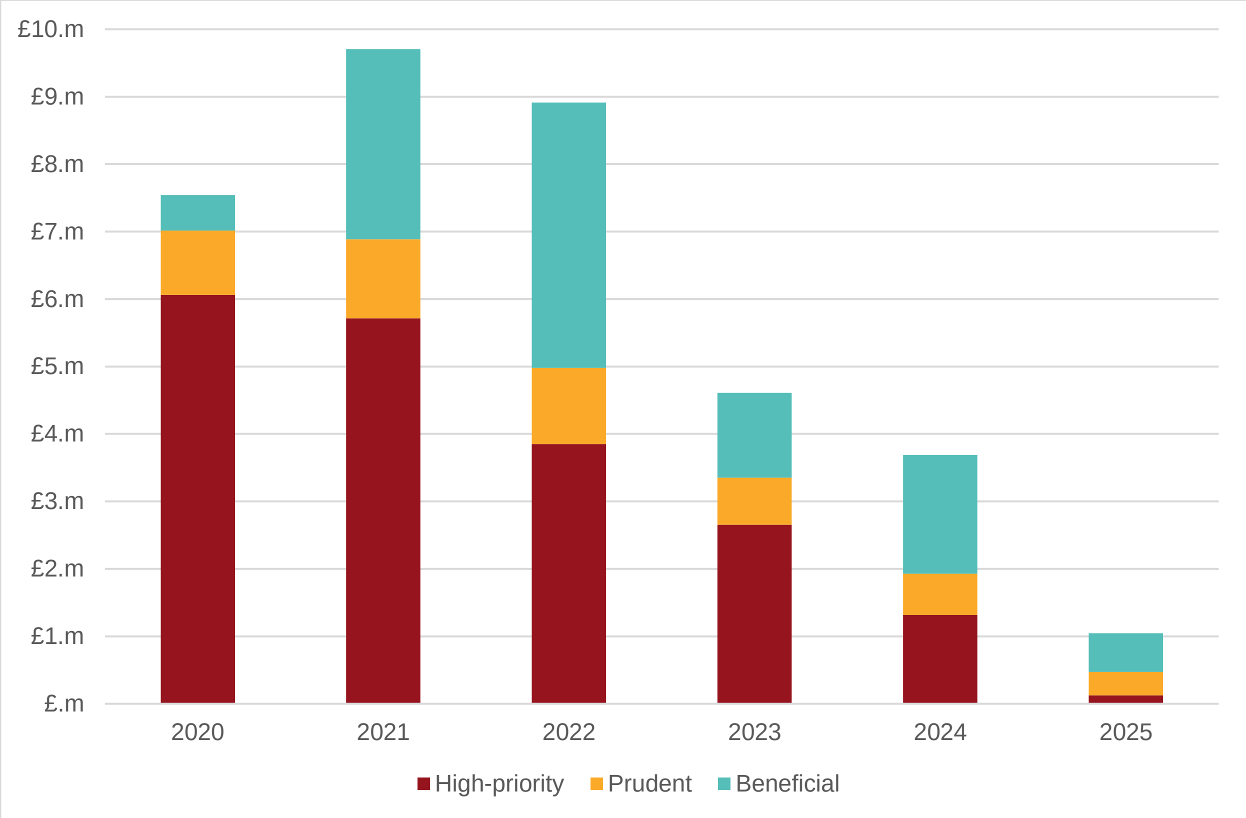

Figure 8 - Investment risk profile

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Economic Assessment of the Restarting of Iron and Steel Making Using the Facilities Previously Operated by SSI UK Limited

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European Union
European Regional Development Fund

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SUMMARY

ECONOMIC ASSESSMENT OF THE RESTARTING OF IRON AND STEEL MAKING USING THE FACILITIES PREVIOUSLY OPERATED BY SSI UK LIMITED

P Kitson, P Leonard

The Materials Processing Institute (the Institute) has been requested by South Tees Development Corporation (STDC) to undertake a desktop study into the economic feasibility of resuming slab making operations at the former SSI UK steel complex on the Redcar/Lackenby site.

It has been assumed that the production capacity would be circa three million tonnes per annum of merchant slab qualities and that there is a market for this quantity of slab at viable selling prices. For the purposes of the operating cost assessment, raw material and other costs for the last 12 months have been used, together with likely consumption figures for the assets under consideration to derive a break-even cost of slab production over a life of 25 years.

The assessment makes assumptions as to the condition of the assets after being idled for four years and based on knowledge of how the assets were shut down, together with published information regarding disposal of some of the assets. A cost estimate has been made to return the assets to a working condition based primarily on publicly available costs for similar asset refurbishments over the past 15 years for iron and steelmaking equipment in predominantly western steel plants. Where specific cost information is unavailable, expert engineering judgement has been used from detailed knowledge of the industry.

The economic assessment considers a discounted cash flow analysis to evaluate the breakeven price per tonne of slab produced. A discount rate of 10% has been assumed. Capital requirements are based on a draft rehabilitation schedule and could be based on a combination of equity and debt.

The initial capital identified to rehabilitate the plant back into production is estimated at £972 million, this will need to be supplemented with additional “sustenance capital” through the plant life. This is due to the assets typically being over 40 years old and not having had any major investment since 2000. Therefore, included within the cost model is a sum of £15 million per annum sustenance capital, based on typical historical levels of European steel industry sustenance capital of £5 million per million tonnes of annual output for iron and steelmaking assets (raw material handling through to slab production).

The break-even cost of slab production has been calculated as £390·09 per tonne which, at an exchange rate of $1·27/£, is $495·41 per tonne, representing the actual ex-works selling price that the plant would have to achieve over the course of its 25-year life in order to realise a 10% return on investment. When compared with historical prices, particularly the last 8 years, the price of traded slab has typically been below the breakeven selling price estimated from this study (see graph in Section 5).

Given that market prices of traded slab have been below the breakeven cost for a number of years, the Institute concludes that the restarting of the iron and steelmaking assets, for the production of merchant slab, would not be economically viable.

INITIAL CIRCULATION

SOUTH TEES DEVELOPMENT COOPORATION

Mr D Allison
Mr C Beck
Mr N Gray
Mr J McNicholas
Ms S Smales

MATERIALS PROCESSING INSTITUTE
ECONOMIC ASSESSMENT OF THE RESTARTING OF IRON AND STEEL MAKING USING THE FACILITIES PREVIOUSLY OPERATED BY SSI UK LIMITED

1. INTRODUCTION

Materials Processing Institute (the Institute) has been requested by South Tees Development Corporation (STDC) to undertake a desktop study into the economic feasibility of resuming slab making operations at the former SSI UK steel complex on the Redcar/Lackenby site. For the purposes of this exercise, it has been assumed that the production capacity (slab sales) would be circa three million tonnes per annum of merchant slab qualities and that there is a market for this quantity of slab at current prevailing slab selling prices.

The assessment covers the processes involved in the production route and the ancillary equipment that would be required to be operated to enable slab production to be reinstated. The report is structured to cover each plant / process giving a general overview of the individual facilities and its capabilities and the likely general assessment of the condition of the equipment after being idled for 4 years. It should be noted that it has not been possible to carry out any physical inspection of equipment to ascertain its condition. Based on this assumption and on knowledge of how the assets were shut down, together with published information regarding disposal of some of the assets, a view of what remedial works will be required has been made.

Regarding the likely remedial works, a cost estimate is included based on publicly available costs for similar asset refurbishments over the past 15 years for iron and steelmaking equipment in predominantly western steel plants. Where specific cost information is unavailable expert engineering judgement has been used from detailed knowledge of the industry. Historical costs have been escalated to take into account likely price changes to arrive at a 2019 cost basis.

For the purposes of the operating cost assessment, raw materials and other costs for the last 12 months have been used, together with likely consumption figures for the assets under consideration, to derive a break-even cost of slab production over a life of 25 years.

A discounted cash flow analysis is used to evaluate the breakeven price per tonne of slab produced and a discount rate of 10% has been assumed.

All capital requirements will be available according to the draft rehabilitation schedule. The capital infusion could be assumed as cash available for the rehabilitation of the steel complex based on a combination of equity and debt, however the level of debt is not considered or accounted for in this study.

The Cost of Capital also uses a discount rate of 10%, which represents the weighted average of capital charges (WACC).

No interest during construction is applied but the timing of capital expenditure is taken into account in the discounted cash flow analysis.

In line with current practice, it is assumed that the refractory relining of the blast furnace will need to be replaced every 15 years of continuous operation. The study has assumed a relining will be carried out in the 15th year from start up with steel production assumed to maintain at 100% full capacity during this period (it is understood that this is a relatively simplistic approach and, in reality, blast furnace performance will start to tail off towards the end of its refractory life.

The initial capital identified to rehabilitate the plant back into production will need, through its life, to be supplemented with additional “sustenance capital”. This is particularly pertinent to the ex SSI UK assets as they are now typically over 40 years old and have not had any major investment since 2000. For the purposes of this report a sum of £15 million per annum sustenance capital is included within the cost model, which is based on typical historical levels of European steel industry sustenance capital of £5 million per million tonnes of annual output.

One area of the plant that will require significant spend to maintain operations in the next few years is the basic oxygen steelmaking vessels. These have been in use since circa 1990 and were designed for a 15 to 20-year life. A similar plant at Tata Steel’s Port Talbot facility is currently undergoing vessel changes and the British Steel plant at Scunthorpe is considering changes in the next few years. All 3 plants’ vessels were installed at the same time. For the purposes of this report it has been assumed that a vessel would be changed at Teesside from year 5 and all 3 vessels would be complete by year 8. An estimated total capex of £60 million would be needed for the 3 vessels spread over 3 years.

Once the break-even cost of slab production has been calculated it can be compared with historical and likely slab selling prices to determine the viability of the proposed investment.

AERIAL VIEW OF MAIN AREAS OF IRON MAKING AND STEEL MAKING FACILITIES (GOOGLE MAPS)

2. PLANT DETAILS

2.1 South Bank Coke Ovens

Built by Gibsons there are 44 ovens per battery, the west battery being commissioned in June 1971 and the east battery in August 1972. The ovens are of Wilputte design and underjet fired with Coke Oven gas.

2.1.1 Design Details

Design Capacity	12,225 tonnes wharf coke per week
Output	96 pushes per day per battery
Carbonisation Cycle	17 hours
Pushing Schedule	5 + 2 system
Oven Charge Volume	
Chamber Height	5·36 m
Chamber Length	15.9
Mean Width	460 mm
Oven Taper	75 mm
Charge Weight	26 tonne
Coking Rate	30 mm per hour
Design Flue Temperature	1285 °C
Supporting Equipment	
Battery Machines	
Pusher Machine	Two
Charging Machine	Two
Cokeside Machine	Two
Coke Locomotive and Quench Car	Two
Coke Handling	
Coke Wharf	1 per battery
Ploughs	2 per wharf
Coke Routes	All coke sent to Redcar via road for screening

2.1.2 Comment on Current Condition

The main Coke oven batteries would require a full rebuild. The design of a coke oven battery is a Silica brick structure held together with what can best be described as a steel girdle. The silica bricks in operation are subject to a temperature of 1300 -1350 °C on the hot side and 1100-1200 °C on the hot face side. During the cooling down process the Silica bricks will have fallen apart, as they undergo a phase change at about 600 °C.

