employees in the promotion of skills development. It is obviously easier for a relationship with the local community to develop in such an environment, than where there is a predominantly casual or itinerant workforce.

On site, fast dry construction from off-site manufactured assemblies is less disruptive to neighbours and provides earlier weatherproofing and hence more reliable and acceptable working conditions for other trades. This contributes to safer working and a higher quality product. The risk of water pollution from wet trades is also minimized.

In Service:

- High quality and long life buildings are achieved, which improves comfort and user satisfaction
- Pressure on landfill sites due to wastage of materials is dramatically reduced.

In Construction:

- Productivity, working conditions and safety are greatly improved in the factory and on the construction site relative to traditional building.
- Excellent training and job opportunities are maintained by factory-intensive construction and by specialist installation teams.

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Sustainability

Although sustainability is partly related to choice of the materials and construction process, the majority of the sustainability benefits arise from improvements in the built environment and the performance of buildings in service. Sustainable buildings, therefore, are high quality, energy efficient, long life and adaptable to future demands; they also add to the economic and social life of the community and the built environment. The strong message is that for a viable long term future any business must pay particular attention to the following issues:

- Maintenance of high and stable levels of economic growth and employment.
- Prudent use of natural resources.
- Effective protection of the environment.
- Social progress which recognizes the needs of everyone.

Examples of how the steel construction sector has progressed to be itself more sustainable and contribute to sustainable construction are set out below.

Energy

Life cycle costing[1] shows that, over a 50-year design life of a typical residential building, the energy required by all activities of a material's production process is equivalent to only 3 to 5% of the operational energy of the building. Therefore, the operational benefits due to energy savings, low maintenance and flexibility in use are of prime importance in choosing the method of construction.

Transport

Transport of materials and personnel to construction sites is greatly reduced by use of prefabricated steel construction technologies as follows:

- Steel is pre-fabricated into frames and modules that are transported 'just in time' to the building site.
- Deliveries to site can be timed to suit local traffic conditions and reduce local congestion.
- Fewer workers on site mean fewer journeys to site and less demand for car parking locally.
- Minimal transport of waste to landfill sites is achieved by off-site construction.

The pre-fabricated nature of steel construction means that deliveries of relatively large components can be made to suit local traffic conditions, rather than requiring many smaller deliveries of materials.

Sustainability is also linked to the proximity of the transport infrastructure and use of public transport systems. Steel buildings are sufficiently lightweight that they can be constructed over railway lines or on poor ground and former 'brownfield' sites.

[1] Widman, J: Sustainability of Modular Construction, The Swedish Institute of Steel Construction, Report 229:2, Stockholm, Sweden

Minimising Polution

Minimising pollution in construction and in service is dependent on careful selection of materials and processes, such as the use of pre-fabricated 'dry' steel construction technologies. Steel construction has negligible impact in terms of pollution at the construction site and in-service. Steel manufacturing facilities are very efficient and modern.

In Manufacture:

- Steel is an inert material, which is recycled at the end of its life
- Pre-fabricated steel components are produced in factory-controlled conditions using energy saving and pollution-reducing technologies

In Construction:

- 'Dry' construction processes minimises water use
- On-site pollution during construction is eliminated by pre-fabricated off-site technologies
- Transport pollution is minimised by fewer deliveries and daily worker travel to the building site.

In-Service:

- Steel does not rot or deteriorate in an internal environment
- Steel is non-combustible and does not produce noxious fumes.

Embodied energy

Embodied energy is the energy consumed in the process of manufacturing, using and later disposing of, or recycling, materials. Whilst a substantial amount of energy is required to manufacture steel, it is a highly efficient structural material and relatively little energy is required for the rolling process to form structural sections. However, through continual improvements to their processes a worldsteel study estimates that steel companies have cut their energy consumption per tonne of steel produced by 50% over the past 35 years .

Steel is a material that lends itself extremely well to the sustainability hierarchy of 'reduce, re-use and recycle' as summarised below.

Reduction

Steel is a material which lends itself to prefabrication. Structural components are delivered to site as finished items; wastage during the construction process is therefore minimal.

Re-use

Re-using materials requires less energy than recycling, although it is likely that some refurbishment will be necessary. Steel structures are conceptually a kit of parts; with appropriate design and detailing of connections both between steel elements and other components there is considerable potential to increase the re-use of structures. The ability to dismantle steel structures on a piece-by-piece basis minimizes the environmental problems often associated with demolition such as noise, dust and safety hazards. Furthermore, steel foundation and substructure components can usually be extracted and recovered at the end of a building's life, eliminating ground contamination. The high monetary value of steel compared with other construction materials justifies the expense involved in recovery. All steel created as long as 150 years ago can be recycled today and used in new products and applications[2].

[2] Sustainable steel – At the core of a global economy, worldsteel, http://www.worldsteel.org/, Brussels, Belgium, 2012, p40

Recycling

Steel is 100% recyclable, and repeated melting, casting and rolling have no detrimental effect on quality. Scrap steel has a monetary value and there are established international markets for steel scrap. The waste products generated from the production of steel such as ferro-lime (steel slag) and blast-furnace slag are also recycled and used as substitutes for primary aggregates and cement. Recent studies into life cycle assessment of steel construction products have shown that currently over 85% of steel from demolition of buildings is recycled.

Life cycle inventory and life cycle assessment of construction products
worldsteel has been collecting life cycle inventory (LCI) data from its members since 1995. The data consist of 'cradle-to-gate' environmental inputs and outputs including;

- resource use (raw materials, energy and water); and
- emissions to land, air and water

The data can also include the benefits associated with recycling the steel at the end of a product's life.

This data can be used to perform life cycle assessment (LCA) studies on steel products, based on an internationally standardised methodology (ISO 14040 series). LCA studies help to fully understand the environmental impact of a product by providing a full picture of where environmental burdens occur along the product life cycle including production, use and end-of-life (recycling or disposal). LCA studies enable informed material selection decisions and more eco-efficient products by identifying potential areas to reduce the product's environmental footprint.

An environmental management system (EMS) helps an organisation to monitor and improve its environmental performance and to increase its operating efficiency. According to worldsteel's sustainability statistics, in 2010 approximately 89% of steel industry employees and contractors worked in EMS registered production facilities (EMAS or ISO 14001 certification), which is an improvement from 85% in 2004.

Proper water management is part of an effective EMS. It also plays a critical role in the viability of steel plants, especially in regions of water scarcity. A recent worldsteel member survey showed that average consumption and discharge for integrated steel plants are 28.6 m^3/tonne steel and 25.3 m^3/tonne of steel, respectively. For the EAF route the average is 28.1 m3/tonne steel for consumption and 26.5 m^3/tonne of steel. Water consumption and discharge are close to each other and few losses occur in the process, indicating an overall efficient use of water. In most cases water loss is caused by evaporation .

Health and Well-Being

Steel framed buildings provide flexible, efficient and functional spaces. In construction:

- Steel manufacturing, fabricating and installation processes are very safe in comparison to site-based operations
- Noise, dust and pollution (on the building site) are reduced.

Social Issues

For any business to be successful it needs skilled and conscientious people. The steel construction sector continues to invest heavily in the education and training of both its employees and its customers in the efficient and safe use of its products. Considerable importance in the sustainability agenda is attached to the effects of businesses on the local community. A factory production environment which encourages a stable workforce is more conducive to both employers and

[3] Worldsteel, Water Management in the Steel Industry, 2011