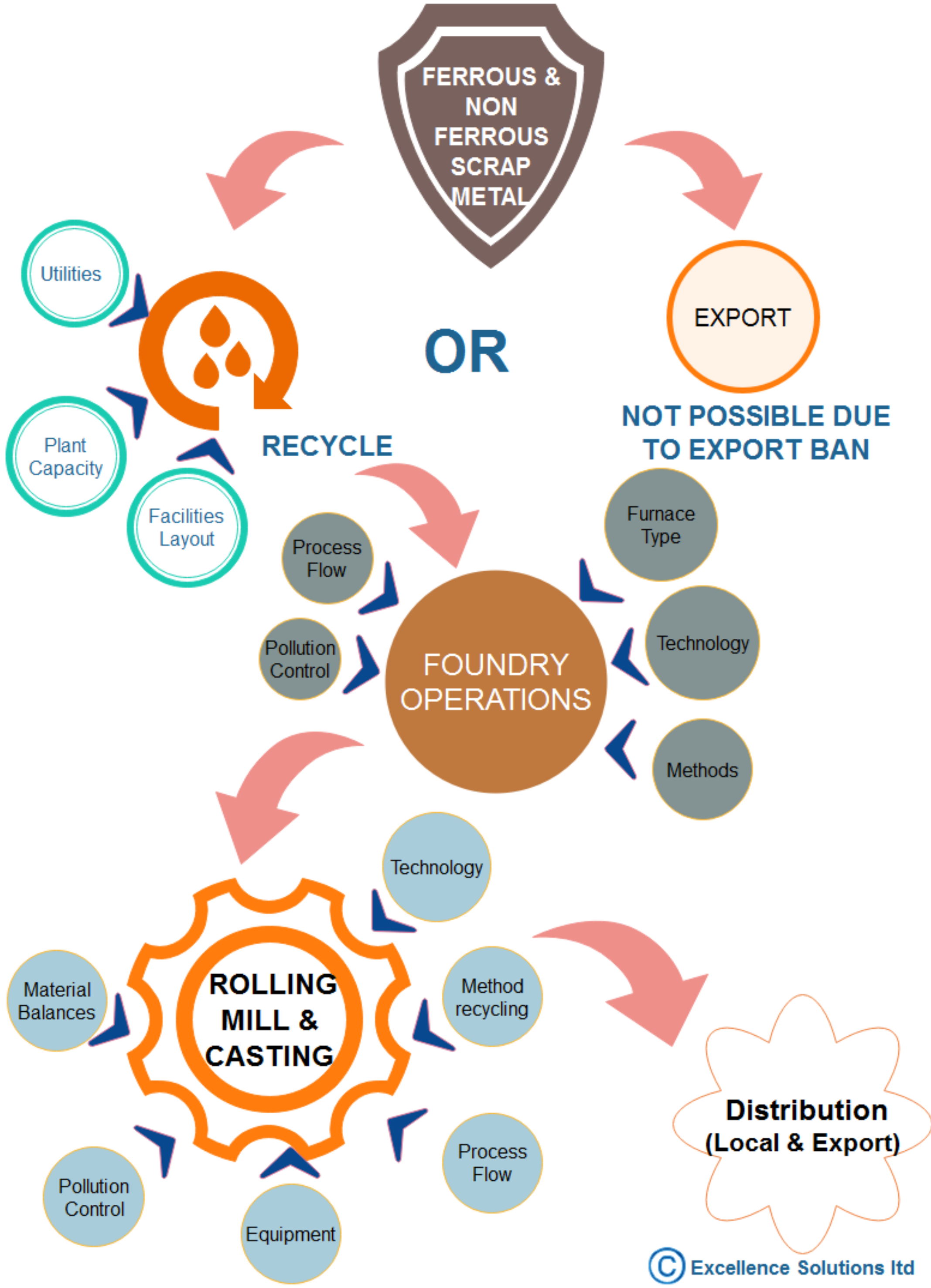
CHAPTER 3: PROJECT DESCRIPTION

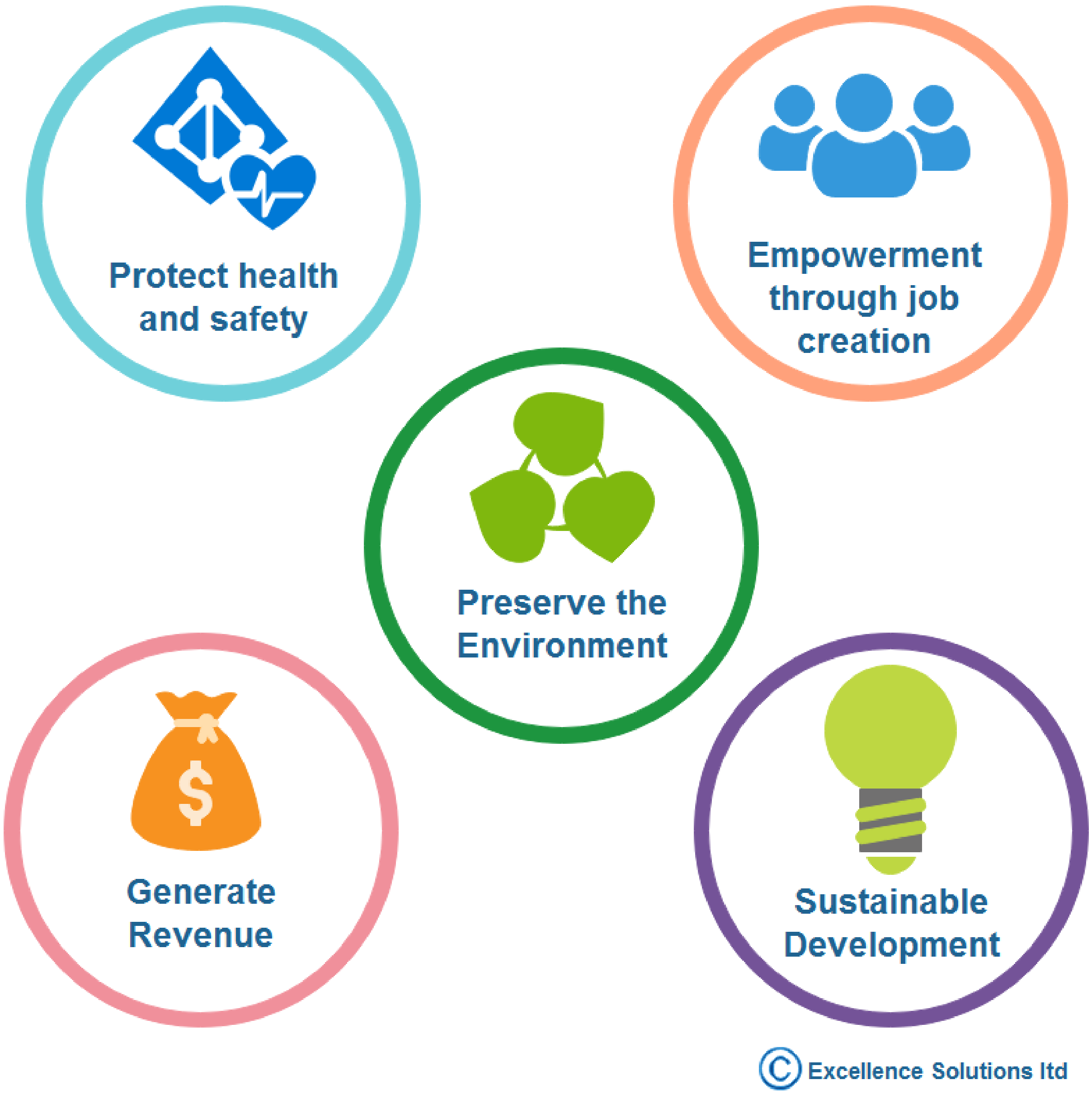
3.1 Project Outline

This chapter of the EIA report provides project particulars for the proposed scrap meta foundry and rolling mill activities at Bananes. The key aspects are sourcing of scrap metal, foundry operations rolling mill and casting. This will be detailed in this chapter of the EIA report.



3.2 Benefits of scrap metal recycling

Uncontrolled scrap metal disposal can pose great environmental, health and safety risks in Mauritius. The country, being an island state is limited in terms of land resources and the water bodies / aquifers are quite sensitive to environmental degradation. The virtues of recycling of scrap metals over their metal ores cannot be over-emphasized when carried out under a structured framework.



This project is expected to provide locally produced construction materials in the form of metal bars and metal casting products. The proposed project could position Mauritius as a regional leader in the production of casting products. Thus, scrap metal wastes will be valorized through this initiative for the socio-economic and environmental benefits of the country.

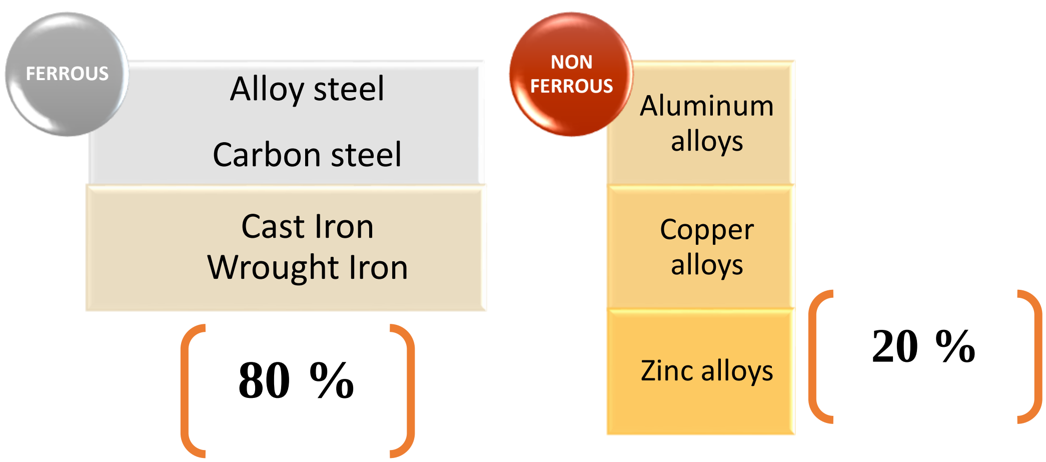
3.3 Scrap Types

According to the CONSUMER PROTECTION (SCRAP METAL) REGULATIONS 2007, scrap metal is:

"metals specified in the First Schedule; and includes any old metal, and any broken, worn out, defaced or partly manufactured articles made wholly or partly of metal and any metallic wastes"

Scrap metal is classified as either ferrous or non-ferrous scrap. While ferrous metals contain some degree of iron (its name derived from the Latin term meaning iron), non-ferrous metal does not contain iron as a component. In terms of ferrous metal, steel, an iron alloy, is the most recycled material both in Mauritius and globally. Scrap metal can be further categorized as either obsolete or prompt scrap. Sources of obsolete ferrous scrap include automobiles, steel structures, household appliances, ships, industrial equipment as well as other sources. Prompt scrap, also known as prime or new scrap, is generated as a by-product of industrial and manufacturing activities such as stampings, turnings, and clippings. Prompt scrap accounts for a relatively small portion of the ferrous scrap supply in Mauritius.

Ferrous alloys are magnetic, although their magnetic attraction will vary as a consequence of the amount of iron in the alloy. Stainless steel is considered to be a ferrous metal but is not always magnetically attracted because a great deal of the iron is removed in the manufacturing process. Euro Castings Ltd will convert scrap metals of ferrous and non-ferrous nature into ingots and billets. The billets and ingots will be used for the manufacture of TMT bars and other casting materials. Although there may be differences in certain operations, basis foundry processes vary only slightly from one foundry to another. All foundry operations produces castings by pouring molten metal into molds. Once the casting has hardened, it is separated from the molding in a shakeout process. The castings are cleaned, inspected and then either shipped for delivery or subjected to the production of value added products. The following metals alloys are expected to be processed from the proposed facility:



The types of scrap metal varies significantly depending various factors and principally the source.

