



# Atmospheric and Soil Corrosion Performance of Magnelis® (Zinc Aluminum Magnesium) Coated Steels for Solar Mounting Structures

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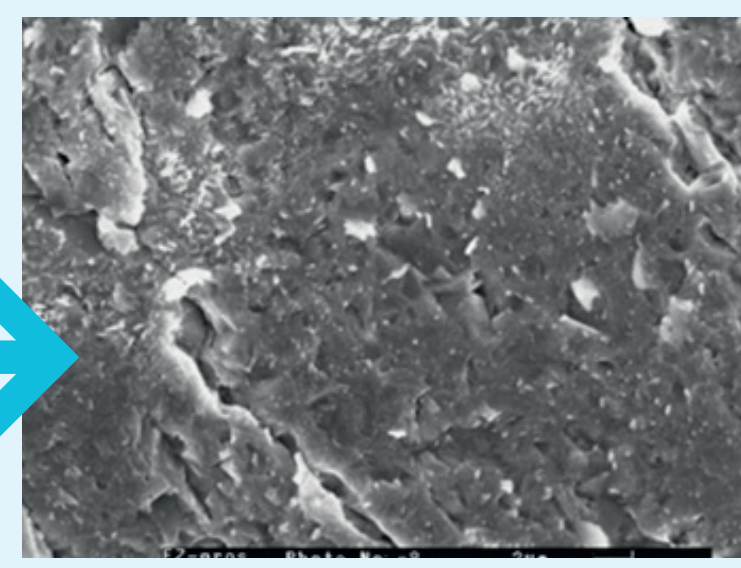
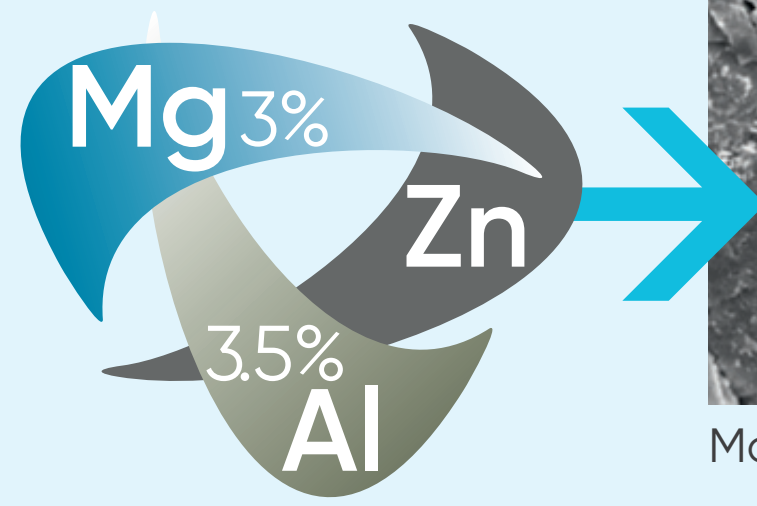
## Goal

To compare the atmospheric and soil corrosion performance of batch and continuous galvanized coated steels to Magnelis® (Zinc Aluminum Magnesium) metallic coated steels and determine which coating offers **better corrosion protection/longer service life** for solar mounting structures.