Under a controlled shutdown of a coke oven it would be normal practise to adjust the tension in the buckstays and tie bars. Hearsay is that this was not done, therefore it is likely that the tension on the system will have added to the brick failures, the tie bars will have contracted as they have cooled and either the springs attached to tension them will have broken or the tie bar will have snapped.

Distortion of the ovens due to failure of bricks and steel structure will have resulted in the oven top distorting and the rails for the charge cars will have also suffered distortion.

The by-products plant will require a full replacement, its condition is unknown but given the recent events of the 19th September resulting in two fatalities, whilst not prejudging events, it would be best to assume that it is in a poor state of repair. It is also known that the facility would not comply with environmental legislation now in place as there is no sulphur treatment.

2.1.3 Cost Estimates for Repair and Refurbishment for Restarting

Initial modelling work on the requirements for coking coke to allow for the production of circa 3 million tonnes of slab per annum indicate that the production can be met by the Redcar Coke Ovens alone. As such, for the purposes of this exercise it has been assumed that the South Bank Coke Ovens would not be rehabilitated.

2.2 Redcar Coke Ovens

Rebuilt by Otto Simon Carves and consisting of two batteries of 66 ovens, battery 1 was commissioned in June 1984 and battery 2 in October 1984.

The design is twin flues burning Coke Oven gas through an underjet underfiring system.

2.2.1 Design Details

Design Capacity	22,320 tonnes wharf coke per week
Output	88 pushes per day per battery
Carbonisation Cycle	18 hours
Pushing Schedule	5 + 2 system
Oven Charge Volume	33·31 m^3
Chamber Height	5·38 m
Chamber Length	14·4 m (between door plugs)
Mean Width	457 mm
Oven Taper	74 mm
Charge Weight	25 Tonne
Coking Rate	25·4 mm per hour
Design Flue Temperature	1290 °C

Supporting Equipment	
Battery Machines	
Pusher Machine	Three
Charging Machine	Three
Cokeside Machine	
Coke Locomotive and Quench Car	

Coke Handling	
Coke Wharf	1 per battery
Louise Ploughs	2 per wharf

Coke Routes	2 Routes ‘a’ and ‘b’ to screening station
Import	
Outloading Facilities	Screened coke to stock at outloading station during furnace stops Emergency dumps adjacent to both quenching stations
Screening	each coke route has 2 single deck screens operating in parallel

2.2.2 Comment on Current Condition

The main Coke oven batteries would require a full rebuild. The design of a coke oven battery as with the South Bank ovens is a Silica brick structure held together with what can best be described as a steel girdle. The silica bricks in operation are subject to a temperature of 1300 -1350 °C on the hot side and 1100-1200 °C on the hot face side. During the cooling down process the Silica bricks will have fallen apart, as they undergo a phase change at about 600 °C.

As with South Bank under a controlled shutdown of a coke oven it would be normal practise to adjust the tension in the buckstays and tie bars. Again hearsay is that this was not done, therefore it is likely that the tension on the system will have added to the brick failures, the tie bars will have contracted as they have cooled and either the springs attached to tension them will have broken or the tie bar will have snapped. Similarly, distortion of the ovens due to failure of bricks and steel structure will have resulted in the oven top distorting and the rails for the charge cars will have also suffered distortion.

Whilst there have been no reported incidents or demolition activities in the press as occurring at Redcar, it has to be assumed that the plant will be in a similar condition to that at South Bank and will require a significant overhaul.

Initial modelling work undertaken as part of this study indicates that the Redcar Coke ovens complex will be required to produce just under 1.1 million tonnes of coke per annum to satisfy the slab output requirement. This is based on the blast furnace coal injection system being capable of providing 200 kg per tonne of hot metal.

2.2.3 Cost Estimates for Repair and Refurbishment for Restarting

Specific costs for the rehabilitation of the Redcar coke oven assets are difficult to estimate at this stage. A new coke making facility to meet the latest environmental standards would likely be of the non-recovery type rather than the current by-products type. Recent references for non-recovery coke ovens in the USA (Suncoke in Kentucky in 2014) confirm the capital cost for 0·8 million tonne per annum capacity facility was $400 million. A similar plant in the UK producing approximately 1.2 million tonnes of coke per annum would be around £450 million to £500 million.

To rebuild the coke ovens, recent references from Japan can be used; JFE Steel Corporation (JFE Steel) rebuilt their A and B batteries of the No. 3 coke oven facility in Fukuyama for a cost of 27 billion Yen in 2017. Assuming a similar pro rata cost for the Redcar assets, this would require an expenditure of approximately £300 million, a figure of around 60% to 70% of the cost of a new coke oven facility.

Modern coke oven installations tend to have installed enhanced coke quenching facilities to raise steam and power from the cooling of the hot coke. Such a facility has not been factored into this study at this stage.

2.3 Sinter Plant

The sinter plant is to a Lurgi design and was commissioned in February 1978. Its design capacity being four million tonnes per annum from a single strand. In the late 1980's the sinter plant waste gas fans were uprated to allow an increase in production capacity. During the 2000's the plant was able to process typically 5-10% in excess of the original design capacity.

Raw Material storage	4 Blend Mix bins 1 Limestone bin 2 coke Breeze Bins 1 Return Fins Bin 1 Burnt Lime Bin
Mixing Drum	24" × 24 m Diameter
Sinter Machine	4 m wide (effective area 336 m^2) Ignition Furnace 13·4 m Coke Oven Gas Fired
Discharge and Screening	Spiked Roll Crusher >5 mm screened out
Cooler	4 m wide Annular Cooler with mean diameter of 35 m (area 380 m^3)
Cold Screening	1 Scalping screen aperture size 50 mm 1 Hearth layer screen with 15 mm and 25 mm aperture 1 final screen <15 mm at 5 mm +5 mm joins product conveyors
Waste Gas System	2 Radial flow fans rated at 22,500 m^3/min at 140 °C 1600 mm WG Static Suction 2 x 4 field electrostatic precipitators (aim <100 mg/Nm^3)
Plant Dedusting System	Hoods and ductwork connect to a separate electrostatic precipitator. Suction is developed by twin blade axial flow fan

2.3.1 Comment on Current Condition

2.3.1.1 Sinter Cooler

The sinter cooler underwent a significant refurbishment during 2000. At that time there was significant misalignment and distortion. It is assumed that given the duty it has seen since the refurbishment it will be in a similar condition as in 2000 and will also require the support structure to be inspected.

2.3.1.2 Sinter Strand

It is understood that the sinter strand has only undergone minor refurbishment works.

2.3.1.3 Waste Gas System

The structural integrity of all the gas duct work and chimney will need to be assessed. The effectiveness of the electrostatic precipitators will need to be determined and probably upgraded to meet the current environmental regulations.

Initial modelling work indicates that the Sinter plant will have to produce approximately 4·2 million tonnes of sinter per annum to satisfy the slab output requirement. This is based on a blast furnace charge of 85% sinter, 15% lump ore.

2.3.2 Cost Estimates for Repair and Refurbishment for Restarting

The estimated cost of a new sinter plant to meet all current environmental legislation would be approximately £250 million. This is based on the recent investment by Russian Magnitogorsk Iron and Steel (MMK) for a new 5·5 million tonne per year plant, sourced from Sinosteel (China) for a published investment cost of 22 Billion Roubles in 2018.

Similarly, Metinvest (Ukraine) invested $360 million in a new sinter plant with a capacity of 4·3 million tonnes per annum at Enkievo. Of this investment some $110 million was published as being required to meet environmental legislation.

For the purposes of this exercise, it has been assumed that only sufficient refurbishment will be carried out to allow sinter production to restart. Investments to meet all environmental improvements has not been accounted for. On this basis it has been assumed a spend of around 15% of the new cost of a sinter plant, i.e. £30 million.

2.4 Redcar Blast Furnace

The furnace was built by the Davy McKee company and first brought into service in October 1979 and blown out in March 1986, at which point it was subject to a significant rebuild undertaken by Davy McKee and was restarted four months later and operated until 2000. During that year, it was subject to ‘a-mid-campaign repair’, including replacement of hearth and installation of copper cooling staves in the stack for its third campaign. On purchase by SSI, a similar ‘mid campaign’ repair was undertaken prior to the furnace being blown in on 15th April 2012 to start its fourth campaign and then blown down on 19th September 2015. During this fourth campaign, Coal Injection facilities were installed and commissioned.

2.4.1 Design Details

Hearth Diameter	14 m
Working Volume	3828 m^3
Number of Tuyeres	36
Number of Tapholes	4

Cooling	Cast Iron and Copper staves
Charging System Paul With Bell-less top (Parallel Hoppers)	Coke 740 tonne/hour Ferrous 2520 tonnes/hour
Gas Cleaning	Dustcatcher Bischoff Scrubber
Stoves	Didier External Combustion Chamber 4
Energy Recovery Turbine	Hitachi Zosen 16 MW at 11 kV 1500 rpm
Casthouse	Four independent trough systems. Refractory lined steel troughs (mean thickness 700 mm) feeding a tilting spot for discharge to torpedo ladle.
Pulverised Coal Injection	Siemens VAI design Installed in August 2013. The coal grinding mill was capable of 120 tonnes/hour. The Injection system was designed for 112 tonne/hour. Maximum achieved was 106 tonnes/hour, after the rotafeed injector units were replaced after the first year

2.4.2 Comment on Current Condition

Initial modelling work indicates that the blast furnace will have to produce approximately 3.1 million tonnes of hot metal per annum to meet the slab output requirement. This is based on a ferrous charge of 85% sinter and 15% lump ore. The reduction requirement will be met by 200 kg of injected coal and 289 kg of coke per tonne of hot metal output.

2.4.2.1 Hearth and Shell

When production ended in 2015 the furnace was not shutdown in a controlled condition. The molten iron was not drained; normally referred to as a salamander tap. The residual iron will therefore have solidified within the furnace hearth. When taking a blast furnace offline at the end of a campaign it is normal to tap off all molten material in the furnace to make rebuilding/relining easier. When this has been poorly planned in the past it has resulted in explosives being required to break the material out of the hearth.

The stave cooling system installed in the furnace are either iron or copper depending on which level in the stack they are positioned at. In an uncontrolled shutdown it is likely that the copper units will have distorted in a similar manner to what occurred with the copper staves installed for the third campaign and had to be replaced for the fourth campaign which ended in 2015. Secondary to the distortion is the cooling water supply to the staves and how this has been left, whether drained or not there is likely to be significant corrosion that will have occurred due to the dissimilar metals being present in the system and in adverse weather conditions any remaining water may have frozen and caused additional damage.

