

Hot-Dip Galvanizing vs. Paint in Life-Cycle Assessment

Case Study # 1 – Balcony Structures

Based on its maintenance-free durability for 75 years or more in most environments, hot-dip galvanized (HDG) steel has a lower economic cost and environmental impact than paint. It uses a healthy, abundant, and recyclable metal, zinc, to provide corrosion protection; therefore, it should be considered the preferred construction material for architectural and industrial applications.

To measure the sustainability of hot-dip galvanized steel and provide a basis for future improvements in life-cycle performance of zinc products, VTT Technical Research, renowned for establishing environmental product declarations (EPDs) for building products, conducted life-cycle assessments (LCA) comparing a hot-dip galvanized balcony to a painted balcony.¹ The scope of the LCA is shown pictorially in *Figure 1* below.

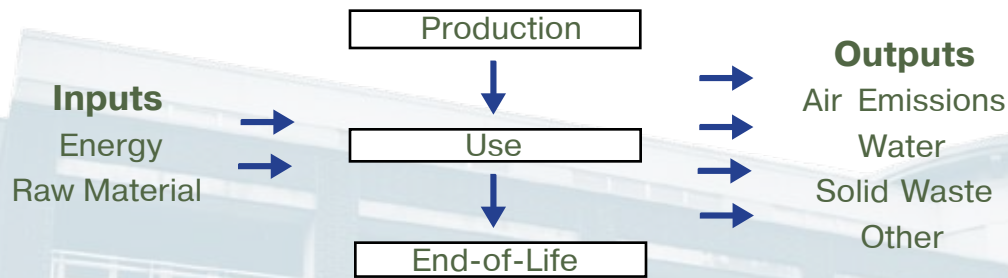


Figure 1

The environmental issues assessed were those most commonly applied in EPDs and “green building” rating systems such as Leadership in Energy and Environmental Design (LEED®) – i.e. use of energy, use of natural resources, and the impacts of emissions on global warming potential (GWP), acidification potential (AP), and photochemical ozone creation potential (POCP), i.e. smog.²

Case Study Parameters

- 60-year service life
- Galvanized coating corrosion rate of 0.5 to 1.0 microns per year (ISO 14713)
- 1,715 lbs (778 kg) galvanized steel; 420 ft² (39 m²) painted steel
- Paint system – zinc-rich epoxy primer (40 microns), epoxy intermediate (160 microns), polyurethane topcoat (40 microns)
- Maintenance painting year 15, 30, and 45 (ISO 12944)³

Results

The total energy consumed during the production, use, and end-of-life phases for the hot-dip galvanized balcony is 23,700 MJ (30.5 MJ/kg) (*Figure 2*, next page). An identical painted balcony uses 64,700 MJ (83.2 MJ/kg) through all three phases, primarily because it must be maintenance painted every 15 years (*Figure 3*, next page).



¹ Vares, S., Tattari, K., Hakkinen, T. 2004. Life-Cycle Assessment study for hot-dip galvanized balcony system compared with painted balcony system. Results. Research report No. RTE1324/4 (confidential), VTT, 57 pages.

² These areas were estimated using established life-cycle impact category indicators from the Eco-Indicator 95 method. Life-cycle inventory data was predominantly sourced from Finnish processes and products, although data for paint materials was sourced from published European databases. Recycling of the steel and zinc was considered in the assessment and allocated using a methodology set out by the International Iron and Steel Institute (IISI).

³ A number of assumptions were made, most notably; the maintenance painting of the structure has the same durability and environmental profile as the original paint application. This was a conservative assumption, but was necessary due to the lack of available environmental data on in-situ maintenance painting.