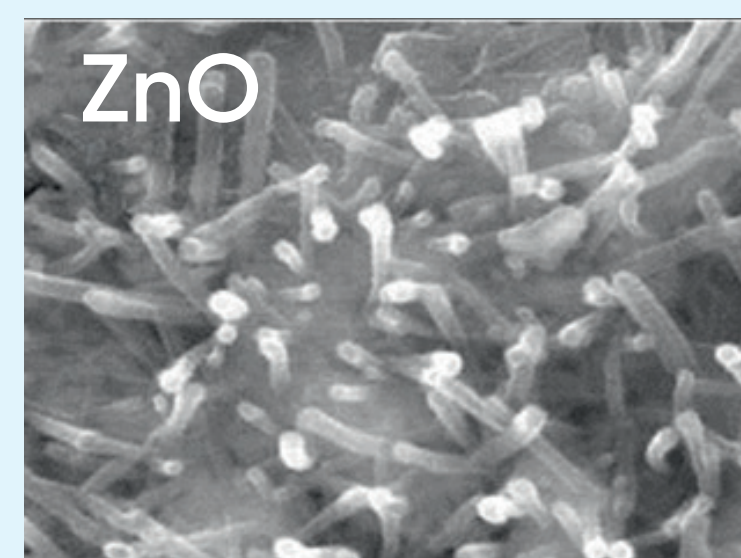
## Results

### Exceptional corrosion protection, the right composition.

- Zinc Aluminum Magnesium (ZnAlMg) coatings offer not only sacrificial, but barrier corrosion protection vs. only sacrificial corrosion protection with Galvanized (Zinc) coatings.
- 3% Magnesium (Mg) in the metallic coating ensures a stable barrier effect on the coating surface and significantly reduces the corrosion rate.
- 3.5% Aluminum (Al) helps develop stable compact corrosion products over a wide pH range.
- The Mg and Al in the Magnelis® coating results in the precipitation of compact and stable barrier corrosion products that strongly inhibits the oxygen reduction rate and therefore reduces the overall atmospheric and soil corrosion rates which results in longer service life than equivalent thickness Galvanized coatings.



Magnelis® – compact & stable structure

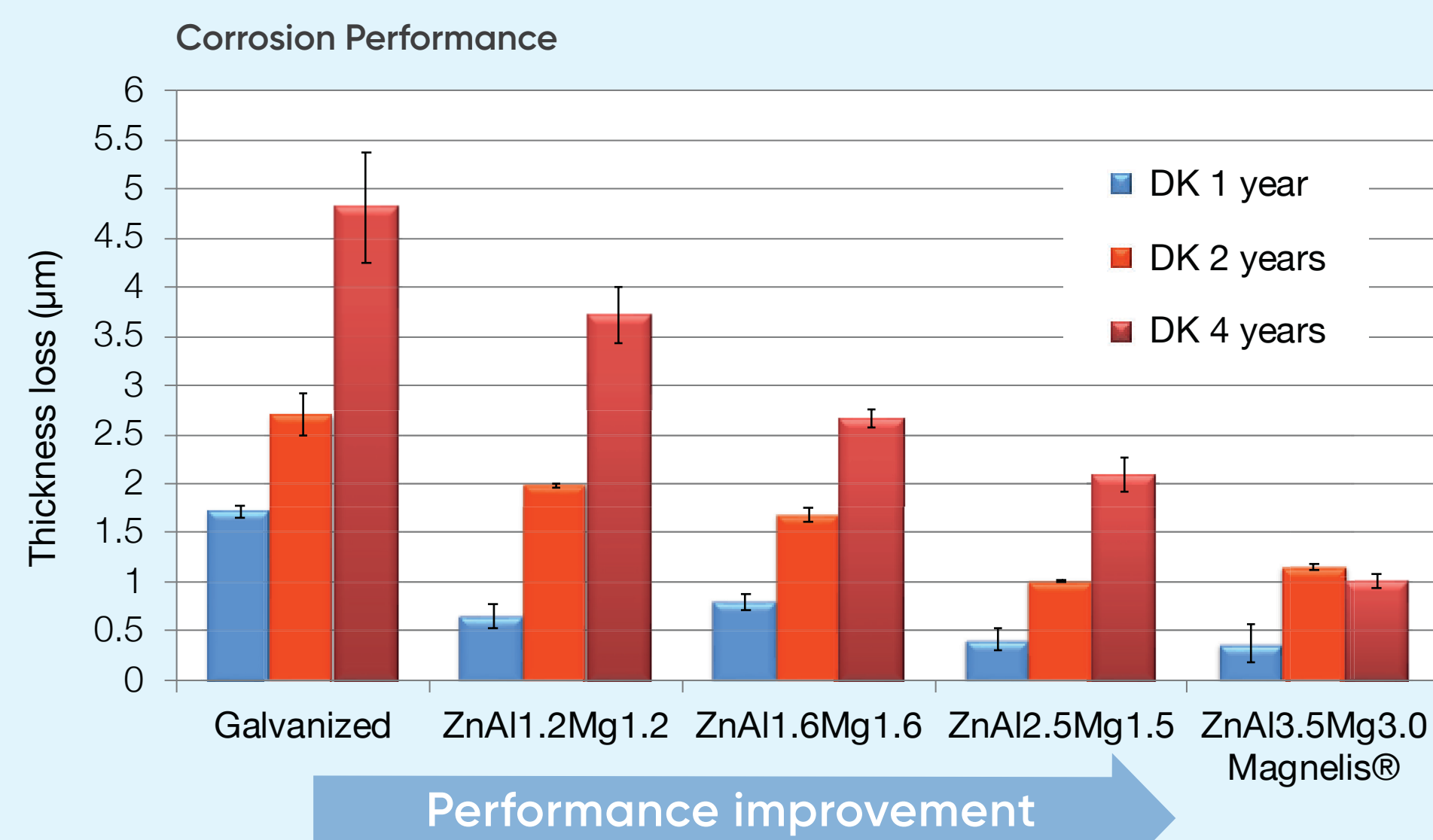


Galvanized – porous structure

Outdoor/seaside exposure in Dunkerque (DK), France (C3 rated)



- Coating mass loss at 1, 2, & 4 years
- Magnelis® composition shows better corrosion performance over lower alloy and pure zinc coatings.