2.4.2.2 Hearth

As stated above as the “salamander” was not tapped, it is likely that the hearth will be in poor condition and will need to be removed along with any residual iron during a rebuild. It is estimated that there could be 800 tonnes of iron solidified in the hearth. From experience of other furnace rebuilds, the removal of this solidified iron will be time consuming, costly and complex.

2.4.2.3 Main Charge Conveyor

The only means of delivering burden to the top of the furnace for charging is the main charge conveyor. This is approximately a quarter of a mile in length and raises material approximately 60 metres in height. Having been unused since 2015 the support rollers will have seized. The four main drive motors and gearboxes have known issues with the holding down frame due to fatigue of parts and needs regular maintenance. The condition of the belt is also likely to have deteriorated, especially if devices such as the gravity take up units have not been released.

As well as the holding down unit of the drives and seized bearings, the main issue is the integrity of the supporting structure for the conveyor. It will require inspection and repair.

It is also likely that the main structures supporting the charge conveyor will require thorough inspection and repair after 4 years of inactivity.

2.4.2.4 Downcomer

The main off gas from the blast furnace is transferred from the top of the furnace to the gas cleaning plant, dustcatcher and bischoff scrubber through a refractory lined pipe nominally 4 m in diameter that is self-supporting along its length of approx. 60 m. The integrity of both the internal refractory and external steel structure will need to subject to inspection and repair. The current downcomer has been in use since the furnace rebuild of 1986.

In May 2009 the downcomer of Tata Steel Number 5 blast furnace at Port Talbot suffered a cracking event which led to loss of gas containment and concerns over its continuing integrity. Significant remedial works had to be made and in-service monitoring to assess the fatigue loading to which it was subject due to wind and thermal effects.

It can be assumed that this will need to be replaced along with all the parts of the off-gas system on the furnace top and the relief valves (bleeders) on the top platform (approx. 97 m level).

2.4.2.5 Blast furnace Stoves

There are known issues with the blast furnace stoves, due to the internal operating temperatures and difficulty in controlling due to the process of using them to warm cold blast to make it hot blast for delivery to the blast furnace. Consequently, there is a tendency for the occurrence of stress corrosion cracking in the domes and higher parts of the shells. This has been severe enough for the four stoves to be re-skinned, i.e., a second shell built over the original shell.

The internals of the stoves are full of refractory bricks that are heated up by a burner on a heating cycle to then release the heat energy to the cold blast as it passes through on route to the blast furnace. Whilst these bricks are designed to operate over a temperature range, having left them to cool in an uncontrolled manor will have caused them to sustain damage. In normal operation, when a blast furnace is taken off for a short maintenance stop, the stoves are ‘boxed up’ to maintain them at a temperature.

These two major issues with the stoves would require significant maintenance but, realistically, a full rebuild will likely be necessary.

2.4.2.6 Torpedo Ladles

The condition of the fleet of torpedo ladles manufactured in the 70’s by Davy Distington is unknown; hearsay is that they have been scrapped. If they have been scrapped, a new fleet will be required. If they are still in existence, they will need to undergo significant repair to the shell and refractories whilst all the supporting bogies will need overhaul, as the wheels and bearings are likely to have ceased due to standing for several years.

2.4.3 Cost Estimates to Restart Operations

2.4.3.1 Blast Furnace Rebuild

For the reasons described above it is likely that a full rebuild of the blast furnace will be required which will involve the wrecking of the existing hearth, shell and cooling stave system and replacement with new, together with repairs to ancillary equipment.

There are many cost references within the public domain for the repair/reline of blast furnaces of various sizes.

Recent rebuilds (in the last 5 years) have been undertaken on several blast furnaces of a similar size to the Teesside furnace such as Thyssenkrupp blast furnace 2 in Duisburg-Schwelgern, Korean POSCO Pohang No. 3, Russian NMLK Lipetsk and Brazil’s Usiminas blast furnace at their Alto Forno plant. The published rebuild costs for these furnaces ranged from $265 million to $500 million.

For the Teesside facility, Materials Processing Institute would estimate a cost of £240 million.

2.4.3.2 Replacement of Torpedo Ladle Fleet

As described above, it is assumed that a new fleet of torpedo ladles would be required for the blast furnace operation. Sixteen torpedo ladle cars were originally supplied to the Teesside facility, this was on the original basis that the Redcar site would have two blast furnaces instead of one. To service a modern hot metal route of this type (circa 8 km from the blast furnace to the steel plant) it has been assumed that ten new torpedo ladles would be required at an estimated cost of £15 million.

2.5 Redcar Power Station

The power station is an integral part of the iron making production at the Redcar site its primary purpose is to generate the blast required for the Blast Furnace stoves.

Fuel for the power station comes from a combination of works generated gases (principally blast furnace but also coke oven gas) and fuel oil.

Steam is raised in the power station using 3 boilers of a rated capacity of 185 tonnes per hour steam superheated to 482 °C at 62.5 bar pressure. Steam from the boilers is used to drive one of two turbo blower units to provide blast for the blast furnace. The remaining steam is used to provide process steam predominantly to the coke ovens with some to the blast furnace (blast moisture) and the balance used for power generation.

In total there are four turbo alternators on the plant, two rated at 30 MW plus two back pressure turbo alternators, one rated at 16 MW and one rated at 5·2 MW. In theory, when new, the power station could generate just over 80 MW which would be enough to power the plant, with minimum import from the national grid.

Initial modelling indicates a net import of electricity from the grid of approximately 10,000 MWh per annum which is equivalent to a base load import of around 1·2 MW.

2.5.1 Comment on Current Condition

The power station is known to have had issues with leaks from boiler tubes during the last campaign of the blast furnace. The preferred operating practise was to always operate with two boilers running to ensure continuity of operation as failure of the plant to generate blast for the blast furnace could have serious consequences for the integrity of the furnace. During the various campaigns of the blast furnace there were instances where the blast to the stoves was lost and molten iron was forced into the blast system resulting in significant furnace stoppage time to instigate repairs. In the later part of the fourth campaign single boiler use was common due to the poor integrity of the boilers; all would need to be replaced.

The rotating equipment, turbo-alternators and turbo blowers would all require major overhaul if not full replacement before restarting. These items all use journal bearings with hydrodynamic films to avoid metal to metal contact. Leaving machines of this type stationary for an extended period, allowing metal to metal contact, will have caused damage, that, to repair, will require the machines to be stripped down and overhauled. The other rotating component, the turbine elements, are also likely to have significant damage due to not being suitably protected since the plant ended operation.

The fuel for the power station has been a combination of works generated blast furnace gas, coke oven gas and fuel oil It is doubtful that the existing facilities would meet the necessary environmental legislation without additional work if replacing the facility.

It is understood that the majority of the existing high voltage infrastructure on the site is age and condition expired, requiring extensive repair and replacement. This will significantly impact the workload and cost of the restart operations.

2.5.2 Cost Estimates for Repair and Refurbishment for Restarting

The estimated cost of a new power station with combined blowing and generating facilities of a similar capacity to Teesside would be approximately £230 million to £250 million. Modern power stations would likely be combined cycle gas turbine plants with a far greater operating thermal efficiency than the Teesside facility (typically 50% against 30%). Modern integrated blast furnace plants do not tend to use steam driven blowers to provide the blast to the furnace, relying on electrically driven blowers. Works generated gases would be used to drive a gas turbine to generate electricity with the exhaust gases used to raise steam to provide both secondary electricity generation (steam turbo generators) and process steam to the works.

For the purpose of this evaluation, it has been assumed that the power plant would be reinstated in its current form. As such, the boilers, turbo blowers and turbo generator units would be replaced or refurbished and ancillary equipment overhauled. The estimated cost of this work would be approximately £85 million.

The above estimate is based on reinstating equipment to a similar specification as originally supplied and does not include for any additional environmental or legislative measures that may be required to operate.

As stated above, work will be required to the high voltage infrastructure on the site to maintain legislative compliance. For the purpose of this report, and based on information supplied by STDC, it is estimated that this could cost as much as £35 million, giving a total spend in the power and distribution area of £120 million.

2.6 Steelmaking Plant

The primary steelmaking facility uses Basic Oxygen Steelmaking. Molten iron delivered to the facility is transferred from torpedo ladles into steel making ladles and is initially treated in the desulphurising station. The iron is then transferred into the BOS vessel along with a quantity of scrap, where it is reduced by blowing oxygen at supersonic speeds. During the process various fluxes and additions may be added. The blowing process results in the generation of a process gas rich in CO and this is treated via a gas cleaning process before it is flared off.

2.6.1.1 Design Details Iron Desulphurisation Plant

Capacity	4·4 Mtpa
Desulphurisation	0·002% Sulphur
Commissioned	1992
Equipment	
Stirring Lance	Argon
Slag Skimming	Mechanical

2.6.1.2 Design Details Primary Steel Making

The Primary steel making facility consists of three basic oxygen convertor vessels. Each vessel is equipped with feed systems for adding fluxes and refining additions as well as an oxygen supply for the lances used to blow oxygen into the vessel at supersonic speeds. The vessels are all supported on trunnions to enable them to be rotated by use of the integrated drive system, to enable the vessel to be rotated and filled with molten iron and scrap on the charging side, and then rotated over to the tapping side. The facility is serviced by a pair of cranes on the charging side and on the tapping side. The cranes are capable of transporting ladles containing 300 tonnes of molten iron and pouring into the vessel.

Capacity	4·88 Mtpa (2 Vessels)
LD Convertor Vessels	3 × 250 tonne
Typical Charge	225 tonne liquid iron 45 tonne scrap
Average Tap Weight	240 tonne

Equipment
Bath Agitation
Sub-lance
Slag Splashing and washing

2.6.2 Comment on Current Condition

Initial modelling work indicates that to meet the slab output requirements, approximately 3·3 million tonnes per annum of liquid steel will need to be produced. Production mix will be based on a nominal 93% hot metal charge, the balance being scrap, lump ore and ferroalloys.

2.6.2.1 BOS Vessels

It is known that the vessel shells have suffered from creep due to the temperature range in which they operate, and that the tendon support system has had repairs. The vessels are now approaching thirty years old. In terms of other plants that replaced their vessels at a similar time, Port Talbot has undertaken significant modifications on one vessel, replacing the tendon support system with lamella supports and has completely replaced another vessel. Given the known issues and the fact that plants with similar aged vessels are undertaking significant works, the vessels at Lackenby will all need major inspection as a minimum. For the purposes of this study, provision within the cost analysis has assumed the 3 vessels would be changed between years 5 and 8 from recommencement of operations.

It is also known that there were issues with the main support bearings on the vessel trunnions and that they were fitted with an online monitoring system to monitor their condition. The system frequently identified contamination in the bearings, and if this was not cleaned out, it was an initiator for damage to the bearing raceways and rolling elements. In the past, these bearings have had to be replaced, typically this can be after five to ten years of service. Given that the vessels will have been left in one position (assumed vertical) since the plant was stopped, and the bearings have not been rotated, the expectation is that all would need to be replaced.