3.4 Sources of metal Scrap

Scrap Metals are generated from diverse activities in Mauritius. Each of the activities generates different types of ferrous and non-ferrous. The metals are generally in the form of alloys. The recycling and processing of the scrap metals will vary depending on the following factors:

- quality of the scrap feed,
- its metal content
- impurities
- any pre-treatment required
- volume of scrap received
- end use

Ferrous scrap also referred to as, iron and steel scrap, or simply scrap comes from end of life products. Iron and steel scrap can be processed and re-melted repeatedly to form new products. The main sources for ferrous scrap are those products, for which iron and steel is the main constituent. These are namely, vehicles (including ships), products of construction, machinery, equipment, and packaging etc. Due to the value of metal in the ferrous scrap, it is recycled or reused wherever it is possible. In fact, ferrous scrap is being recycled long before current awareness of environmental concerns started. The amount of scrap collected and finally recovered depends on many factors, such as the collection system, the possibility and techniques used for the collection, etc. as well as a variety of legislation and regulations. Old scrap is collected after a consumer cycle, either separately or mixed, and it is often contaminated to a certain degree, depending highly on its origin and the collection systems.

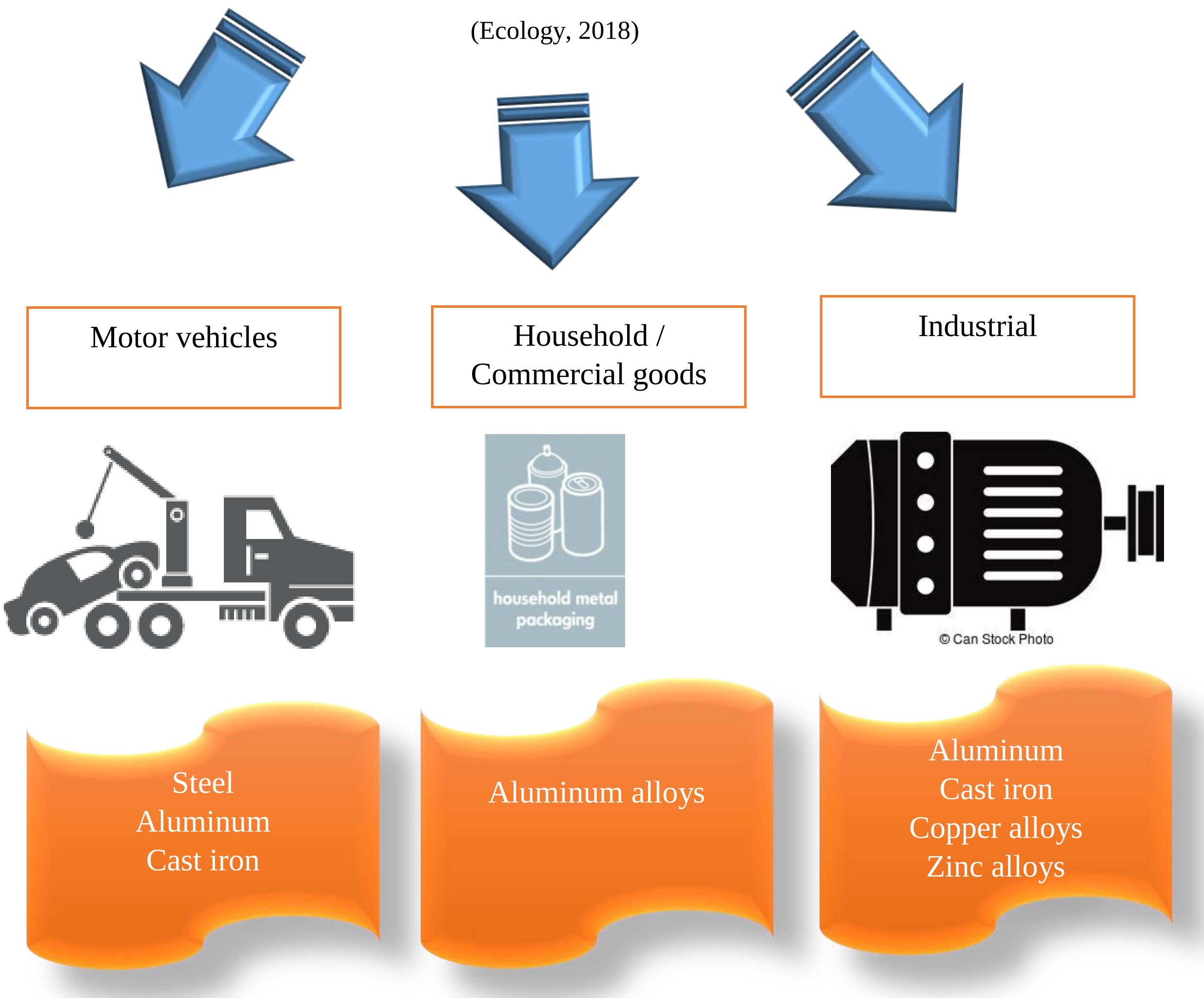

(Source: Indiamart)

Aluminum and copper, categorized as non-ferrous metals are also extensively recycled globally. Both metals are present in vehicles, construction materials and heavy machineries. The volume of non-ferrous metals scrap generated annually is far less as compared to ferrous metals scrap. On the other hand, the cumulative value generated from non-ferrous metals is much higher compared to ferrous metals. A major challenge in recycling scrap is to maintain the quality of steel products and minimize contamination with other metals. Potential residual element contamination can come from the recycling of automobiles and municipal scrap. Recovery of ferrous scrap from mixed waste is difficult as well as costly and hence results in some potentially recyclable ferrous scrap getting lost.


(Source: waste360)

The following are the main sources of scrap metals and types generated in Mauritius:

(Ecology, 2018)



3.5 Scrap Metals Characterization

In order to improve the curability or hardness of steel and aluminum, different alloying elements are added in the steel. Common alloying elements in steel are Ni, Cr, Cu and Mn etc. Residual elements is an undesirable alloying element trapped in the iron matrix. All recycled steel and aluminum has an increased tendency to contain residual elements in very small % since the steel is recycled and re-melted. Some of the residual element and their effects on steel recycling are as follows:

Chromium (Cr) Cr is today seen as the fifth most important metal. Approximately 0.001 % of the earth crust contains Cr. Cr's effect on steels is the forming of a passive layer of chromium oxides at the surface which makes the steel more resistant to corrosion. The passive layer is the reason why high levels (above 12%) of Cr in steels are referred to as stainless steel.

Nickel (Ni) Ni is present in the earth's crust as a compound with oxygen, sulphur, silicon or other elements. It is estimated that the crust contains around 0,002 % Ni. Ni is an important alloying element in steel due to the element's ability to increase the ductility and the toughness of the steel. Ni is also an austenite stabilizer which makes it a valuable alloying element for austenitic (non-magnetic) steels.

Cu is one of the major intrinsic residual impurities and is proven to have an impact on the mechanical properties of the steels, often in an undesired way for the steel manufacturers. Presence of more than 0.25 % in steels usually forms complex compounds that cause unwanted distortions in the microstructure, leading to change in the mechanical properties. Copper (Cu) Cu has a large impact on surface defects in steels and can lead to surface cracking and hot shortness. Addition of Ni in steel containing Cu, ratio Ni:Cu; 2:1, prevents the hot shortness. Cu may be added in the steelmaking process because of its characteristics and previous studies have shown that precipitates of Cu may improve the poise between strength and ductility. This phenomenon is due to the different characteristics of the precipitates of Cu compared to other precipitates, e.g. nitrides.

Manganese (Mn) Manganese is an important alloying element in steel alloys. High Mn steels provide an increase in ductility, formability, strain hardening and strength levels. By using high strength steels, it is possible to reduce the amount of steel which will reduce the cost and the environmental impact. Manganese also has an important role when the steel contains sulphur (S), which may contaminate the steel. Mn has the ability to form MnS when S is present. The kinetic of the precipitation of MnS reduces the sulphur content and thereby the hot ductility increases.

Scrap characterization is quite important aspects to consider while recycling scrap metals. In fact, there are EU regulations and best practices in regards to scrap content for foundry operations. For example, according to Eurofer (2013), EU regulations requires that mixed old scrap (individual metals) should have copper $\leq$0.25 %, $\sum$Cr, Ni, $\leq$0.25%. The proposed facility will comply with these regulations despite not being a regulation in Mauritius. The following factors influencing the characteristics of scrap and accordingly have some implications in foundry operations:

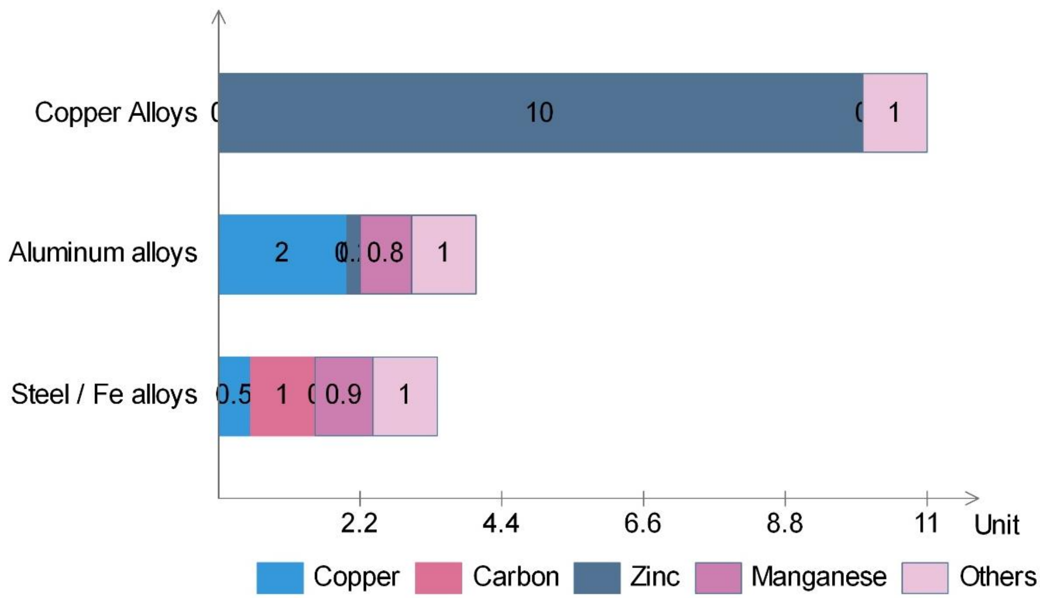
- Metal content
- Metal & non-metal impurities
- Melting points

The following are the melting point for the common metals which will be recycled are shown hereunder:

Metal	Lower	Upper
Brass	900	940
Aluminum		660
Aluminum Alloy	463	671
Aluminum Bronze	1027	1038
Brass, Red		1000
Brass, Yellow		930
Chromium		1860
Copper		1084
Iron, Wrought	1482	1593
Iron, Gray Cast	1127	1204
Iron, Ductile		1149
Magnesium		650
Magnesium Alloy	349	649
Manganese		1244
Nickel		1453
Steel, Carbon	1425	1540
Steel, Stainless		1510
Yellow Brass	905	932
Zinc		419.5

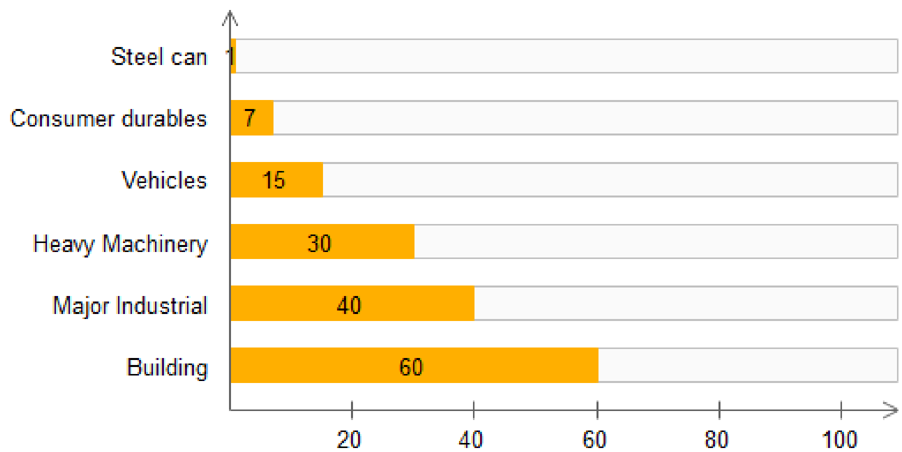
The exact melting point is influenced by other metals and impurities present in the scrap metals mix.