Performance improvement

### Cut edge performance

**3 mm thick steel structure, inland environment**

Initial exposure period (up to several weeks)  
The exposed cut end of the substrate is oxidised and forms red rust.

after 1 week

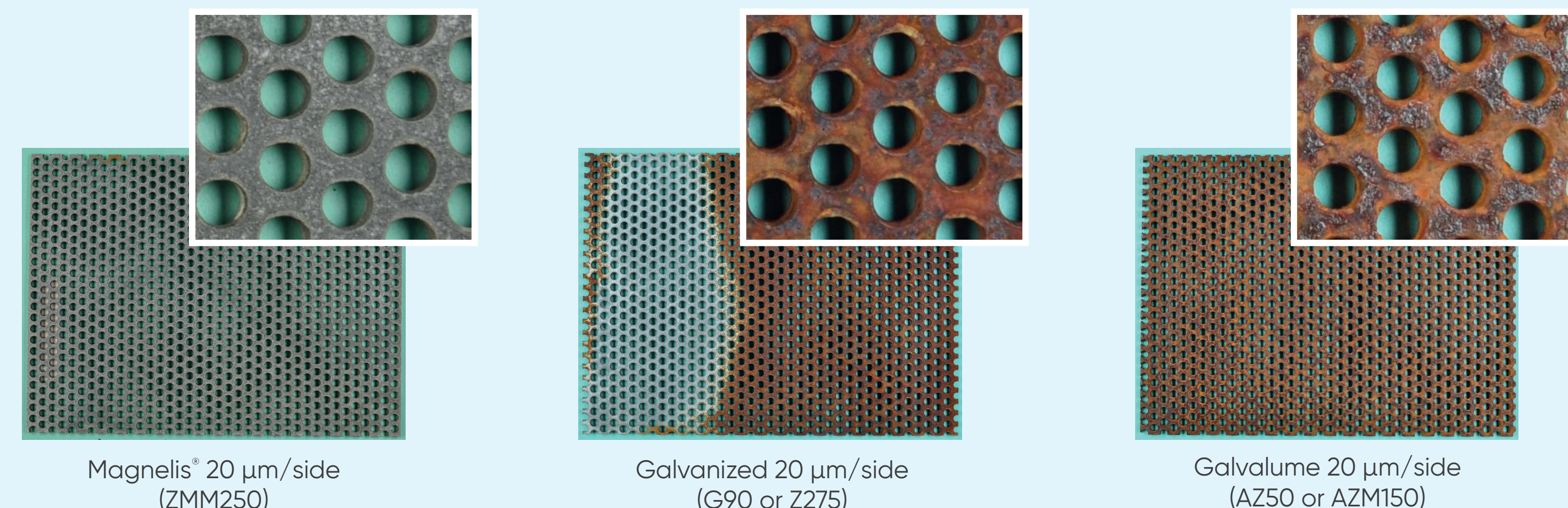
Subjected to rain and condensation

after 15 months  
The zinc-based film containing magnesium on the coating layer migrates over the cut end.

after 25 months  
Disappearing of red rust and increasing of white rust.

\* Note: The speed of Magnelis® self-healing is affected by the environmental conditions. Corrosion and self healing of cut edges takes more time in less corrosive environments (ex. non-seashore)