2.6.2.2 Fume Extraction, Flare Stacks, Chimneys etc.

The flare stacks / chimneys / exhaust stack associated with the plant will need to be subject to a structural inspection

2.6.2.3 Cooling Water Systems and Cooling Towers

Throughout the primary and secondary steelmaking facility are numerous water-cooling systems. Their condition is unknown, but all will require extensive inspection and refurbishment. Where water has been drained, corrosion is likely to have occurred in steel pipework. In systems that have not been drained, the possibility of damage due to freezing is also considerable, especially in any pumps. In the case of cooling towers, all packing would need to be replaced as a minimum. The clarifiers used to settle out dust particles in the open cooling water system on the BOS hoods are reported not to have been drained. This will have resulted in the dust solidifying, requiring extensive works to restart the unit.

2.7 Secondary Steel Making Plant

The secondary steelmaking facility is designed to refine the primary steel into specific compositions and grades, whilst ensuring it is at the correct temperature prior to delivery to the continuous casting process.

The facility utilises several processing units to degas and refine the chemistry.

2.7.1.1 Design Details RH Degassing Facility

The RH degasser is a secondary refining process that can remove dissolved gases, e.g., hydrogen, from molten steel to allow the production of high-grade steel products. The system operates by having a vacuum chamber fitted with ‘snorkels’ that are attached to the steel ladle. A gas, normally argon, is blown from the sides of the snorkel, causing the molten steel to be drawn into the vacuum chamber, the buoyancy generated by blowing the gas allows the dissolved gasses to be removed from the steel.

Capacity	1·6 Mtpa
Commissioned	1983
Design	Vacmetal
Circulation Rate	100 tonne/min

2.7.1.2 Design Details Ladle Metallurgy Furnace

The ladle metallurgy furnace is designed to reheat molten steel using electricity, by use of graphite electrodes. By the addition of various alloying materials in powder or wire form, stirring the molten steel using a combination of argon bubbling and electromagnetics the temperature and chemistry within a ladle of steel is homogenised.

Capacity	
Commissioned	1988
Power	4 MVA
Heating Rate	4 °C/min
Powder Injection	
Wire Feeder	
Alloy Feed System	
Stirring	Electromagnetic or Argon

2.7.1.3 Design Details Vacuum Tank Degasser

The Vacuum degassing facility consists of a chamber into which a ladle of steel can be placed and closed with a lid/roof. The chamber can be evacuated, which enables retained gas in the steel to be extracted, thus enabling the production of low nitrogen, oxygen and hydrogen steels as well as low sulphur. The use of argon stirring by means of a porous plug in the base of the ladles enables homogenisation by bubbling argon.

Capacity	
Commissioned	1998
Design	Vacmetal

2.7.2 Comment on Current Condition

As with other plants, all the secondary steel making processing units will have deteriorated over the four years since the cessation of production. The refractory linings in all units will have deteriorated. The vacuum facilities will require a major overhaul of all the components. The associated steam plant required for producing the vacuum, will need a full inspection as it forms part of a pressure system, and all seals and safety relief systems will require testing. A number of components will also be beyond there statutory re-inspection periods and will require full inspections.

2.8 Continuous Casting Plant

The continuous casting plant has two twin strand slab casting machines capable of producing steel slabs up to 2030 mm wide and in 4 discrete thicknesses, 200, 225, 250 and 300 mm.

The machines are equipped with systems for mould level monitoring and mould thermal monitoring to protect the machines from breakouts. In operation, the machines are capable of continuously casting steel by using the tundish as a buffer and swapping ladles of molten steel at the top of the machine. The continuous strand of steel is then cut into discreet slabs on the exit of the machine. The system used to cut the slabs is a Gega cutter that runs on natural gas.

Tundish Capacity	18 tonnes
Mould Level Control	NKK System
Stopper Control	VAI System
Mould Thermal Monitoring	
Backbone Radius	9·8 m
Spray Chamber Water Cooling	
Multipoint Unbending	
Soft Reduction	Fixed

Sizes	
Thickness	200 – 300 mm
Width	800 – 2030 mm

2.8.1 Comment on Current Condition

The continuous casting machines will have both deteriorated in the time they have not been in operation. The spray chamber in service is a very harsh environment, consequently, it would be expected that all pipework and spray nozzles will have significant corrosion and would need to be replaced, including the pumps for the delivery system.

There are numerous hydraulic systems used to drive various components, for example, driving the mould oscillation system and the dynamic width control on the mould. Due to the operating environment and the possibility of fire if a system component, e.g., hose or cylinder, was to fail, the majority were high water based - typically 95% water. It is assumed that there will have been no maintenance of the systems and all will have deteriorated, requiring significant repair and/or replacement.

It is understood that the loose plant and tools, such as moulds, top zones and spare segments have been removed from the plant, as such, new items will be required.

2.8.2 Costs for Restarting – Steelmaking and Continuous Casting

There is very little published data for the cost of restarting a basic oxygen and continuous casting plant. To determine the likely costs, the authors have used their extensive knowledge of the Teesside steel making assets together with detailed intelligence on the steel industry in general.

Purchase of new equipment such as vessel hoods, hot metal and steel ladles, moulds top zones and segments for continuous casting are based on recent estimates for similar equipment supplied into Europe. Refurbishment of other technological items such as secondary steel making, fume extraction, etc, are based on allowing a proportion (typically 15-25%) of the cost of new equipment.

Using this approach, the estimated cost to restart the steelmaking and continuous casting assets are £108 million and £38·5 million respectively.

Modern oxygen steel plants have systems in place to collect the arising basic oxygen steel gases for use as fuel in other parts of the process. On new vessels, the hood design is such that steam can be raised for either process requirements or for power generation. The Teesside facility has neither of these capabilities and the costs and benefits of these systems have not been built into this study at this stage.

2.9 Hot Metal Rail Route

The internal railway network functions as the hot metal route linking the blast furnace facility at Redcar with the primary steel making facility at Lackenby; a distance of approx. 8 km. It has dual track along most of its length with additional sidings and passing locations, and an extension to the workshop facility for maintenance of the Torpedo ladles, both the mechanical components and the refractory linings. There are known areas of the network that suffered from subsidence due to the nature of the ground.

In total there was approximately 260 km of rail track installed on the Teesside site.

2.9.1 Comment on Current Condition

Given the duration of time since last use, there will be remedial works required to the entire track to ensure its quality is suitable for transporting hot metal; this includes track gauge, line and level, as well as the operation of all switches and crossings.

Full inspection and repair are critical given the incident at the Tata Steel Port Talbot facility on the 26th April 2019, where a torpedo ladle was overturned, resulting in explosion and injury to two people. The initial report suggested a broken rail was the cause of the incident.

TORPEDO LADLE ACCIDENT PORT TALBOT (PICTURE BBC NEWS)

2.10 Works Arising Gas Networks

Works arising gas distribution around the site is by two main gas distribution networks, one carrying coke oven gas and the other blast furnace gas. It is assumed for the purpose of this report that the gas holders are part of the gas networks. There are three gasholders on site, two for coke oven gas associated with the coke ovens at South Bank and Redcar, and a blast furnace gas holder at Redcar. The three holders are all of a M.A.N. design. They have tar seals between the piston and shell in the coke oven holders, and oil seals in the case of the blast furnace gas holder.

2.10.1 Comment on Current Condition

The main maintenance issue to be addressed will be the structural integrity of the gas holders. The holders based at Redcar have had various structural issues throughout their life. During statutory maintenance, the internal piston has had to be trimmed to minimise loading on the structural columns due to their distortion. In service between maintenance periods, the working volume of the blast furnace gas holder had to be reduced to avoid reaching a height where the load became excessive. Even without any structural repairs, the seals between the piston and shell will need replacing; standard recommendation is for maintenance on a five-year cycle.

There are publicly reported incidents of the loss of integrity of the pipelines within steelworks, an example being that at Tata steel Scunthorpe in February 2009. The reported incident was around the repair and an accident that occurred whilst instigating the repair, the defect being larger than the initial repair technique would allow. Knowing that operating plant have been subject to the failure of pipelines, one that has been left for five years and previously used to transport a corrosive gas is likely to have many defects present that will require significant maintenance or replacement.

It is understood that the current coke oven gas mains linking the Redcar and Lackenby sites is in a poor state of repair. Indeed, a significant length of the pipework is below ground. It is likely that a large proportion of this pipeline would require replacement (this would be required to transport coke oven gas from the coke ovens to the steel plant). For the purposes of this study, the cost of replacement has been excluded. Similarly, this pipeline is advised as containing extensive deposits of pyrophoric material that will need removal prior to its reuse. Again, the related costs have been excluded.

2.10.2 Cost Estimates for Repair and Refurbishment for Restarting

The cost estimates for replacement of a gas holder are dependent on the design of holder installed. A M.A.N would be the preferred option for storage of blast furnace gas, whilst coke oven gas can be stored in either a M.A.N type or a dryseal (Wiggins) type. The cost of a replacement gas holder to M.A.N design would be of the order of £15 million plus civils costs of typically £2 million if it is not possible to reuse the foundations. The cost of a dryseal design will be of the order of £2 million cheaper but will have higher through life maintenance costs. If two holders are required, one for coke oven gas and one for blast furnace gas, given the assumption that only one of the coke oven plants will be required, consideration would have to be given to having a similar design of holder for both applications and, where possible, ensure working spares are interchangeable where process requirements allow.

2.11 Oxygen and Argon Gas Supplies

The production of iron and steel from the Teesside complex will require significant amounts of both oxygen and argon gases. Historically, the requirements were provided from the Linde (BOC) air separation complex on Teesside. For the purposes of this study, it has been assumed that the facilities still exist and that these gases would be supplied at typical commercial rates.

3. ACCUMULATED COSTS OF REBUILD / REFURBISHMENT

The cost estimates within this report can be considered budgetary and would fall within a typical accuracy range of -10% to +30%. This accuracy is on the basis that this report is a desk top study without the benefit of the information that would be obtained by carrying out detailed surveys of the condition of the plant and infrastructure. The estimate is based on sound engineering practices and a detailed knowledge of the steel industry.

The accumulated costs of reinstatement of the iron and steelmaking operations on the Redcar and Lackenby facilities are in the region of £972 million (this does not include ongoing sustenance capital to maintain operations). The table lists the estimated costs for each individual major plant area.

Plant Area	**Cost**
Redcar Bulk Terminal	Note 1
Sinter Plant	£30,000,000
Coke Ovens	£300,000,000
Blast Furnace	£240,000,000
Steelmaking	£108,000,000
Continuous Casting	£38,500,000
Power Plant & Distribution	£120,600,000
Infrastructure	£50,200,000
Project Management/ Engineering	85,000,000
Total	**£972,300,000**

Note 1. Redcar Bulk Terminal has continued in operation since the closure of iron and steelmaking. It is assumed for the purposes of this study that it is therefore still capable of unloading the volume of coal and iron ore, etc, required for the resumption of operations, without the need for remedial works.