A typical chemical composition for metal alloys are shown below. The exact composition varies from alloys to alloys and intended end uses. The balance is the core metal content.

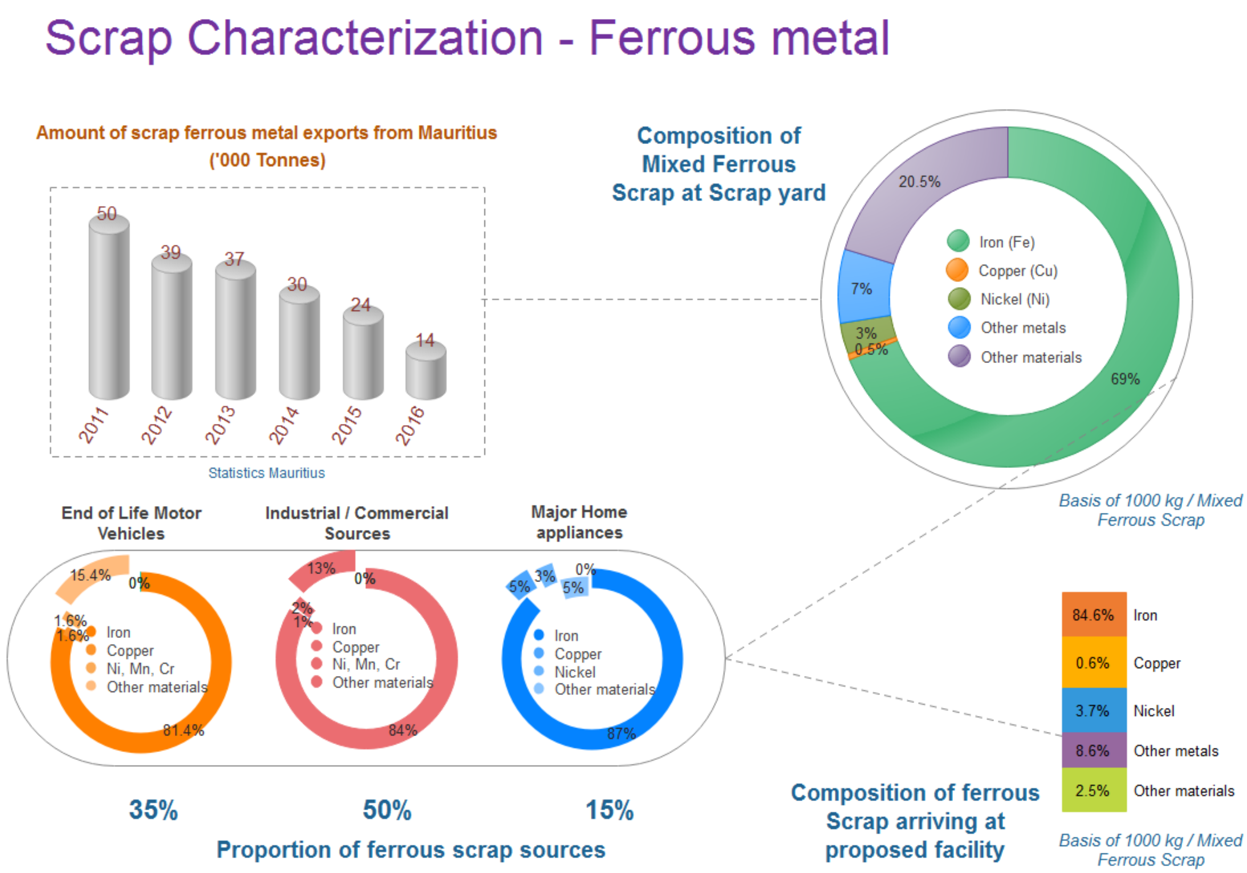


3.6 Metal scrap composition

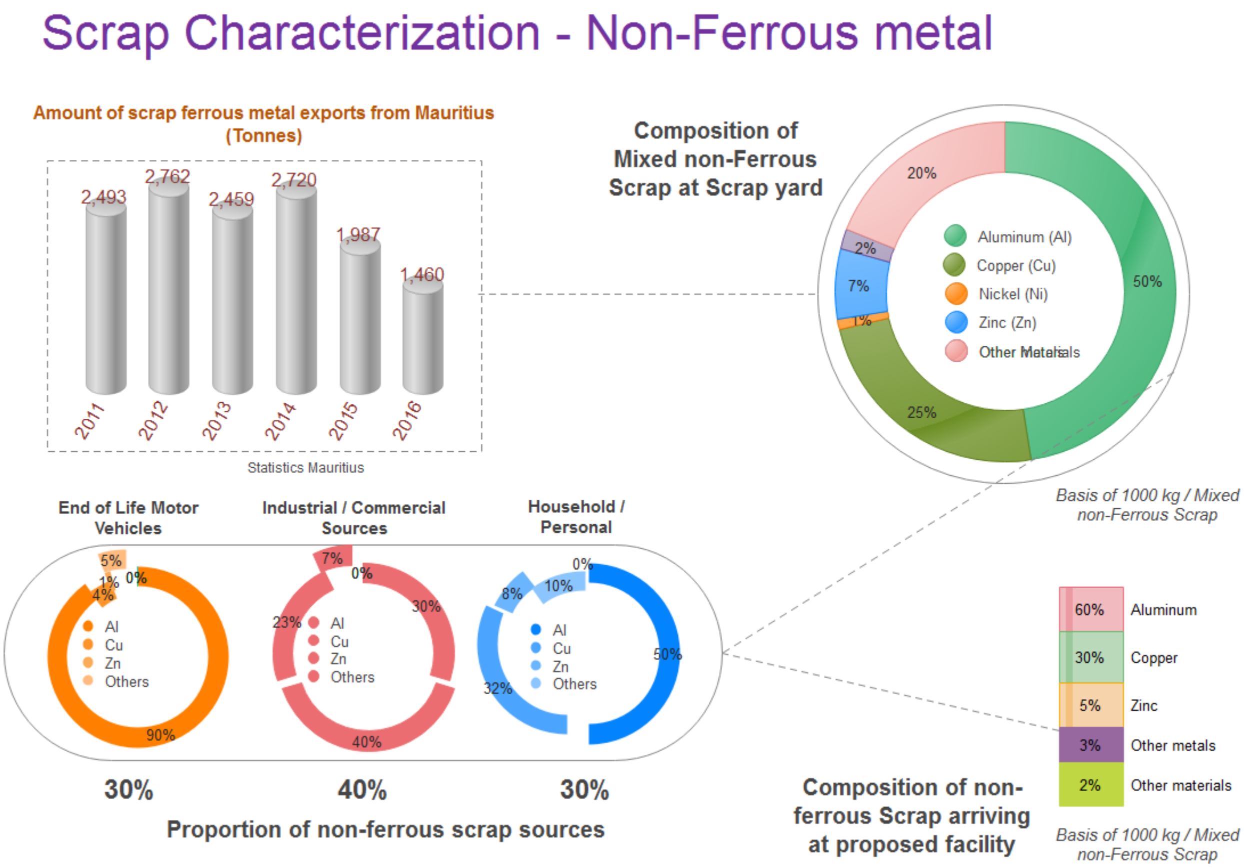
This section provides details on the composition of typical metal scrap collected in Mauritius. Metal scrap are usually gathered in a scrap yard at a scrap dealer facility. It can be observed according to the bar chart below that has been a significant reduction in amount of ferrous metal export based on the scrap export ban. Typical life span for steel scrap according to Brooks and Pan (2004) are:



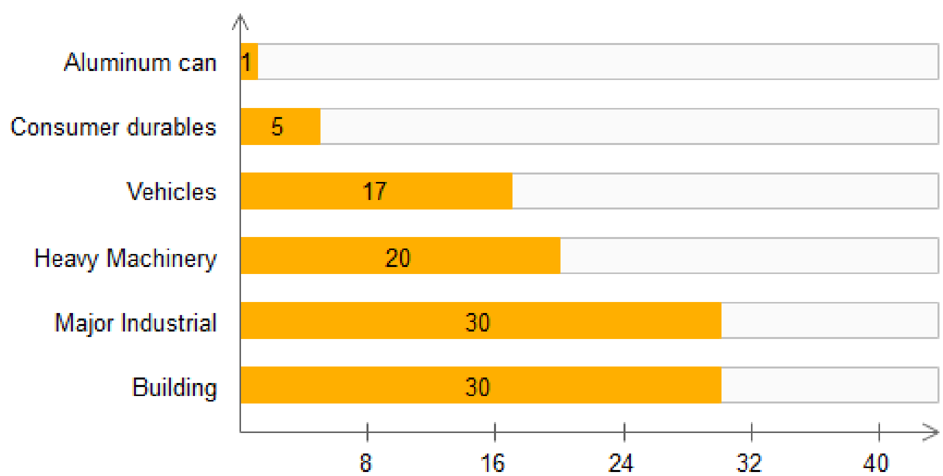
The composition of scrap ferrous metals arriving at the proposed site is expected to be as follows:



Similarly the scrap from non-ferrous will be as follows:



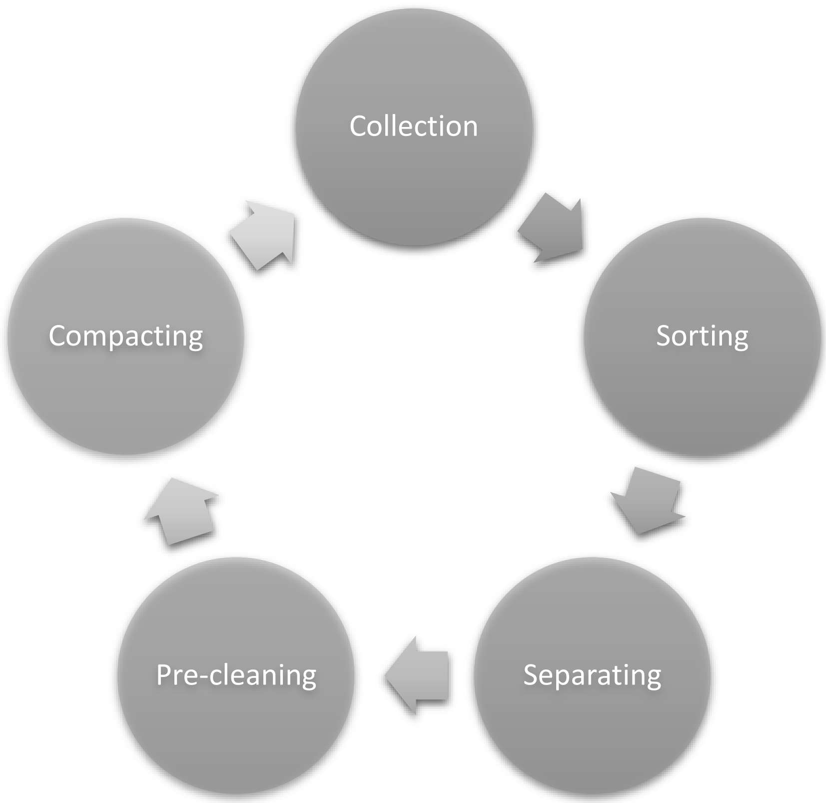
The average lifespan for non-ferrous metal (Aluminum and copper) are:



Since the old scrap is often material that has been in use for many years or decades, chemical composition and physical characteristics are not usually well known. It is also often mixed with other trash. Due to these reasons, old scrap is the most difficult and costly form of steel/aluminum/copper to reuse. Incorporation into recycled products may require cleaning, sorting, removal of coatings, and other preparation prior to use.