2 mm thick R4T6 perforated panel C5 Marine environment after 5 years

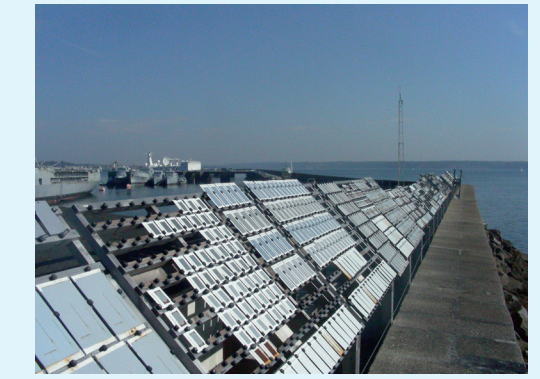
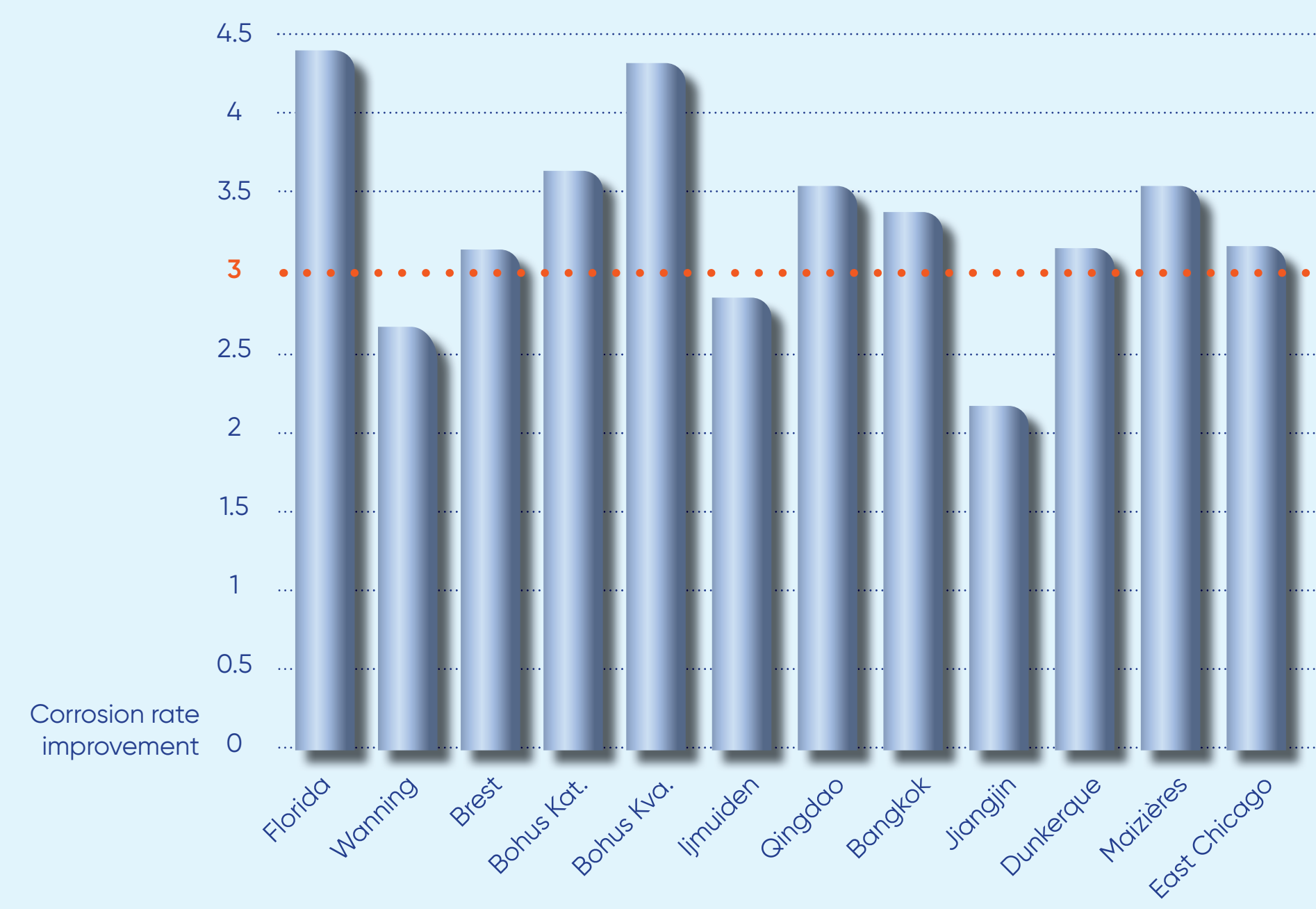


- Magnelis® sample exhibit no red rust vs. significant surface and cut edge rust on Galvanized and Galvalume samples

## Atmospheric corrosion performance

Galvanized (GI) / Magnelis® (ZM) Mass Loss Ratio after 6 Years of Outdoor Exposure