4. TIMESCALE FOR ASSET RESTART

As identified in previous sections of the report, there are significant remedial works required to return the former SSI UK Limited assets into a condition that will enable resumption of iron and steel production at an annual rate of circa thee million tonnes.

An estimated project plan is included as a Gantt chart in Appendix 1. All major areas of plant have been included. For each plant, the tasks have been subdivided, in broad terms, into; wrecking / dismantling of current asset, procurement of new equipment, installation of new equipment, commissioning, start up and first product produced.

The estimated plan shows a nominal start date of the 1st April 2020 and a completion date of the 28th April 2022, a duration of some 25 months. A significant period in the plan is taken up by procurement. This is a best estimate and may alter depending on the availability of the limited number of suppliers for the equipment needed. At the time of this report, there has been no communication with potential equipment suppliers to further validate timescales or costs.

5. OPERATING COST MODEL

As part of this study, a comprehensive operating cost model has been developed to determine the break-even cost of slab production over the proposed life of the asset (assumed 25 years). This analysis is based on the following:

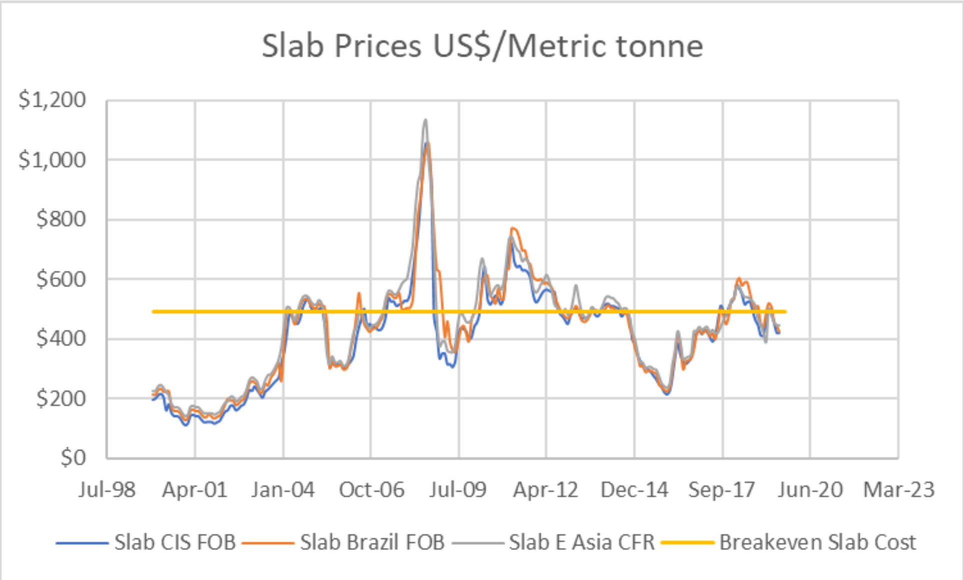
- Assumptions on raw material costs based on current average pricing delivered to Europe.

- Energy costs based on prevailing UK averages for large industrial users.

- Personnel costs based on current UK steel industry costs (from company account data).
- Other raw material costs at current prices from numerous published sources.
- Consumption figures for each stage in the iron and steelmaking processes using anticipated rates for equipment of the type installed at Teesside.
- Capital costs to reinstate production and sustenance capital throughout the life of the asset to maintain operations.

Combining all the above into the model has yielded a breakeven cost of slab production of £390·09 per tonne which, at an exchange rate of $1·27/£, is $495·41 per tonne. This is the actual ex-works selling price that the plant would have to make over the course of its 25-year life to realise a 10% return on investment.

It is difficult to estimate the future selling price of steel slab, however, from an historical perspective, the prices of slab is shown on the graph below, together with the break-even cost calculated above.



From the above graph, it can be seen that, historically, and in particular the last 8 years, the price of slab on the open market has been typically below the breakeven selling price estimated from this study. On this basis, if the trend in selling price was to continue, the investment in reinstating the ex- SSI UK assets would not be a viable option.

6. EXCLUSIONS AND ASSUMPTIONS

This is a high level report, as such, a number of assumptions have had to be made regarding the operational philosophy of the rehabilitated plant. It has not been possible in the time available to apply rigorous financial evaluations to the study which, in a feasibility report, would have looked at alternative operating scenarios, such as variation of the blast furnace and basic oxygen steelmaking charge mix, impact of changes to capital, raw materials, labour and energy costs, etc, and project phasing.

As such, this report is an initial assessment of the potential viability of restarting iron and steelmaking operations at Teesside in its current form.

The requirements for the report to be a desk top study, mean that it has been prepared without access to the detailed information of the various systems on site, e.g., ref Pressure Systems Regulations, that would require there to be written schemes of inspections. Should these not be available when restarting the facility, additional works would be required for the preparation of such.

The study has considered equipment such as cranes and mobile plant required to operate the facility to be included in the cost of the whole plant. Cranes and lifting equipment would all require thorough inspection and, in most cases, major overhaul, as ropes are likely to have permanently set and will therefore need replacing. Brakes are likely to have seized and it has to be assumed that no statutory inspections will have taken place since the idling of the plant.

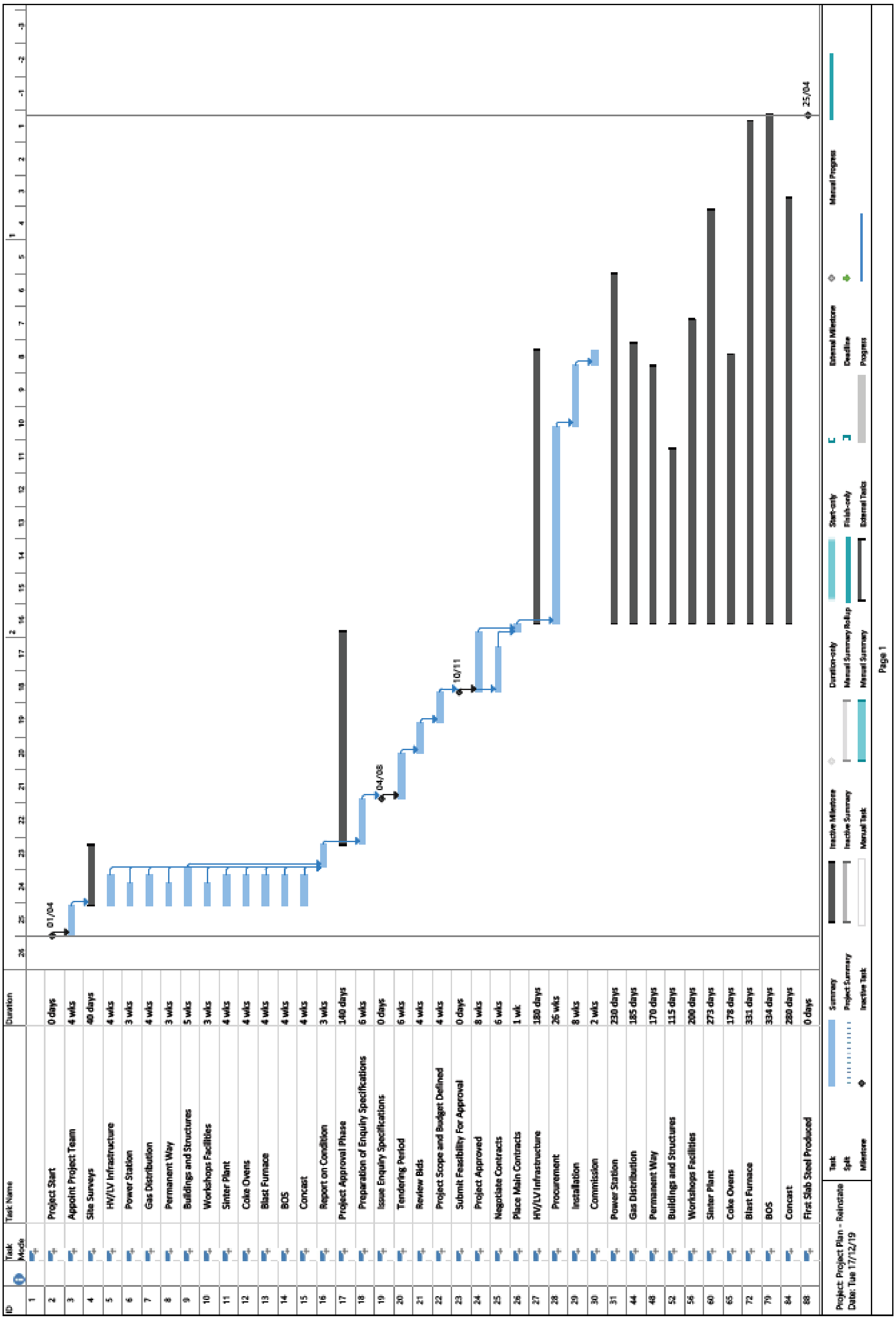
The electricity supply network is also assumed to have remained in place. Key infrastructure including transformers, substations, etc, will all need inspection and testing prior to reconnection to the network.

The site also has many cellars and pits; there are differing reports on what has been done to each. In some cases, it is suggested that pits have been infilled with rubble and in other cases that pumping systems are operating in cellars. It must be assumed as a worst-case scenario that the pits have been infilled and cellars flooded, thus requiring extensive recovery works to be undertaken in locations where these facilities will need to be brought back into service.

The environmental permits required for the operation of the facility have not been considered. It is known that two permits were registered with the Environment Agency for the site, RP3434HP granted 2011 and JP3638HM granted 2016. These are typically subject to review / renewal on a four to six-year cycle Both permits are therefore likely to need renewing and this may add to the investment required for restarting the assets in order to meet the requirements of any new permits.

APPENDIX 1

OUTLINE PROJECT PLAN FOR ASSET RESTART



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Economic Assessment of the Restarting of Steel Making using Electric Arc Furnaces on the Facilities Previously Operated by SSI UK Limited

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European Union
European Regional Development Fund

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SUMMARY

ECONOMIC ASSESSMENT OF THE RESTARTING OF STEELMAKING USING ELECTRIC ARC FURNACE TECHNOLOGY ON THE FACILITIES PREVIOUSLY OPERATED BY SSI UK LIMITED

P Kitson, P Leonard

The Materials Processing Institute (the Institute) has been requested by South Tees Development Corporation (STDC) to undertake a desktop study into the economic feasibility of resuming slab making operations at the former SSI UK steel complex on the Redcar/Lackenby site.

It has been assumed that the production capacity would be circa three million tonnes per annum of merchant slab qualities and that there is a market for this quantity of slab at viable selling prices.

The study considers the option of substituting the existing ironmaking and primary steelmaking facilities with Electric Arc Furnace (EAF) steelmaking technology, using recycled steel as its primary feed stock and feeding into the secondary steelmaking and continuous casting plants remaining on the site.

The assessment covers the works required for the installation of electric arc furnaces and recycled steel handling facilities within the current primary steelmaking footprint, as well as the processes involved in the production route and the ancillary equipment required to enable secondary steelmaking and slab production to be reinstated. The assessment makes assumptions as to the condition of existing facilities that have been idled for four years and is based on some knowledge of how the assets were shut down, together with published information.