3.7 External scrap yard & Scrap Metal dealers

Old scrap is also known as post-consumer scrap or obsolete scrap. It is steel that has been discarded when industrial and consumer ferrous and non-ferrous products (such as automobiles, appliances, machinery, buildings, ships, cans, etc.) have served their useful life. Old scrap is collected after a consumer cycle, either separately or mixed, and it is often contaminated to a certain degree, depending highly on its origin and the collection systems. Scrap metal, whether ferrous or non-ferrous will **not be sent directly** to the proposed facility from sourcing or point of collection. The scrap will on the other hand sent to a **scrap metal yard** for pre-processing prior to sending to the scrap metal recycling facility. The following processes are carried out on typical scrap yard:



In general, ferrous scrap recycling consists of collection, sorting, shredding and/or sizing, and final conveying to recycling facility for melting. The large number of sources and forms of metal scrap requires the use of numerous scrap sorting and preparation processes to remove the contaminants and/or recover other valuable materials (i.e. non-ferrous metals) prior to entering the metal recycling process. This process can be summarized in the figure above. Metal scrap is collected either separately or mixed and then sorted in the scrap yard. Scrapyards use a variety of processes including sorting, shearing, shredding, baling to sort and prepare ferrous & non-ferrous scrap to commodity-grade specifications. The process of shredding, provides the´ ability to handle large items and to separate nonferrous material. The scrap yard from which Euro Castings Ltd will source the scrap is a fairly big player as a scrap metal dealer and is fully licensed to carry out the activity of scrap metal and dealership. A copy of letter is attached in ***Annex 24*** of this EIA Report.

The various stages at the external scrap yard are:

Collection – The ferrous and non-ferrous scrap are usually collected at the scrap generating source and then transported to the scrap yard for processing.

Sorting – This is mainly a manual process to pick out the scrap metal, according to the type of metal and sources, from the mixed waste.

Separating – When there is the risk of mixed ferrous and non-ferrous metal scrap, magnetic separation is to be done through a simple magnetic device, such as magnetic conveyor, via mechanical or manual separation.

Cleaning and de-polluting – If necessary, the sorted scrap is required to be cleaned and then dried to have minimal moisture or pre-treated (e.g. thermal treatment under sun) to eliminate residues such as oil and paint etc.

Compacting – Baling is to be done with baling machine or when sizing is taken place using a shredder such that the resulting material is naturally compacted.

Baling – In baling process, the scrap material is compressed in a powerful mechanical or hydraulic press, to produce dense, cubical blocks called bales. In baling press, loose scrap which has a high surface area and low density (i.e. lathe turnings) is compacted. A baling press is a heavy piece of processing equipment which uses up to three hydraulic rams to compress the scrap that requires higher density for charging in the scrap metal furnace.

The advantages of baling process are

(i) more weight can be loaded on a truck thus reducing the transport cost
(ii) more material can be stored in a given space
(iii) handling and storage of the scrap becomes easier, quicker, and systematic which in turn reduces the cost of handling and storing of the scrap
(iv) a denser furnace charge is obtained.

All categories of scrap sent to the proposed recycling plant for processing but will exclude the following materials:

- Pressurized, closed or insufficiently open containers of all origins which can cause explosions.
- Dangerous material, inflammable or explosive, dirt or pollutants which may contain or emit substances dangerous to human health or to the environment or to the steel production process.
- Lead and tin recycling will not be undertaken in the proposed recycling facility
- All scrap categories will to be free of all but negligible amounts of other metal impurities except for nominal amounts of surface rust arising from outside storage of prepared scrap under normal atmospheric conditions.
- All scrap categories are to be free of all but negligible amounts of combustible non-metallic materials, including, but not limited to rubber, plastic, fabric, wood, oil, lubricants and other chemical or organic substances.

3.8 Recycling Process

The proposed scrap metal recycling facility will be engaged in a scrap metal foundry and rolling mill activities. The processes will vary slightly depending on whether ferrous or non-ferrous metal are handled. The key activities could broadly be categorized as sourcing of scrap metal feedstock from scrap yard, scrap metal preparation, foundry processes and further processing using rolling mill and casting.

METAL SCRAP PREPARATION

This involves ensuring absolute metal segregation and also performing final cleaning on scrap prior to be fed to the metal furnace.

FOUNDRY PROCESSES

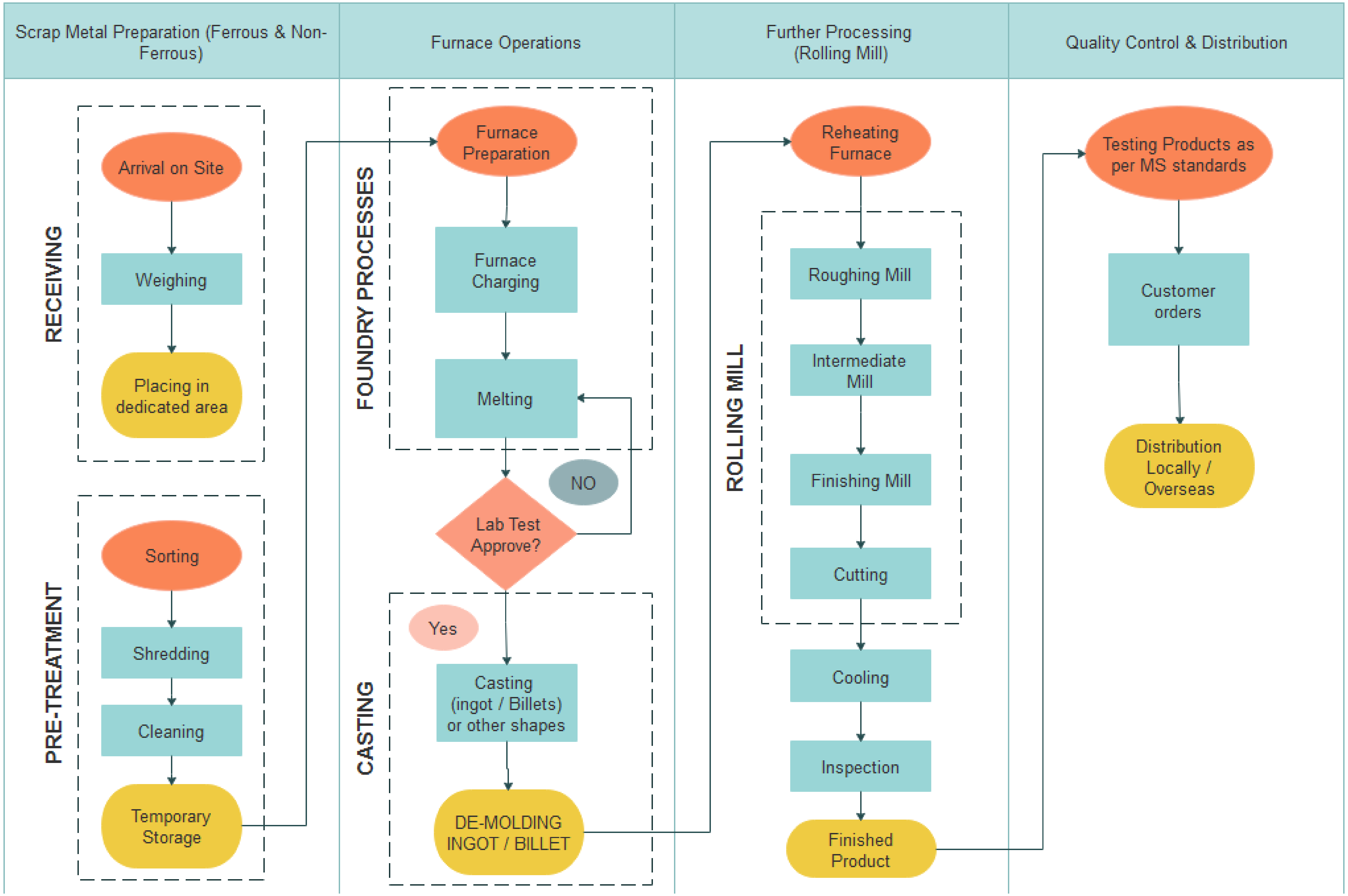
The proposed site will have two types of melting furnaces and will operate **only one** at a time. The type of furnace used will depend on the metal under processing.

ROLLING MILL & CASTING

The output from the metal foundry furnaces will be processed in the rolling mill and casting equipment. The utilization of the rolling mill and casting activities will be influenced by type of product in demand and their respective volumes. The factory will run on a PULL system rather than a PUSH system (production will be based on customer demand)

It is expected that on average, 150-200 MT of scrap metal, both ferrous and non-ferrous will be process on a daily basis. The facility will run over 6 days a week. The furnaces will operate continuously 24/5 during the weekdays. This is based on the strategy of optimizing electricity and fuel consumption. Delivery of scrap metal feedstock will be carried out several times over day-time from 7am to 7pm. Night deliveries of scrap will be avoided as far as possible. Since all scrap will be sourced from an approved and authorized scrap dealer, due diligence in terms of the source of scrap will be limited. The approved scrap dealer will provided evidence and guarantee on the legitimate source of the scrap metals.

Process Flow Chart for Proposed Scrap Metal Foundry & Rolling Mill activity at Bananes



Secondary metal processing may be described as the processing of metal-containing materials to recover and reuse the metal. The specifics of the recovery process vary depending on the type of metal being processed, especially between ferrous and non-ferrous industries. Processes may even vary among facilities processing the same type of metal. However, the processes used by the different industries to recover metals may be grouped or classified by one of the following five general processes:

- Raw materials handling
- Scrap pretreatment
- Metals melting
- Metal refining
- Metal forming

3.9 Metal Scrap preparation

The scrap metals will be received on site in a fairly sorted and cleaned state. This is based on the fact that the company will be working with scrap metal dealers and scrap yard that will already do the sorting and grading of the scrap metal prior to sending to the facility. However, to ensure an optimum foundry performance, the appropriate type of metals need to be fed to the furnace. Furthermore, pre-treatment is also required prior to sending to the proposed furnace.

Material handling operations include receiving, unloading, storing, and conveying the metal-containing materials and the materials required for metal processing (i.e., scrap metal, fluxes, alloys, fuels, and casting materials). The types of materials used may vary depending on the metal being processed.