Life-Cycle Energy: Galvanized

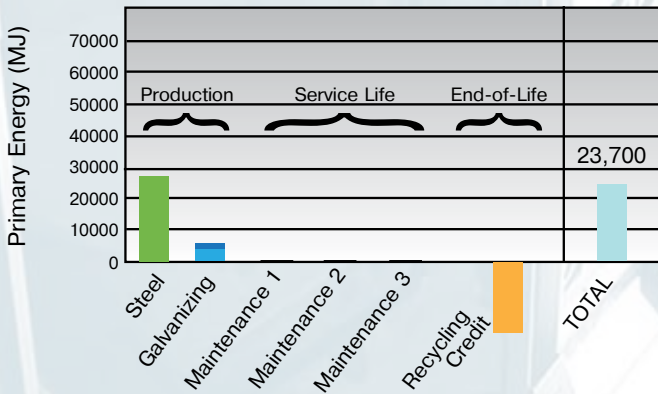


Figure 2

Life-Cycle Energy: Painted

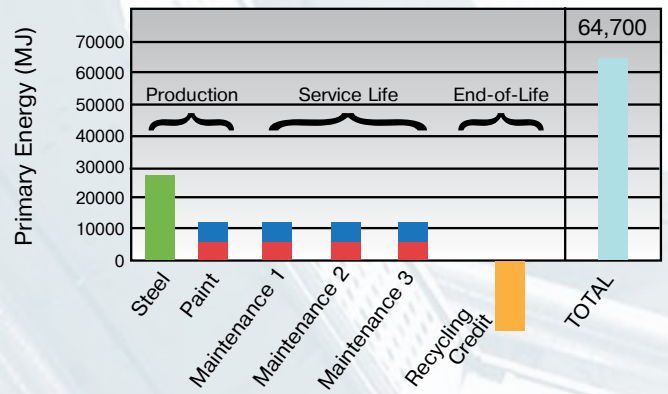


Figure 3

When analyzing just the hot-dip galvanized coating and the paint coating energy consumption as a percentage of the total energy consumed, it is clear the best choice is hot-dip galvanizing. To provide corrosion protection for 60 years, the hot-dip galvanized coating represents just 16% of the 23,700 MJ energy requirement of the balcony, compared to the paint coating's 69% of the 64,700 MJ consumption (Figure 4).

The output as measured by three key indicators for the entire 60-year life is an important consideration in corrosion protection system selection. In addition to assessing the energy input required to produce the balcony (raw materials + process) and that required in the use and end-of-life phases, Figure 5, below, shows the environmental impact of the hot-dip galvanized coating compared to the paint coating in terms of GWP, AP, and POCP (smog). For each indicator, hot-dip galvanizing has a fraction of the environmental impact of paint, primarily because the painted balcony requires periodic maintenance.

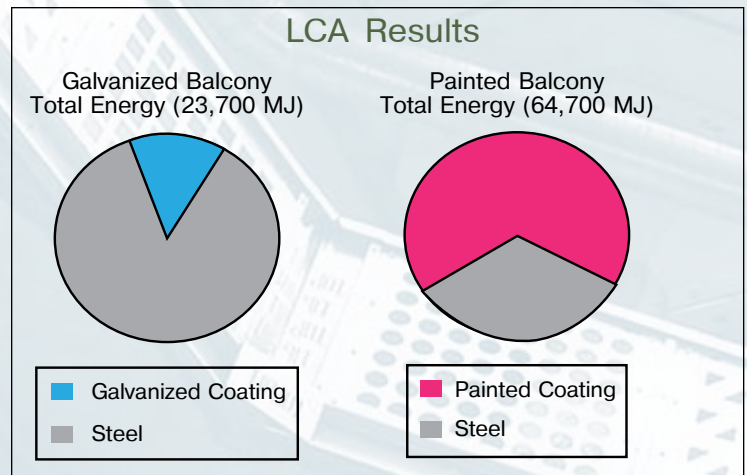


Figure 4

Conclusions

This pilot study has quantified the principal environmental impacts for both a galvanized steel balcony and a painted balcony. For the impact categories considered, the efficiency and durability of the galvanized balcony provided significantly lower life-cycle environmental indicators than the painted balcony.

Hot-dip galvanized coatings make economical sense, too. The initial cost of a hot-dip galvanized coating is often less than or equal many paint systems utilized for corrosion protection of architectural and structural elements. Additionally, galvanizing's life-cycle cost is almost always far less. For an economic cost analysis example, see *Hot-Dip Galvanized Steel Costs Less, Lasts Longer*.

Impact Indicator LCA Results Full Life-Cycle

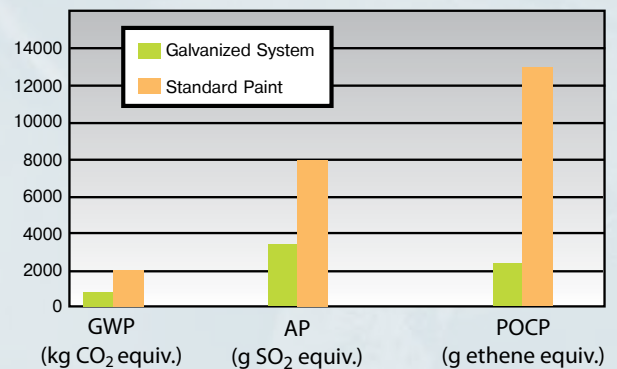


Figure 5