The economic assessment considers a discounted cash flow analysis to evaluate the breakeven price per tonne of slab produced. A discount rate of 10% has been assumed. Capital requirements are based on a draft rehabilitation schedule and could be based on a combination of equity and debt.

The initial capital identified to substitute the primary facilities with electric arc furnaces and rehabilitate other plant back into production is estimated as £380 million, this will need to be supplemented with additional “sustenance capital” through the plant life. This is due to the assets typically being over 40 years old and not having had any major investment since 2000. Therefore, included within the cost model is a sum of £5 million per annum sustenance capital based on typical historical levels of European steel industry sustenance capital (covering steelmaking assets only).

The break-even cost of slab production has been calculated at £395·33 per tonne which, which, at an exchange rate of $1·27/£, is $502·07, representing the actual ex-works selling price that the plant would have to achieve over the course of its 25-year life in order to realise a 10% return on investment. When compared with historical prices, particularly the last 8 years, the price of traded slab has typically been below the breakeven selling price estimated from this study (see graph in Section 5).

Raw materials and energy costs for EAF production typically represent circa 80% of total operating costs (BF / BOF route ~60%) and, with current scrap prices of around £230 per tonne, the breakeven cost stated above is therefore some £5 per tonne more expensive than the integrated route at today's costs.

Given that market prices of traded slab have been below the breakeven cost for a number of years, the Institute concludes that the restarting of the assets, using EAF technology for the production of merchant slab, would not be economically viable.

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MATERIALS PROCESSING INSTITUTE
ECONOMIC ASSESSMENT OF THE RESTARTING OF STEELMAKING USING ELECTRIC ARC FURNACE TECHNOLOGY ON THE FACILITIES PREVIOUSLY OPERATED BY SSI UK LIMITED

1. INTRODUCTION

Materials Processing Institute (the Institute) has been requested by South Tees Development Corporation (STDC) to undertake a desktop study into the economic feasibility of resuming slab making operations at the former SSI UK steel complex on the Redcar/Lackenby site. For the purposes of this exercise, it has been assumed that the production capacity (slab sales) would be circa three million tonnes per annum of merchant slab qualities and that there is a market for this quantity of slab at current prevailing selling prices.

The study considers the option of substituting the existing ironmaking and primary steelmaking facilities with Electric Arc Furnace (EAF) steelmaking technology, using recycled steel as its primary feed stock and feeding into the secondary steelmaking and continuous casting plants remaining on the site.

The assessment covers the works required for the installation of electric arc furnaces and recycled steel handling facilities within the current primary steelmaking footprint as well as the processes involved in the production route and the ancillary equipment required to enable secondary steelmaking and slab production to be reinstated. The report is structured to cover each plant / process giving a general overview of the individual facilities and its capabilities, and where a facility is to be re-used the likely general assessment of the condition of the equipment after being idled for 4 years. It should be noted that it has not been possible to carry out any physical inspection of buildings or equipment to ascertain their condition. Based on some knowledge of how the assets were shut down, together with published information regarding disposal of some of the assets, a view of what remedial works will be required has been made.

With regard to the likely remedial works, a cost estimate is included based on publicly available costs for similar asset refurbishments over the past 15 years for iron and steelmaking equipment in predominantly western steel plants. Where specific cost information is unavailable, expert engineering judgement has been used from detailed knowledge of the industry. Historical costs have been escalated to take into account likely price changes to arrive at a 2019 cost basis.

For the purposes of the operating cost assessment, raw material and other costs for the last 12 months have been used, together with likely consumption figures for the assets under consideration, to derive a break-even cost of slab production over a life of 25 years.

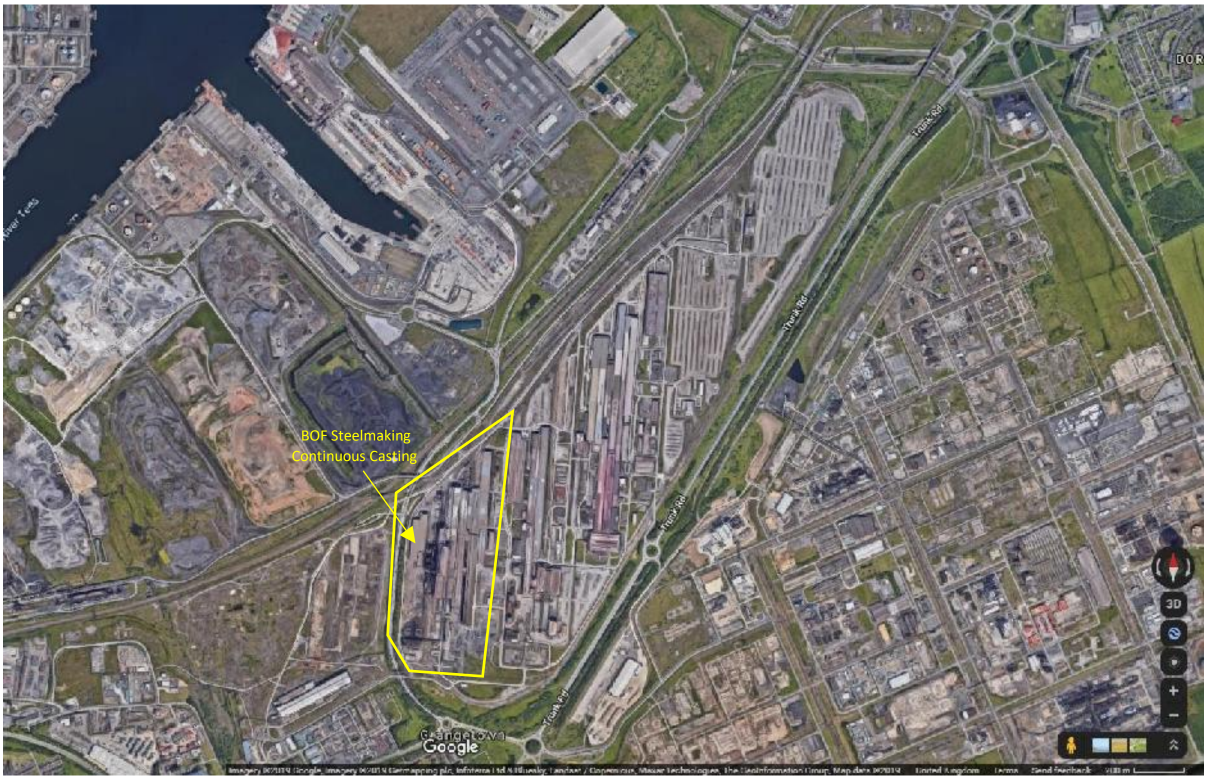
A discounted cash flow analysis is used to evaluate the breakeven price per tonne of slab produced and a discount rate of 10% has been assumed.

All capital requirements will be available according to the draft rehabilitation schedule. The capital infusion could be assumed as cash available for the rehabilitation of the steel complex based on a combination of equity and debt, however, the level of debt is not considered or accounted for in this study.

The Cost of Capital also uses a discount rate of 10%, which represents the weighted average of capital charges (WACC).

No interest during construction is applied, but the timing of capital expenditure is taken into account in the discounted cash flow analysis.

The initial capital identified to rehabilitate the plant back into production will need, through its life, to be supplemented with additional “sustenance capital”. This is particularly pertinent to the former SSI UK assets in the steel plant as they are now typically over 40 years old and have not had any major investment since 2000. For the purposes of this report, a sum of £5 million per annum sustenance capital is included within the cost model, which is based on typical historical levels of European steel industry sustenance capital for relevant assets.



AERIAL VIEW OF MAIN STEEL MAKING FACILITIES (GOOGLE MAPS)

2. PLANT DETAILS

2.1 Steelmaking Plant

2.1.1 Comment on Current Condition and Future Use

2.1.1.1 BOS Vessels

In a production process that uses recycled steel as a feed material and an electric arc furnace to process it into liquid steel, prior to further refinement in secondary steelmaking to produce the required grades of steel for slab production, the installed BOS vessels would not be required. The three units and a significant amount of the associated equipment would need to be removed and the space generated to form the area for installation of two electric arc furnaces.

2.1.1.2 Fume Extraction, Flare Stacks, Chimneys etc.

The flare stacks / chimneys / exhaust stack associated with the plant will need to be subject to a structural inspection; most will not be required for electric arc furnace production as the fume extraction system will need to be designed specifically for these installations.

2.1.1.3 Cooling Water Systems and Cooling Towers.

Throughout the primary and secondary steelmaking facility are numerous water-cooling systems. Their condition is unknown, but all will require extensive inspection and refurbishment. Where water has been drained, corrosion is likely to have occurred in steel pipework. In systems that have not been drained, the possibility of damage due to freezing is also considerable, especially in any pumps. In the case of cooling towers, all packing would need to be replaced as a minimum. The clarifiers used to settle out dust particles in the open cooling water system on the BOS hoods are reported not to have been drained. This will have resulted in the dust solidifying, requiring extensive works to restart the units.

2.2 Secondary Steel Making Plant

The secondary steelmaking facility is designed to refine the primary steel into specific compositions and grades, whilst also ensuring it is at the correct temperature prior to delivery to the continuous casting process.

The facility utilises a number of processing units to degas and refine the chemistry.

2.2.1.1 Design Details RH Degassing Facility

The RH degasser is a secondary refining process that is able to remove dissolved gases, e.g., hydrogen, from molten steel to allow the production of high-grade steel products. The system operates by having a vacuum chamber fitted with ‘snorkels’ that are attached to the steel ladle. A gas,, normally argon is blown from the sides of the snorkel, causing the molten steel to be drawn into the vacuum chamber, the buoyancy generated by blowing the gas allows the dissolved gasses to be removed from the steel.

Capacity	1·6 Mtpa
Commissioned	1983
Design	Vacmetal
Circulation Rate	100 tonne/min

2.2.1.2 Design Details Ladle Metallurgy Furnace

The ladle metallurgy furnace is designed to reheat molten steel using electricity, by use of graphite electrodes. By the addition of various alloying materials in powder or wire form, stirring the molten steel using a combination of argon bubbling and electromagnetics the temperature and chemistry within a ladle of steel is homogenised.

Capacity	
Commissioned	1988
Power	4 MVA
Heating Rate	4 °C/min
Powder Injection	
Wire Feeder	
Alloy Feed System	
Stirring	Electromagnetic or Argon

2.2.1.3 Design Details Vacuum Tank Degasser

The Vacuum degassing facility consists of a chamber into which a ladle of steel can be placed and closed with a lid/roof. The chamber can be evacuated, which enables retained gas in the steel to be extracted, thus enabling the production of low nitrogen, oxygen and hydrogen steels, as well as low sulphur. The use of argon stirring, by means of a porous plug in the base of the ladles, enables homogenisation by bubbling argon.