Scrap refers to discarded materials, such as old appliances and automobile parts that contain a metal of interest, as well as to metal-bearing by-products or wastes generated by other operations in secondary metal processing. The scrap pretreatment process prepares the scrap for melting and involves sorting and processing metal-containing scrap to separate the metal of interest from unwanted materials and contaminants such as dirt, oil, plastics, and paint. Scrap pretreatment also involves the preliminary separation of the metal of interest from other metals contained in the scrap. The most commonly used operations, one or more of which are used by all secondary metal processing facilities, are described below.

Shredding – It is used for steel scrap which may contain other materials (glass, plastic, rubber, any non-ferrous metals, etc.) such as automobiles and household appliances. Hardened steel hammers or knives, driven by electric motors of enormous power, reduce the object to small pieces which can then be sorted, mainly by the magnets that remove the steel scrap and leave all other materials.

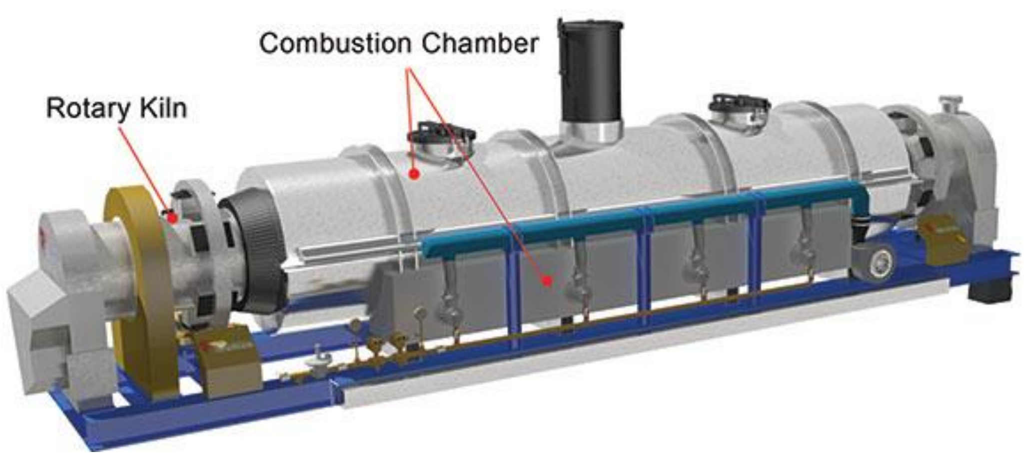
A medium-size shredder uses 36 hammers weighing around 120 kg each to pound the scrap to pieces. Although the predominant raw material for the shredder is automobile bodies, ‘white goods’ (household appliances such as stoves, washers, dryers, and refrigerators) and other large items can also be shredded. Depending on its size, a shredder can process from 100-150 metric tonnes per day. The shredding process produces three types of materials namely

(i) ferrous metal (iron and steel),
(ii) light fraction shredder residue
(iii) heavy fraction shredder residue.

The two residue fractions, either singularly or collectively, are often referred to as shredder residue (SR). 'Shredder fluff' is the term given to the low density or light materials, which are collected during the shredding process. Each ton of steel that is recovered produces about 300 kg of SR, comprised of plastics, rubber, glass, foam and textiles, contaminated by oil and other fluids. The shredder residue will be significantly less for the proposed site based on off-site cleaning. The ferrous metals are recovered by the shredder operator using magnetic separation. The SR heavy fraction contains primarily aluminum, stainless steel, copper, zinc and lead. The non-ferrous and ferrous metals are recovered from the SR heavy fraction. Heavy media separation and eddy current separation are the technologies primarily used to recover the metallic material from the SR heavy fraction. Secondary copper processing and secondary aluminum processing are two of the secondary metal processing industries that make use of mechanical separation operations.

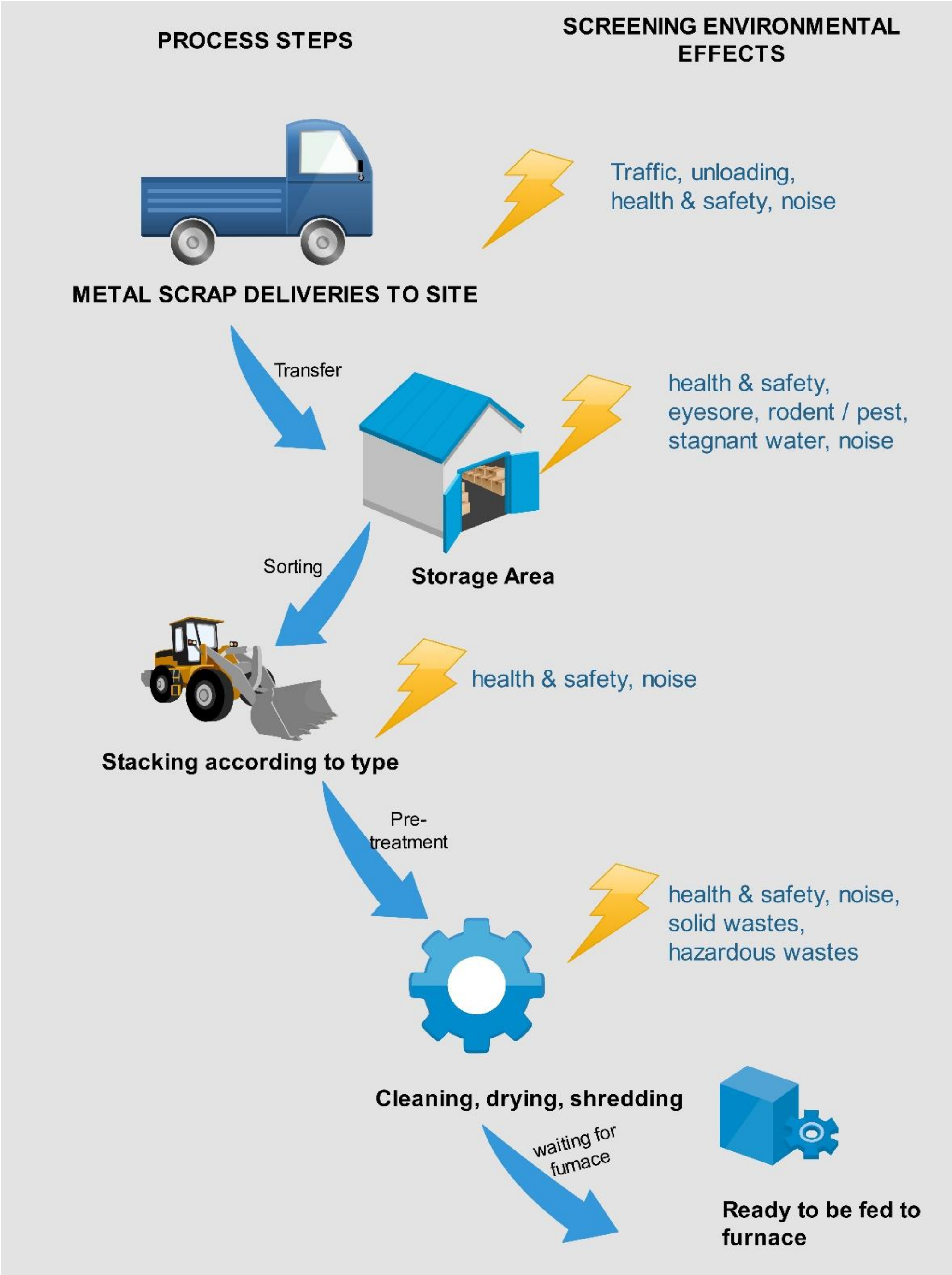
Magnetic separation process - is used when a large quantity of ferrous scrap is to be separated from other materials. Permanent magnets and electromagnets are used in this process. The latter can be turned on and off to pick-up and drop items. Magnetic separation process can be of either the belt-type or the drum-type. In the drum type process, a permanent magnet is located inside a rotating shell. Material passes under the drum on a belt. A belt separator is similar except that the magnet is located between pulleys around which a continuous belt travels. A belt separator will be used for the proposed process. Hand sorting is often used in conjunction with magnetic separation to avoid potential mix-ups. Scrap materials are typically identified by skilled operators (sorters) using a limited number of physical and chemical tests.

De-coating processes - Several steel products will be used for scrap metal that have coating of other metal or paint on them. Examples are galvanized sheets, paints etc. It is essential that the steel scrap generated from such coated products is stripped of the coating material before it is processed in the g furnaces. A rotary kiln will be used for de-coating and treating the material prior to sending to melting. It is expected that about 1/3 of the scrap received on site will be subjected to rotary kiln process to remove any coating on the scrap material.



Source: Feeco

Solvent cleaning of scrap is also performed to remove grease and oils. This method is used in facilities that utilize electric furnaces to melt metal. The last step of the pre-treatment of scrap is to ensure that it is free from water. Any trace of water can results in potential risk of explosion. It is therefore very important that all scrap be free from water prior to be sent to the melting furnace. It is for this reason that all scrap metal will be stored in an inside shed. The rotary kiln process ensure that water and impurities are removed from the scrap metal prior to melting furnace operations. The activities involved in the metal scrap preparation are as follows:



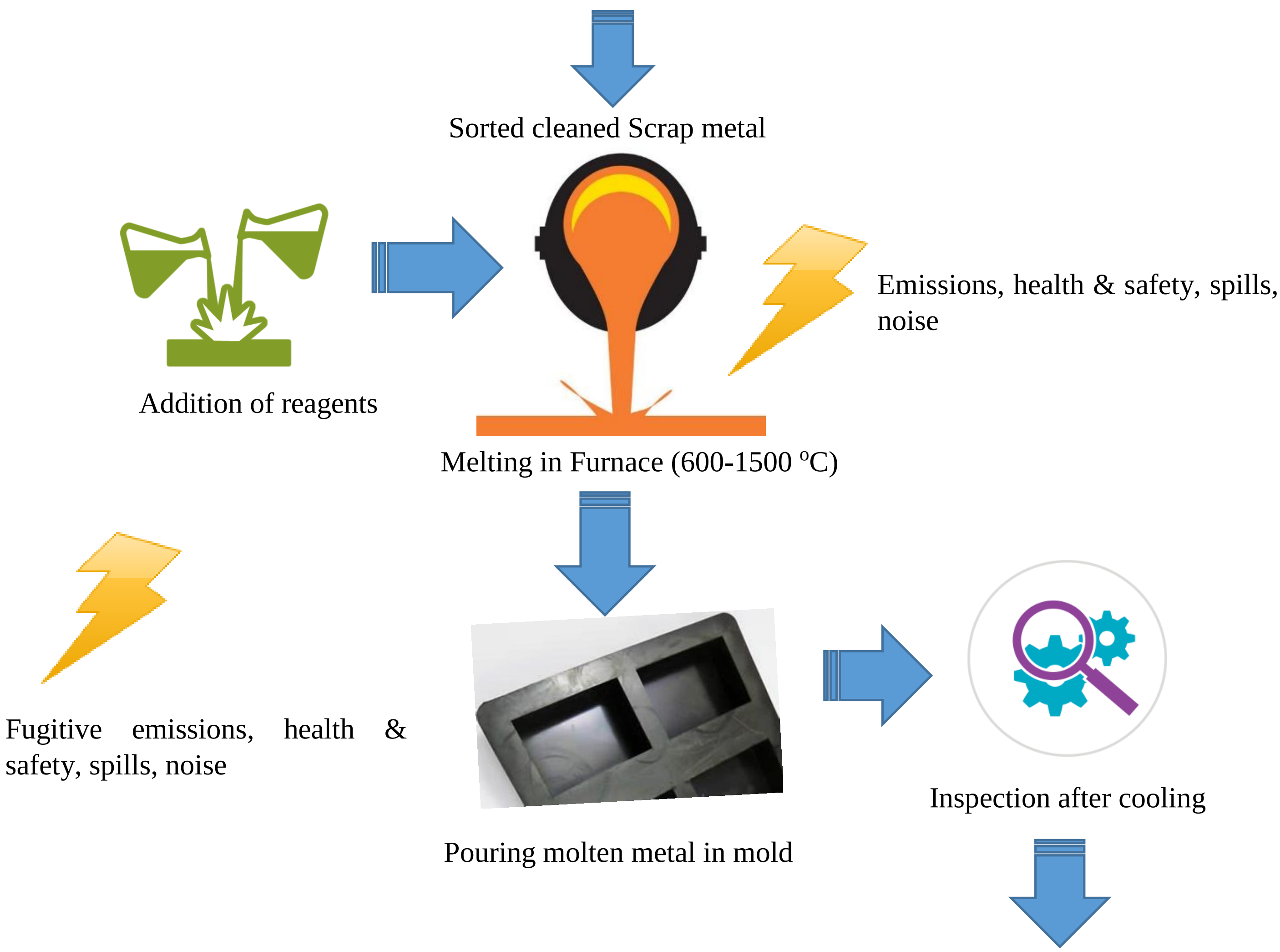
3.10 Furnace Operations

Melting is performed primarily to separate the metals of interest from their metallic compounds, although impurities and contaminants remaining after the pretreatment operation may also be removed. In addition, melting allows the creation of an alloy and allows castings to be made from the metal in a liquid state. Smelting in nonferrous metal processing, takes place in furnaces or heated crucibles. The furnaces may be heated with fuels or through the use of electricity. Pretreated scrap, fuels, and flux materials are added ("charged") to the furnace where melting takes place. The mixture of the flux materials depends on the type of metal being processed. Also, the flux may oxidize impurities in the scrap and further purify the metal. There will be three furnace at the proposed facility: ***1 electric melting induction furnace, 1 oil-fired melting rotary furnace, 1 oil-fired reheating furnace and 1 oil fired rotary kiln***. The typical furnace operations are as follows:

The refining operations further purify the metal, producing the desired properties. Refining may take place in the melting furnace, or it may be performed in holding furnaces or other heated vessels separate from the melting furnace. These furnaces may be heated with fuels or with electricity. Materials are added to the molten metal in the furnace to remove impurities. For example, in copper processing, air is introduced to oxidize any contaminants. Chlorides may be added to an aluminum refining furnace to react with magnesium, facilitating its separation from the aluminum. Alloying is the adding of materials to melted metals in the refining furnace to produce desired properties of the metal. Strength, resistance to corrosion, and ductility are examples of properties enhanced by alloying. Alloying materials may include nickel, molybdenum, and silicon.

After refining, the metal may be formed to make bars and ingots, or it may be formed to make a final product. At metal foundries, this process is normally referred to as "metal coating" or "coating." For the proposed facility, the metal is cast into a final product at the melting facility. Forming the metal into a final product requires the use of molds and cores. Molds are forms used to shape the exterior of castings. Cores are shapes used to make internal voids in castings. After the metal is formed, it is removed from the mold or container in which it was formed.

The standard process flow for secondary scrap metal processing are as follows:



The operations of the furnace is highly influenced by the metal feedstock, any impurities present and the actual type of metals.

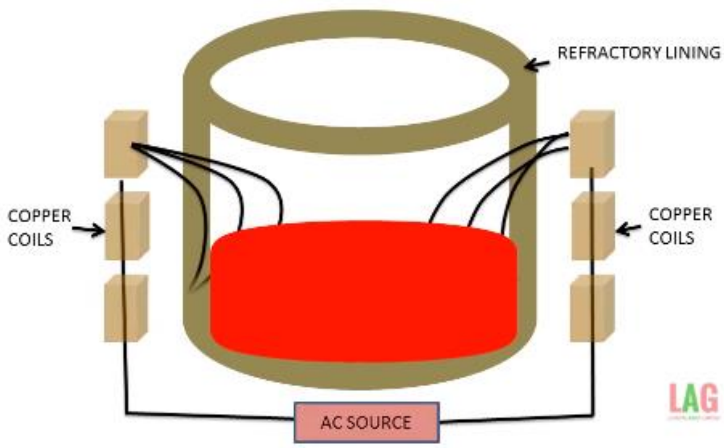
The proposed foundry activity is the intermediate step towards the production of high value products from the rolling mill and casting processes. It is however a critical step in the operation of the proposed facility. It is also quite intensive in terms of energy requirement but significantly less when compared to the processing of ore metal. The proposed furnace will be equipped with an integrated pollution control equipment. This is discussed in details in the subsequent section of this EIA report. It is expected that the proposed activity will run smoothly based on the significant amount of experience from the promoter of this project. As mentioned, the furnace will be operational 24/5 in order to optimize the consumption and utilization of energy on the proposed facility. The idea is to ensure a robust recycling plant performance in order to maintain competiveness.

3.11 Working principle – Induction Furnace

Induction furnace is a type of electric melting furnace which uses electric current to melt metal. The principle of induction melting is that a high voltage electrical source from a primary coil induces a low voltage, high current in the metal (secondary coil). Induction heating is simply a method of transfer of the heat energy. Two laws which govern induction heating are:

(i) electromagnetic induction,
(ii) the joule effect.

Induction heating is the process of heating an electrically conducting object by electromagnetic induction, through heat generated in the object using eddy currents. Induction heating is a non-contact form of heating.



Operating frequencies range from utility frequency (50 to 60 Hz) to 400 H or higher, usually depending on the material being melted, the capacity (volume) of the furnace and the melting speed required.

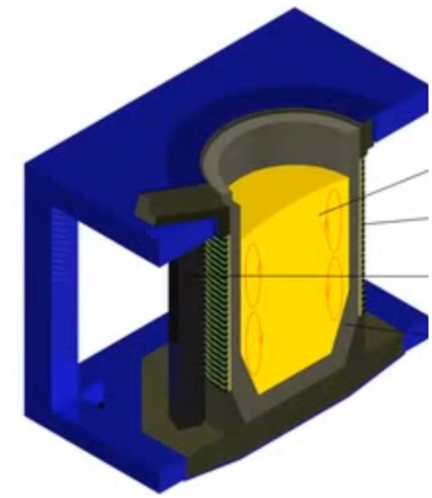
Principle of induction heating is mainly based on two important well known phenomenon:

1. ***Electromagnetic Induction:*** The energy transfer to the object to be heated occurs by means of electro-magnetic induction. Any electrically conductive material placed in a variable magnetic field is the site of induced electric currents, called eddy currents which will eventually lead to joule heating.
2. ***Joule Heating:*** Joule heating also known as OHMIC heating and RESISTIVE heating is the process by which the passage of an electric current through a conductor releases heat.

The advantages of an Induction Furnace are:

- Clean
- Less Pollutant
- Energy efficient
- Well controllable melting process compared to other method of melting

A Coreless induction furnace will be used and comprises a relatively thin refractory crucible encircled by a water cooled copper coil excited from a single AC supply. When the coil is energized, the fluctuating axial magnetic field causes a current to flow in electrically conducting pieces of charge material within the crucible. The power induced in the charge depends on the physical properties of the material, the flux linking it and its geometric shape. Dependent on the resistivity of the material being melted, the coreless induction furnace converts electrical energy to heat the charge at an efficiency of between 50 % and 85 %, although furnace efficiency is further reduced by thermal losses from radiation from the melt surface and conduction through the furnace lining.



Medium frequency induction furnaces will be adopted and uses the heat produced by eddy currents that are generated by a high frequency alternating field. The inductor is usually made of copper in order to limit the electric losses. The inductor is water cooled. The furnace consists of a crucible made of a suitable refractory material surrounded by a water cooled copper coil. In this furnace type, the charge is melted by heat generated from an induction furnace. The coil carries the high frequency current. The alternating magnetic field produced by the high frequency current induces powerful eddy currents in the charge resulting in very fast heating.

Electrical energy needed for heating one ton of iron scrap to about 1500 deg C is around 396 kWh. In furnace several losses takes place which increases the specific energy consumption. The losses consists of

(i) thermal losses
(ii) furnace coil losses
(iii) capacitor bank losses
(iv) convertor losses,
(v) losses on main side transformer.

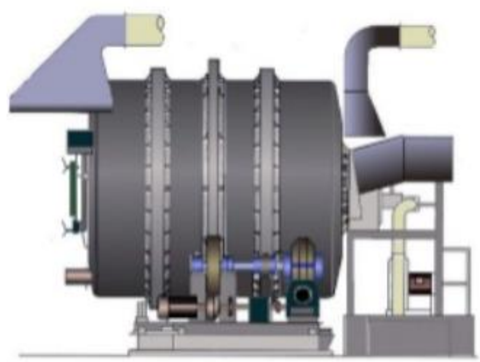
The higher the losses lower is the furnace efficiency. Thermal losses contributes maximum towards loss of energy. The major thermal losses are

(i) radiation loss from furnace top
(ii) conduction losses from refractory lining
(iii) heat losses in cooling water of the coil
(iv) heat carried by the removed slag.

During the making of a heat, the furnace is constantly losing heat both to the cooling water and by radiation from the shell and the exposed metal surface. Electrical energy is required to be spent to substitute this heat loss. Hence longer the heat time the greater is the furnace inefficiency.

3.12 Working principle – Oil-Fired Furnace

An oil-fired rotary furnace will be used for the melting on non-ferrous metal on the proposed site. The rotary melting furnace is the most flexible and universal design of equipment to recycle non-ferrous scrap. Due to the nature of its operation all scrap forms can be recycled with good results. The rotary furnace is rotated either by a friction drive wheel system or a positive rack/pinion or chain drive depending upon the size and production requirements. A single door is utilized with either vertical, horizontal rotation or a pendulum type swing arrangement depending upon the plant layout. A high efficiency fume extraction system is provided either fixed directly on the furnace which tilts with the furnace and exhausts through a rotary joint or simply by a high level fume collection hood / housing.



Rotary furnaces have been traditionally static but over recent years tilting designs have been implemented due to the many advantages with regard to reduced cycle times, yields and consumptions. Typical scrap types include painted and anodised extrusions sections, thermal break, UBC, litho, oily rolling mill scrap, fragmentised scrap, white dross, black dross, engine blocks.