Capacity	
Commissioned	1998
Design	Vacmetal

2.3 Continuous Casting Plant

The continuous casting plant has two twin strand slab casting machines capable of producing steel slabs up to 2030 mm wide and in 4 discrete thicknesses, 200, 225, 250 and 300 mm.

The machines are equipped with systems for mould level monitoring and mould thermal monitoring to protect the machines from breakouts. In operation, the machines are capable of continuously casting steel by using the tundish as a buffer and swapping ladles of molten steel at the top of the machine. The continuous strand of steel is then cut into discreet slabs on the exit of the machine. The system used to cut the slabs is a Gega cutter that runs on natural gas.

Tundish Capacity	18 tonnes
Mould Level Control	NKK System
Stopper Control	VAI System
Mould Thermal Monitoring	
Backbone Radius	9·8 m
Spray Chamber Water Cooling	
Multipoint Unbending	
Soft Reduction	Fixed
Sizes	
Thickness	200 – 300 mm
Width	800 – 2030 mm

2.3.1 Comment on Current Condition and Future Use

The continuous casting machines will have both deteriorated in the time they have not been in operation. The spray chamber in service is a very harsh environment, consequently, it would be expected that all pipework and spray nozzles will have significant corrosion and would need to be replaced, including the pumps for the delivery system.

There are numerous hydraulic systems used to drive various components, for example, driving the mould oscillation system and the dynamic width control on the mould. Due to the operating environment and possibility of fire if a system component, e.g. hose or cylinder, was to fail, the majority were high water based - typically 95% water. It is assumed that there will have been no maintenance of the systems and all will have deteriorated and requiring significant repair and/or replacement.

It is understood that the loose plant and tools, such as moulds top zones and spare segments, have been removed from the plant, as such, new items will be required.

2.4 Hot Metal Rail Route

There was approximately 260 km of rail track installed on the Teesside site. A large proportion of this would not be required in a scenario of producing primary steel by the electric arc furnace method. The sections of railway around the steel plant could be utilised to form part of the delivery for scrap into the scrap storage facility.

2.4.1 Comment on Current Condition and Future Use

Given the duration of the time since past use, there will be remedial works required to the track around the steel plant. Part of the network will also be required to integrate with scrap delivery, but a significant amount of the network will not be required.

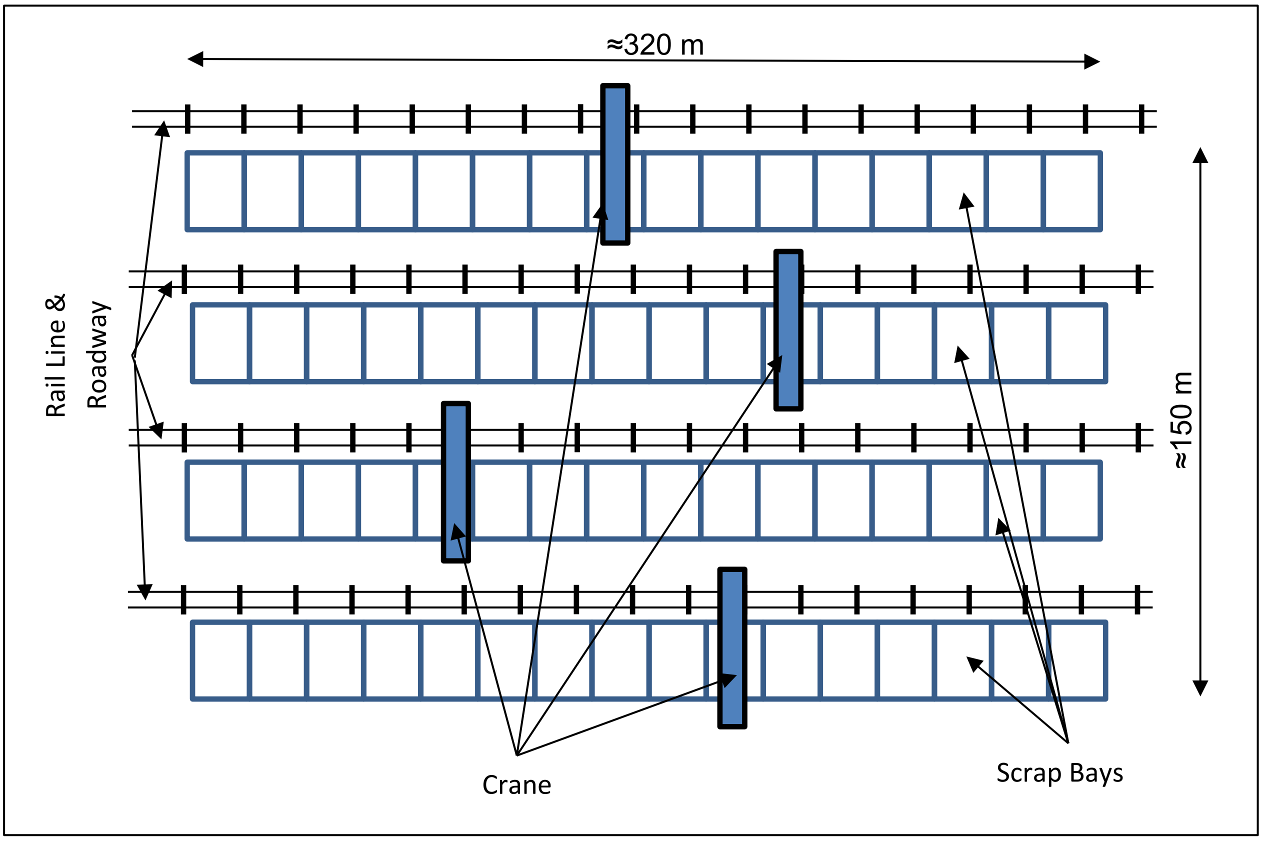
3. INSTALLATION OF ELECTRIC ARC FURNACE STEEL MAKING

The replacement of the main primary steelmaking facilities within the same plant footprint as that taken by the BOS process will require a significant period of time to remove redundant equipment, such as the existing BOS vessels, fume extraction equipment, etc, and for the design and procurement of the new electric arc furnaces and associated equipment.

3.1 Scrap Handling Facility

To produce primary steel using the EAF route will require the installation of a large scrap handling facility. Initial modelling work indicates that the raw material charge requirement to produce 3 million tonnes per annum of slab will be approximately 3·3 million tonnes of scrap and hot briquetted iron (HBI). A typical facility for the size of plant would have four rows of sixteen pens in which scrap could be stored. The pens would be nominally 20m × 32m by 5m high. Alongside each row of pens is rail access and access for vehicles to transport scrap buckets from the area to the EAF. Each row of pens will be serviced by a Goliath crane (capacity 20 tonne) fitted with a combined magnet and grab lift, that will be used to unload both rail and road wagons and charge the scrap buckets. Screening equipment for radioactive sources will also be required in this area.

(This area will be in excess of four times the area required for the scrap requirements of the BOS process)



3.2 Electric Arc Furnace

The facility will require two operating electric arc furnaces to produce circa 3 million tonnes of molten steel per annum. For the study, it has been assumed that the charge mix would be approximately 80% scrap and 20% HBI. This level of mix and the addition of “virgin iron units” provided by the HBI will allow dilution of “tramp” elements from the scrap to facilitate the production of a range of qualities of slab, broadly similar to that which was produced at the Teesside site previously.

3.2.1 Power Requirements

The electrical distribution system to the plant will need to be uprated and be significantly reconfigured to feed 2 high-capacity electric arc furnaces. Each furnace will need to be supplied with a transformer of circa 200 - 250 MVA.

The requirements that these transformers will place on the local power grid will require involvement of the local Distributed Network Operator (DNO). The closest connections to the DNO is at Grangetown, where there is a super grid substation and a 275 KV incomer.

Initial modelling indicates an overall power requirement for the steel complex of approximately 1,500,000 MWh per annum, which is equivalent to an average base load in excess of 180 MW. Peak loads with both EAF furnaces operating simultaneously would be in excess of 400 MW.

This level of demand is obviously well in excess of that supplied to the plant previously. Also, it does not have the added benefit of utilising the existing power station on the site which was powered by works generated gases from the coke ovens and blast furnace.

It is understood that the majority of the existing high voltage infrastructure on the site is age and condition expired, requiring extensive repair and replacement.

3.2.2 Material Handling

Scrap charging of the EAF will be by bucket feed from the blended scrap handling facility described above Existing overhead cranes will be utilised to carry out scrap feeding operations.

Charging of additional materials to the furnace, such as lime, dolomite, ferro alloys, etc, will by a combination of modifications to the existing BOS charging systems, together with injected carbon, oxygen and lime lances.

3.2.3 Furnace Shell Maintenance

For continued operation, it is envisaged that a spare furnace shell will be provided together with associated refractory lining stands and handling equipment. Typical EAF operations require a shell exchange after circa 4-6 weeks operation to replace the worn refractory lining in the EAF vessel. Having shell exchange facilities and a spare shell allows for a quick shell exchange (4-6 hours) thus maintaining a high level of output from the plant.

The complete furnace shell with refractory is likely to weigh in excess of 400 tonnes, as such, this weight is beyond that of the current overhead cranes within the BOS shop. It will need to be investigated in detail the possibility of either:

- Uprating existing shop cranes from the existing 375 tonne safe working load to ~425 tonne safe working load (this will involve structural assessment of building crane gantries and foundations, as well as the crane structures and drives).

- Enabling a shell change using a tandem lift; this is not a normal production operation and would require very careful planning and assessment.

- Allowing the shell exchange to be in two lifts (upper/lower shell);, this is not ideal and would require careful design of the vessel to allow this to be undertaken. It would also increase significantly the vessel exchange time, thus reducing the productivity from the plant.

3.3 Ancillary Equipment

The New EAF facility will require new water systems for cooling of the vessel components. New closed cooling systems will be required for:

- Roof
- Shell
- Burner Modules
- Electrode Arms
- Power Cables
- Transformers

To feed 2 furnaces of this size it is anticipated that recirculating cooling systems in excess of 8,500 Nm^3/hr will be required.

In addition to the closed cooling water systems, open water systems will be required for:

- Electrode Sprays
- Emergency Water

Estimated flow requirements for open cooling systems would be approximately 2000 Nm^3/hr.

In addition to cooling water, facilities to provide approximately:

- 25000 Nm^3/hr oxygen
- 500Nm^3/hr argon
- 4000 Nm^3/hr compressed air, and
- 10000 Nm^3/hr natural gas

will be required to supply the requirements of the new EAFs.

4. TIMESCALE FOR ASSET RESTART

As identified in a previous section of the report, there are significant remedial works required to return the former SSI UK steelmaking assets into a condition that will enable resumption of steel production at an annual rate of circa thee million tonnes.

An estimated project plan is included as a Gantt chart in Appendix 1. All major areas of required plant have been included. For each plant, the tasks have been subdivided, in broad terms, into; wrecking / dismantling of current asset, procurement of new equipment, installation of new equipment, commissioning, start up and first product produced.