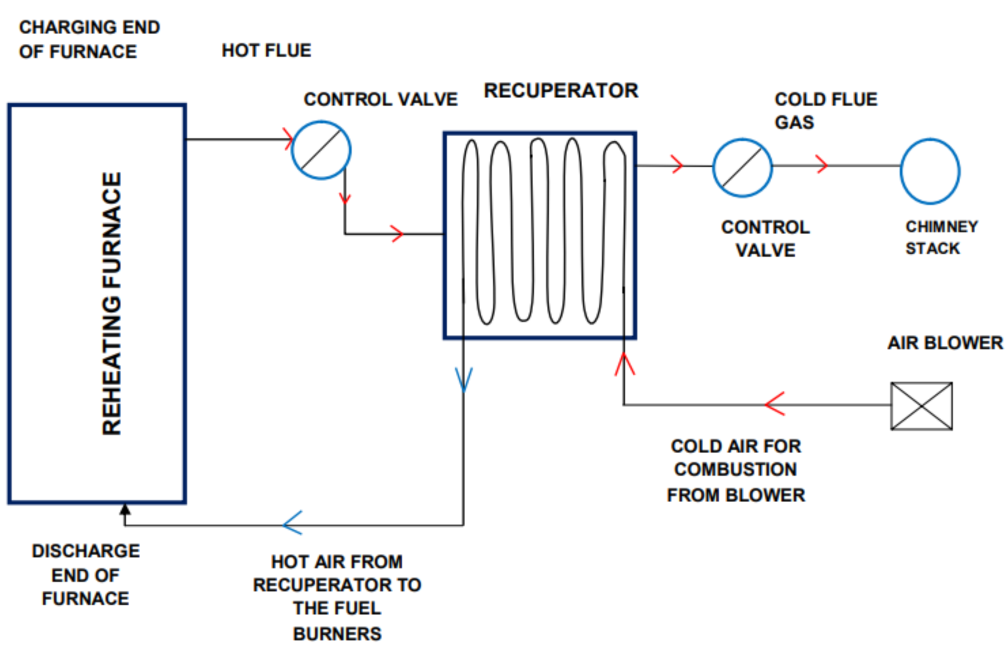
Refined used oil is a common heat source for many industrial applications because it can reduce the energy cost significantly. Besides, used oil is inexpensive as compared to conventional fuels and will also be readily available from the sister company, Advance Oil Ltd. In oil burners, oil is atomized in to a fine spray by controlling combustion of air to fuel ratio. The used oil furnace uses standard electrical blower to atomize oil for burning. The parameters for melting process in foundry is generally based on selection criteria that can affect efficiency of the furnaces. The factors influencing the performance of the oil-fired furnace are:

- air Blow rate (ABR),
- fuel drop rate (FDR),
- inclination angle of fuel runner (IAFR),
- inclination angle of air runner (IAAR),
- position of fuel and air mixed (PFA)
- diameter of fuel and Air mixed orifice (DFAM)

3.13 Working principle – Reheating Furnace

Reheating is a continuous process where the cold stock (either ingot or billet) is charged at the cold rear end of the furnace and heated. The hot blooms (in the rollable temperature) come out from the front, i.e., the discharged end of the reheating furnace and then proceed in the direction of rolling. Heat energy from the hot burner flames and flue gases is transferred to the cold input steel during their travel across, i.e., from the rear to the discharge end of the furnace. This exchange of heat energy takes place by means of conduction, convection and radiation by/from the hot flames, hot flue gases and the hot furnace walls. The rollable temperature of the hot blooms/slabs ranges between 11500 C-1200° C.

Thus the temperature inside the furnace is still higher. There are many types of reheating furnaces with various designs. The workings of these furnaces are also unique in nature. Heating takes place by burning of fuel oil or gas inside the furnace with the help of combustion air supplied through an air blower. The air is the sole supplier of oxygen for the exothermic heat of reaction resulting from the oxidation of the fuel. This heat of reaction is the source of heat input in the furnace.



It is good to note that the temperature of operation for the re-heating furnace is much lower than that of the melting furnace as the intent is to only make the metal malleable for the rolling operations. The extent of reheating depends on the criteria mentioned below:

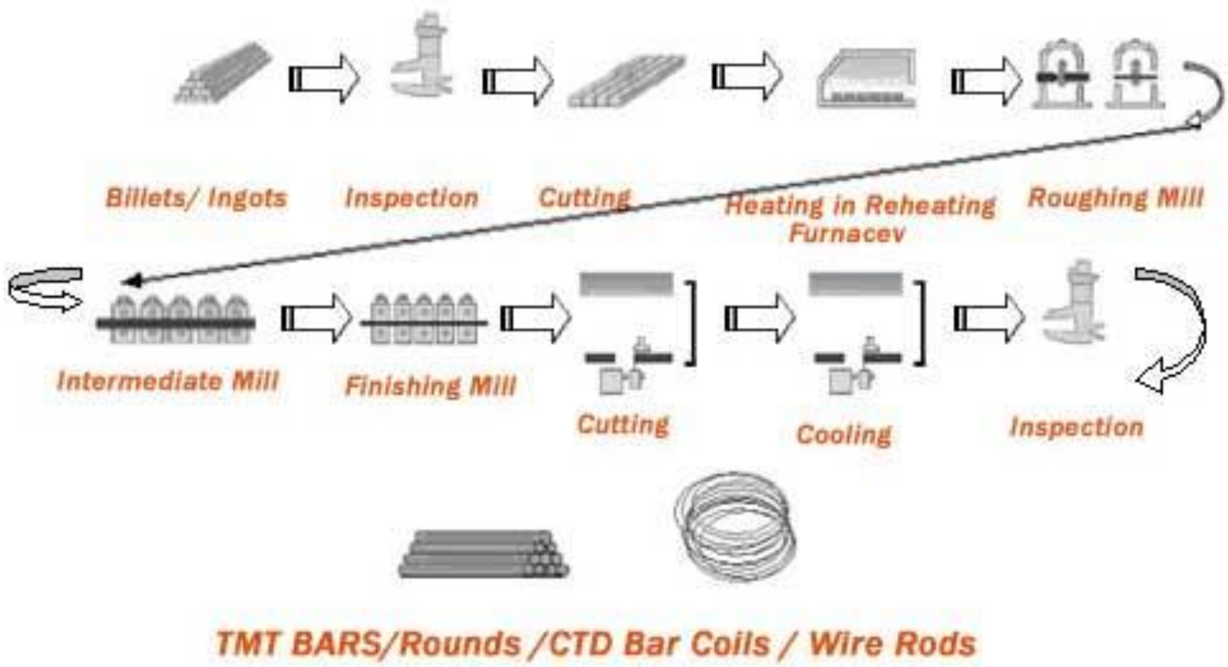
- The furnace throughput, i.e., the capacity of the furnace
- The expected present rolling rate
- The time duration of travel of the cold stock from charging end to the discharging end.
- The dimension of the input stock being heated and the steel composition.

3.14 Rolling Mills Operations

Rolling is a metal forming process in which metal stock is passed through a pair of rolls. There are two types of rolling process - flat and profile rolling. In flat rolling the final shape of the product is either classed as sheet, also called "strip" (thickness less than 3 mm,) or plate (thickness more than 3 mm). In profile rolling, the final product is either a round rod or other cross sections shaped products such as structural sections (beam, channel, joist, rails, etc). The initial breakdown of ingots into blooms and billets is done by hot-rolling. The process involves plastically deforming a metal work piece by passing it between rolls. Rolling is the most widely used method of forming / shaping metals, which provides high production, higher productivity and close control of final product than other forming processes. This is particularly important in the manufacture of steel for use in construction and other industries.

Rolling is classified according to the temperature of work piece rolled. If the temperature of the metal is above its recrystallization temperature, then the process is termed as hot rolling. For hot working processes, large deformation can be successively repeated, as the metal remains soft and ductile. The metal stock is subjected to high compressive stresses as a result of the friction between the rolls and the metal surface. Rolling involves passing the material between two rolls revolving more or less at the same peripheral speed but in opposite directions, i.e., clockwise and counterclockwise. The distance between them is spaced, which is somewhat less than the height of the metal stock entering them. These rolls can either be flat or grooved (contoured) for the hot rolling of rods or shapes. Under these conditions, the rolls grip the piece of metal and deliver it, reduced in cross-sectional area and therefore, increased in length.

- The initial hot-working operation for most steel products is done on the primary roughing mill (blooming, slabbing or cogging mills).
- These mills are normally two-high reversing mills with 0.6 -1.4 metres diameter rolls (designated by size).
- The objective is to breakdown the cast ingot into blooms or slabs for subsequent finishing into bars, plate or a number of rolled sections.
- Steel is squeezed between rolls until the final thickness and shapes are achieved. To achieve this, rolls exert forces of tens of millions of Newton - equivalent to a weight of thousands of tonnes. The rolls run on massive neck bearings mounted in housings of enormous strength and driven by powerful electric motors. These are known as mill stands.
- The layout of a rolling mill varies, from a simple single stand mill to several stands positioned either side by side or in a line.
- A mechanism, commonly called a roller table, directs the work piece to the rolls, and another roller table for handling the pieces emerging out of the roll.
- The table in front of the rolls forces the steel against the rolls which grip and pull the steel between them. Steel is, thus, reduced to a thickness equal to the distance between the rolls, and if the rolls are grooved it is shaped according to the groove design.
- Hot rolling permits large deformations of the metal to be achieved with a small number of rolling cycles.



(Casiaroc, 2018)

3.15 EMISSIONS

There are various emissions which may take place from secondary metal processing occur throughout production, beginning with material handling and storage until final dispatch of the goods.

Some of the metal processing operations are enclosed and emissions are collected and vented through stacks to reduce employee exposure. Secondary metal processing also produces fugitive emissions, much of which results from raw material storage and handling. Several types of pollutants may be generated during secondary metal processing. Among these are sulfur oxides (SO_x), nitrogen oxides (NO_x), carbon monoxide (CO), carbon dioxide (CO_2), particulate matter (PM), organic compounds, acid gases, chlorides, and fluorides. Sulfur oxides, NO_x, CO, and CO_2 are primarily combustion byproducts from oil-fired furnace operations; PM emissions occur from many of the operations. The constituents in PM, organic compounds vary according to the type of metal scrap being processed and the processes used.

The pollutants produced are specific to the process and operation. Although the operations used in metal processing can be similar and have some pollutant emissions in common (for example, NO_x, CO, and PM), there are no data available to indicate that qualitative and quantitative emissions information developed for one type of metal processing can be used to estimate emissions from another type of metal processing. Emission factors, for example, are specific to the industry for which they were developed. However, in some cases where processes and materials are similar, it may be reasonable to use emissions information or estimation methods from one industry for another. A detailed assessment of the air emissions is presented in ***Annex 6*** of this report. The assessment was carried out using an air dispersion modelling.

3.16 Summary of Equipment

Induction furnace and oil-fired furnace will not be operational at the same time.

Metal Processed are:

Iron / Steel & alloys

Cycle Capacity = 8 tonnes

Range of 13-20 cycle daily

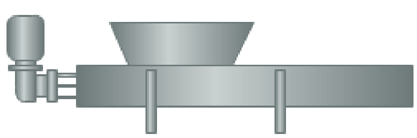
METAL FOUNDRY - FURNACE A
ELECTRICALLY OPERATED

Metal Processed are:
Copper & alloys
Aluminum & alloys

Cycle Capacity = 3.5 tonnes

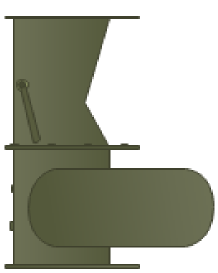
Range of 6-10 cycles daily

METAL FOUNDRY - FURNACE B
OIL-OPERATED



Metal Processed are:
Aluminum & alloys
Iron / Steel & alloys

Rolling Mill



Casting

Metal Processed are:
Aluminum & alloys
Iron / Steel & alloys
Copper & alloys

3.17 Equipment

The typical equipment for the proposed metal foundry & rolling Mill will be as follows:

Description	FURNACE A	FURNACE B
01. Furnace Capacity (Kgs)	8000	3500
02. MF Power (KW)	3000	NA
03. Transformer Capacity (KVA)	3500	NA
04. Solid State Power Panel Efficiency	97%	97%
05. Frequency (Hz)		500
06. Maximum Mains (KVA)	3880	1940
08. Load Matching	Better than 0.95	Better than 0.95
09. Steel Melting Rate @ 1675 deg cent for steel scrap 100% yield (Kgs/Hr)	6300	3200
10. Energy Consumption @ 1675 deg cent for steel scrap 100% yield (KWH/Ton)	530	540
11. DM Water Requirement (Litre)	1500	1000

Electric Induction Furnace

Item	Product Name	Qty
1	Power Supply Cabinet	1
2	Capacitor Cabinet	1
3	Furnace Pot	1/2
4	Hydraulic Station	1
5	Crucible Model	1/2
6	Water Cooling Cable	4
7	Hydraulic Tilting Console	1
8	Water CoolingSystem(Optional)	1

Oil fired Rotary furnace

Bearing Type Rolling Mill Machine

Automation Grade	Automatic
Voltage (V)	220-380 Volt
Material	Cast Iron
Power (W)	25-240 kW
Power Source	Electric

Die Casting Machine

Type - Automatic
Power source – Electrical
Voltage – 380V

3.18 Quality Assurance

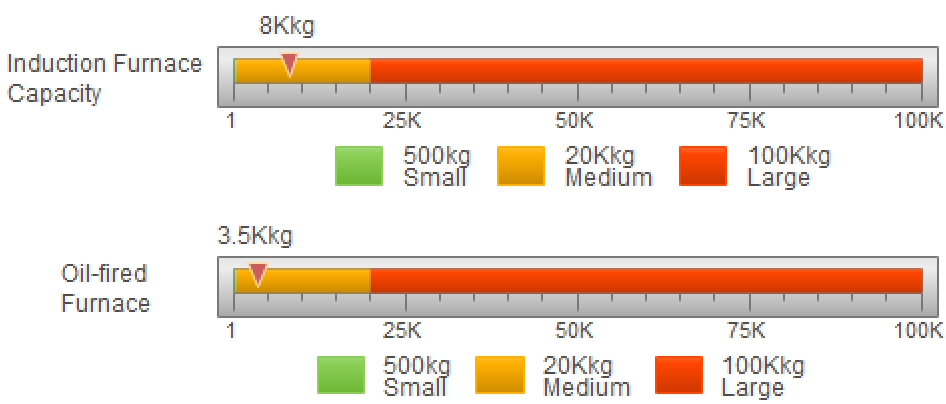
The proposed facility will have a dedicated lab for the in-process control at various stages of the process. The melt, ingot as well as any finished products will be subjected to strict quality control to ensure that they achieved pre-determined specifications. Euro Castings Ltd intends to implement ISO 9001: 2015 once the operations is fully established. The possibility of implementing ISO 14001 will also be assessed once the company is fully operational. These certification will provide assurance on the stewardship of the company towards product quality and compliance to the environment. The steel bars manufactured will comply with local standards (MS 10). The associated certifications will be obtained from accredited institutions before marketing of the products.

For example, the MS 10: 2015 specification for the reinforcement of concrete-weldable reinforcing steel – bar, coil and decoiled product specification will be followed. The standard specifies requirements for ribbed weldable reinforcing steel used for the reinforcement of concrete structures. It coves steel delivered in the form of bars, coils and decoiled products. The standard contains provisions for three steel grades, all of 500 MPa characteristics yield strength, but with different ductility characteristics. The three grades are B500A, B500B and B500C.

The weldability requirements for all grades of steel are specified in terms of the chemical composition and in particular the equivalent value. Steel bars produced by re-rolling finished products, or by rolling material of which the metallurgical history is not fully documented is not covered under this standard.

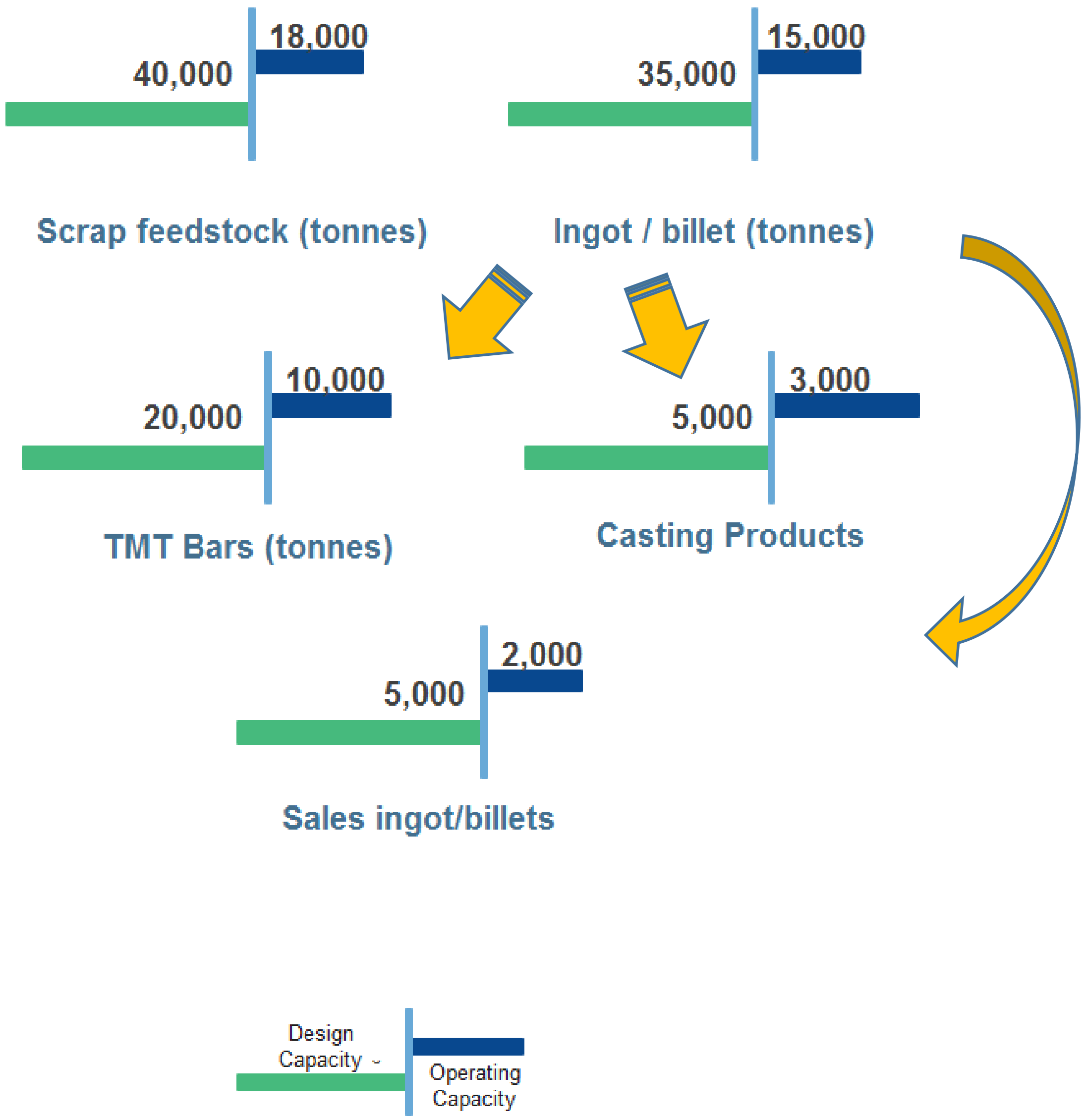
3.19 Production Capacity & Operating hours

The capacity of the processing activity and operating volumes are presented in this section. The recycling plant will initially run on two shifts over 24 hours based on the requirement of maintaining continuous operation of the furnace. The site will however be operational 6 days per week. The proposed facility will have a combined capacity of recycling about 40,000 metric tonnes of mixed scrap metals on an annual basis. However, the plant will initially operate at 40%-50% capacity. Electric Induction and oil-fired furnace capacities range from less than 1 kg to one 100,000 kg and are used to melt ferrous as well as non-ferrous metals globally.



The proposed facility is considered as medium capacity based on this scale requirements.

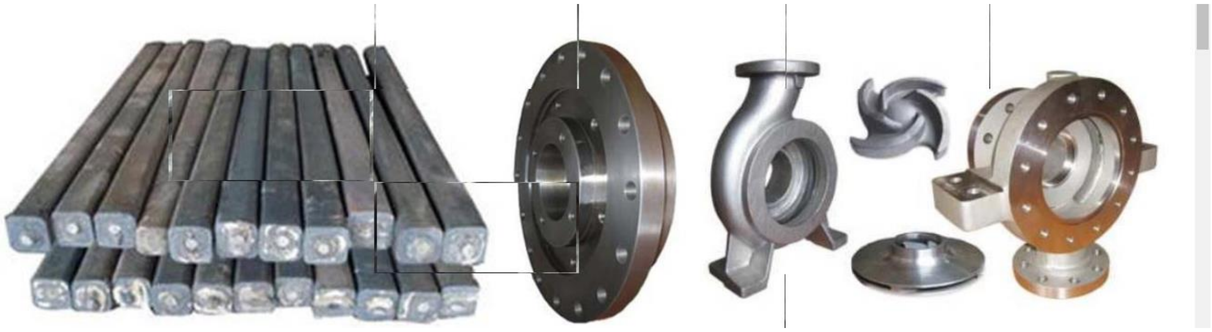
PRODUCTION CAPACITY: Design & Operational (yearly)



The above figure provides the design and operational capacity for the proposed scrap metal recycling plant. For example, annual scrap feedstock is expected to be around 40,000 metric tonnes for the design capacity of the facility. However, the actual processed scrap during initial year of operation will be 18,000 metric tonnes. Similarly, from the 40,000 metric tonnes scrap metals, about 35,000 metric tonnes could be recovered in the form of ingot or billets. However, considering operational capacity of 18,000 metric tonnes, only 15,000 metric tonnes could be recovered. From the design capacity of 35,000 metric tonnes ingots, it is estimated that 20,000 metric tonnes be converted into metal bars, 5000 metric tonnes into casting products and the remaining 5000 metric tonnes sold as is in the form of ingot/billets.

3.20 Products to be manufactured

The scrap metals received on the proposed site will be initially converted into either ingot or billet through dedicated metal foundry furnaces. A significant portion of output (around 80%) from the foundry will be sent to the rolling mill for the production of various value added products such as metal bars and casting products. A few examples of products to be manufactured is shown below:



Ingot and casting products

Metal ingot & billets

Metal bars for construction industry

Casting products to cater the needs for local as well as regional markets

3.21 Storage Requirements

Sufficient and dedicated space will be provided for storage of scrap metal feedstock and finished products. The storage area will be covered and be part of the building in order to ensure that activities does not become an eyesore. The storage of scrap metal will be equivalent to over 2 week's production.

3.22 Energy Requirements

The plant will run on electricity and refined used fuel. The facility will be connected to 3 phase power supply. It is estimated that about 3500 kVA of electricity will be required. Furthermore, plant used oil requirements for heating is equivalent to around 5,000 L at design capacity on daily basis. Electricity is the only energy source for steel melting in the induction furnace. Induction furnace is to run at maximum power since beginning. Power factor will be maintained near to one.

3.23 Water requirements

Water will be required for the cooling water system. The system runs in a closed loop system and will only require make-up water. It is estimated that about 9 m^3 water will be required on a daily basis at design capacity. Water storage tank of combined capacity of 10 m^3 will be available on the proposed site. Rain water harvesting will be strongly considered once the scrap metal recycling plant is established.

3.24 Facilities Layout

The proposed facility will have a shed which will be used for the recycling activities. An office block with mess-room and sanitary facilities will also be available on the proposed site. An outline of the facilities features for the proposed metal foundry & rolling mill is as follows:

FEATURE	AREA (SQM)
SCRAP RECEIVING AREA (STORAGE)	2500 (25*100)
FOUNDRY, ROLLING MILL & CASTING AREA	2000 (20*100)
WORKSHOP AREA	1000 (20*50)
OFFICE BLOCK/MESS ROOM / SANITARY FACILITY	300
STORAGE TANK AREA	Combined area of 100 sq m
POLLUTION CONTROL EQUIPMENT	100 sq m
PARKING	6 parking
LOADING/UNLOADING BAY	2
GREEN SPACE	Along the site boundary