The estimated plan shows a nominal start date of the 1st April 2020 and a completion date of the 13th January 2023, a duration of some 34 months. A significant period in the plan is taken up by the design and procurement of the new electric arc furnaces and associated equipment. This is a best estimate and may alter depending on the availability of the limited number of suppliers for the equipment needed to operate a steel production facility. At the time of this report, there has been no communication with potential equipment suppliers to further validate timescales or costs.

5. ACCUMULATED COSTS OF REBUILD / REFEBISHMENT

The cost estimates within this report can be considered budgetary and would fall within a typical accuracy range of -10% to +30%. This accuracy is on the basis that this report is a desk top study without the benefit of the information that would be obtained by carrying out detailed surveys of the condition of the plant and infrastructure. The estimate is based on sound engineering practices and a detailed knowledge of the steel industry.

The accumulated costs of substituting the ironmaking and primary steelmaking with an electric arc steel making facility using recycled steel as its primary feed stock and reinstatement of the secondary steel making and continuous casting facilities remaining on the site are in the region of £380 million (this does not include ongoing sustenance capital to maintain operations). The table lists the estimated costs for each individual major plant area.

Plant Area	**Cost**
Scrap Handling Facility	£33,500,000
Steelmaking	£231,000,000
Continuous Casting	£38,500,000
Infrastructure (including HV)	£45,500,000
Project Management/ Engineering	£31,000,000
Total	**£379,500,000**

6. OPERATING COST MODEL

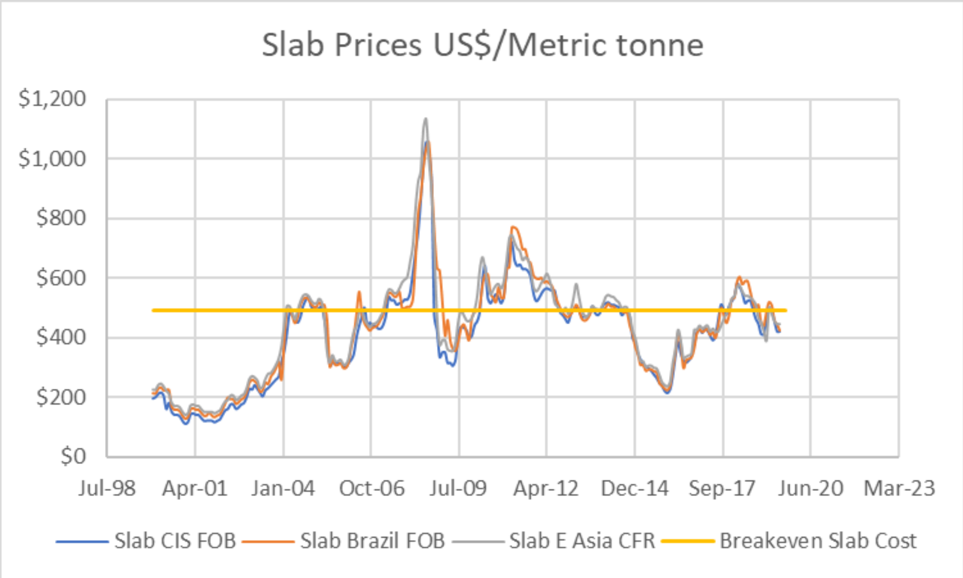
As part of this study, a comprehensive operating cost model has been developed to determine the break-even cost of slab production over the proposed life of the asset (assumed 25 years). This analysis is based on the following:

- Assumptions on raw material costs based on current average pricing delivered to Europe.
- Energy costs based on prevailing UK averages for large industrial users.
- Personnel costs based on current UK steel industry costs (from company account data).
- Other raw material costs at current prices from numerous published sources.
- Consumption figures for each stage of the steelmaking process using anticipated rates for equipment of the type installed and proposed at Teesside.
- Capital costs to reinstate production and sustenance capital throughout the life of the asset to maintain operations.

Combining all the above into the model has yielded a breakeven cost of slab production of £395·33 per tonne which, which, at an exchange rate of $1·27/£, is $502·07 per tonne. This is the actual ex-works selling price that the plant would have to make over the course of its 25-year life to realise a 10% return on investment.

It is difficult to estimate the future selling price of steel slab, however, from an historical perspective, the prices of traded slab are shown on the graph below together with the break-even cost calculated above.

Raw materials and energy costs for EAF production typically represent circa 80% of total operating costs (BF / BOF route ~60%) and, with current scrap prices of around £230 per tonne, the breakeven cost reported above is therefore some £5 per tonne more expensive than the integrated route at today's costs.



From the above graph it can be seen that, historically, and in particular the last 8 years, the price of slab on the open market has been typically below the breakeven selling price estimated from this study. On this basis, if the trend in selling price was to continue, the investment into reinstating slab production utilising new electric arc furnace technology within the existing ex-SSI UK steel plant (utilising existing secondary steelmaking and continuous casting facilities) would not be a viable proposition.

7. EXCLUSIONS AND ASSUMPTIONS

This is a high level report, as such, a number of assumptions have had to be made regarding the operational philosophy of the rehabilitated plant with the replacement of the basic oxygen steelmaking vessels with 2 large electric arc furnaces. It has not been possible in the time available to apply rigorous financial evaluations to the study which, in a feasibility report, would have looked at alternative operating scenarios such as variation of the electric arc furnace charge mix (scrap, HBI, DRI or pig Iron), impact of changes to capital, raw materials, labour and energy costs, etc, and project phasing.

As such, this report can be seen as an initial assessment of the potential viability in restarting steelmaking operations at Teesside substituting the existing iron and steel making facilities with an electric arc furnace.

The requirements for the report to be a desk top study mean that it was prepared without having detailed information on, for example, the various systems on site which would fall under the Pressure Systems Regulations and therefore require written schemes of inspections that would stipulate the inspection periods and maintenance requirements. Should these not be available when restarting the facility, additional works would be required for the preparation of such.

The study has considered equipment such as cranes and mobile plant required to operate the facility to be included in the cost of the whole plant. Cranes and lifting equipment would all be requiring of a thorough inspection; in most cases, major overhaul, as ropes are likely to have permanently set and will therefore need replacing, brakes are likely to have seized, etc. It has to be assumed that no statutory inspections will have taken place since the idling of the plant.

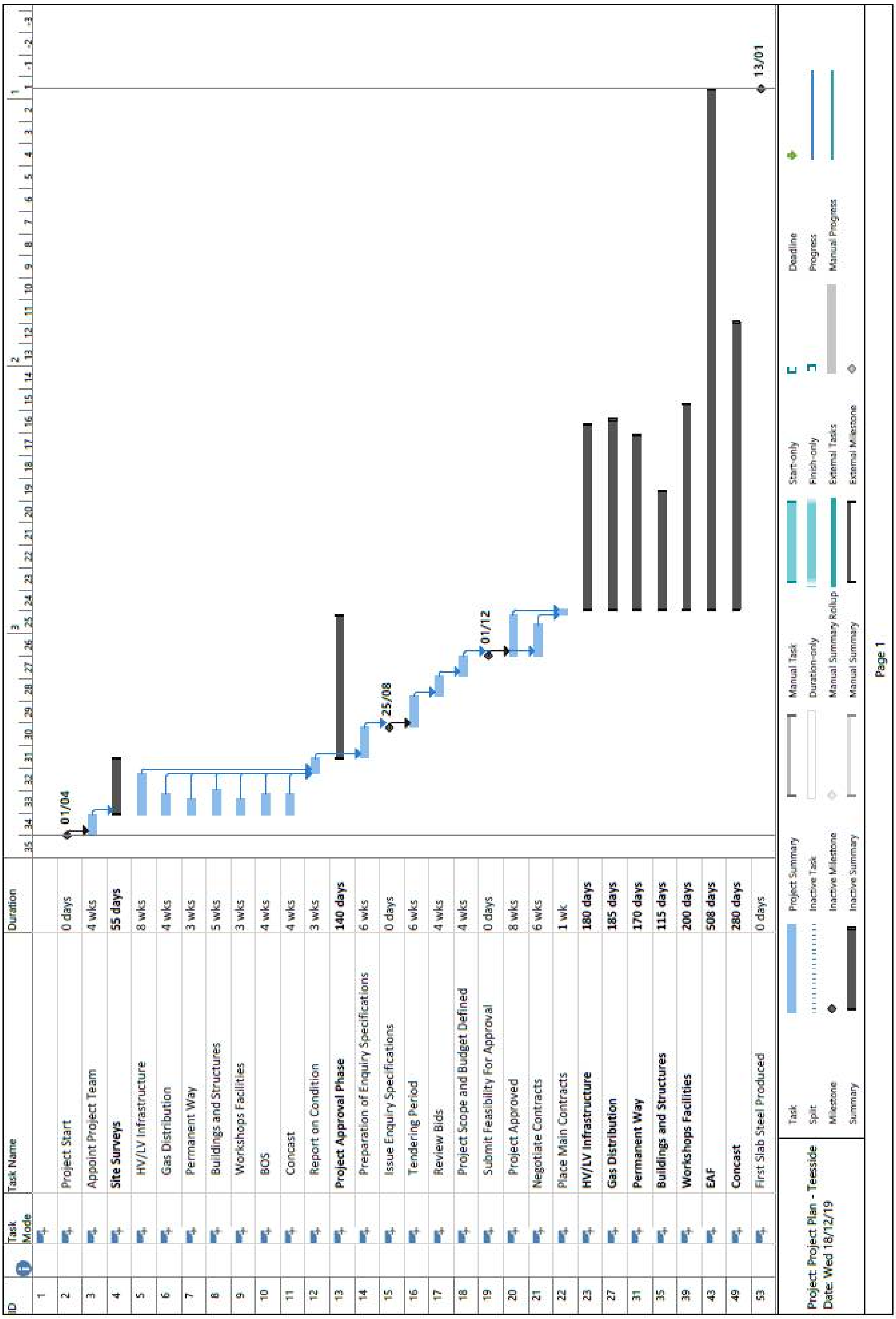
Whilst the need for additional electrical supply equipment has been considered for the installation of electric arc furnace steelmaking, it has been assumed that other areas of the electricity supply network will have remained in place. Key infrastructure that make up the systems, including transformers, substations, etc, will all need inspection and testing prior to reconnection to the network.

The site also has many cellars and pits and there are differing reports on what has been done to each. In some cases, it is suggested that pits have been infilled with rubble and in other cases that pumping systems are operating in cellars. A worst-case scenario must be assumed, i.e., that the pits have been infilled and cellars flooded, thus requiring extensive recovery works to be undertaken in locations where these facilities will need to be brought back to service.

The environmental permits required for the operation of the facility have not been considered. It is known that two permits were registered with the environment agency for the site, RP3434HP granted 2011 and JP3638HM granted 2016. These are typically subject to review / renewal on a four to six-year cycle and both permits are therefore likely to need renewing. This may add to the investment required for restarting the assets in order to meet the requirements of any new permits.

APPENDIX 1

OUTLINE PROJECT PLAN FOR ASSET RESTART



Appendix 4 - SSI Land Options