Improvement factor between Magnelis® and regular galvanized steel in field testing



Brest (France)



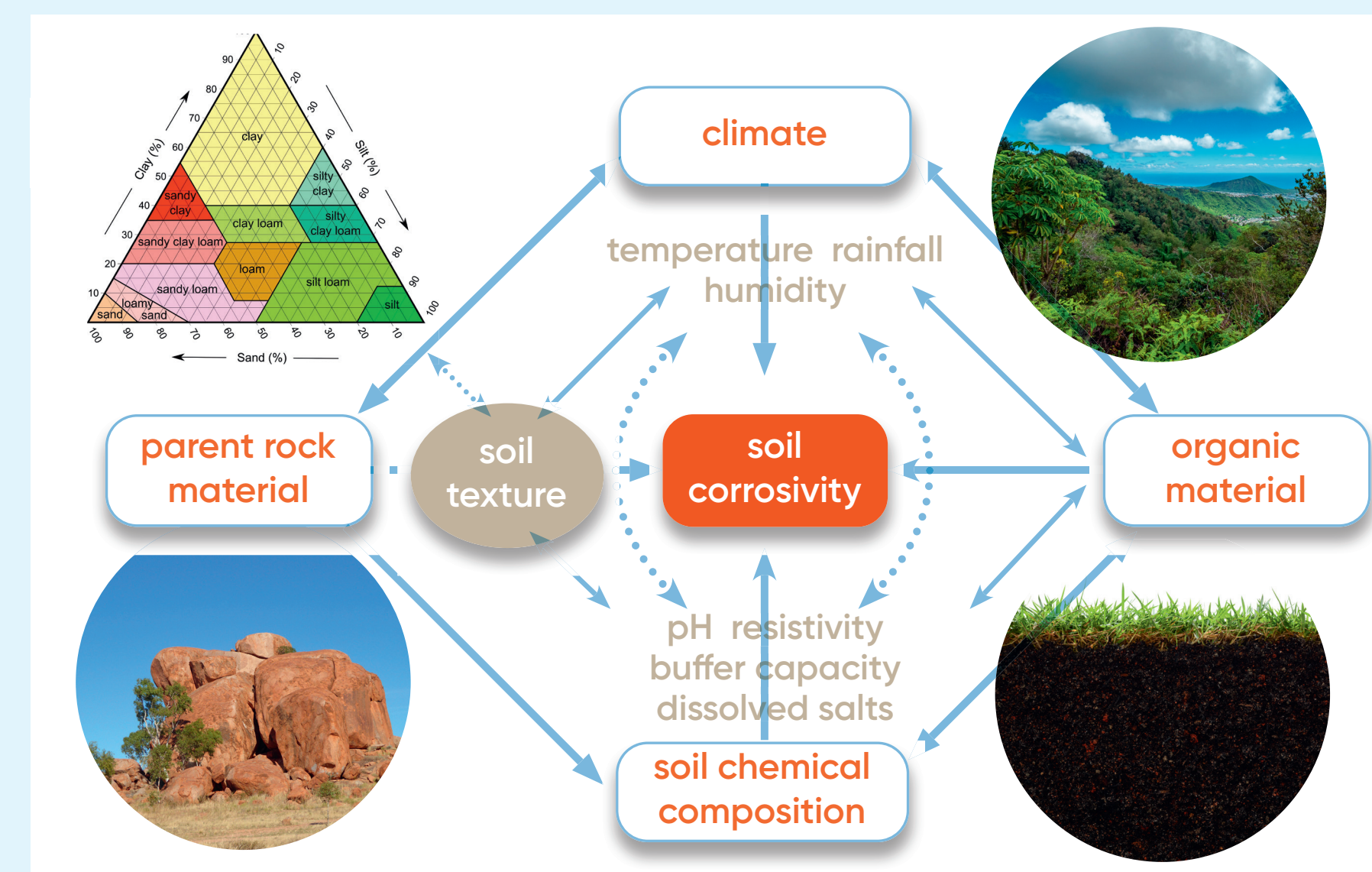
East Chicago (IN)

Average improvement: ~3 compared to regular galvanized steel

- Magnelis® (ZM) outperforms Galvanize (GI) regardless of the exposure site worldwide in rural to marine environments.
- Magnelis® shows much lower mass loss vs. Galvanize reference: GI corrosion rate is ~3 times that of ZM.
- Includes worldwide results from Worldcoat and internal studies.

## Soil corrosion

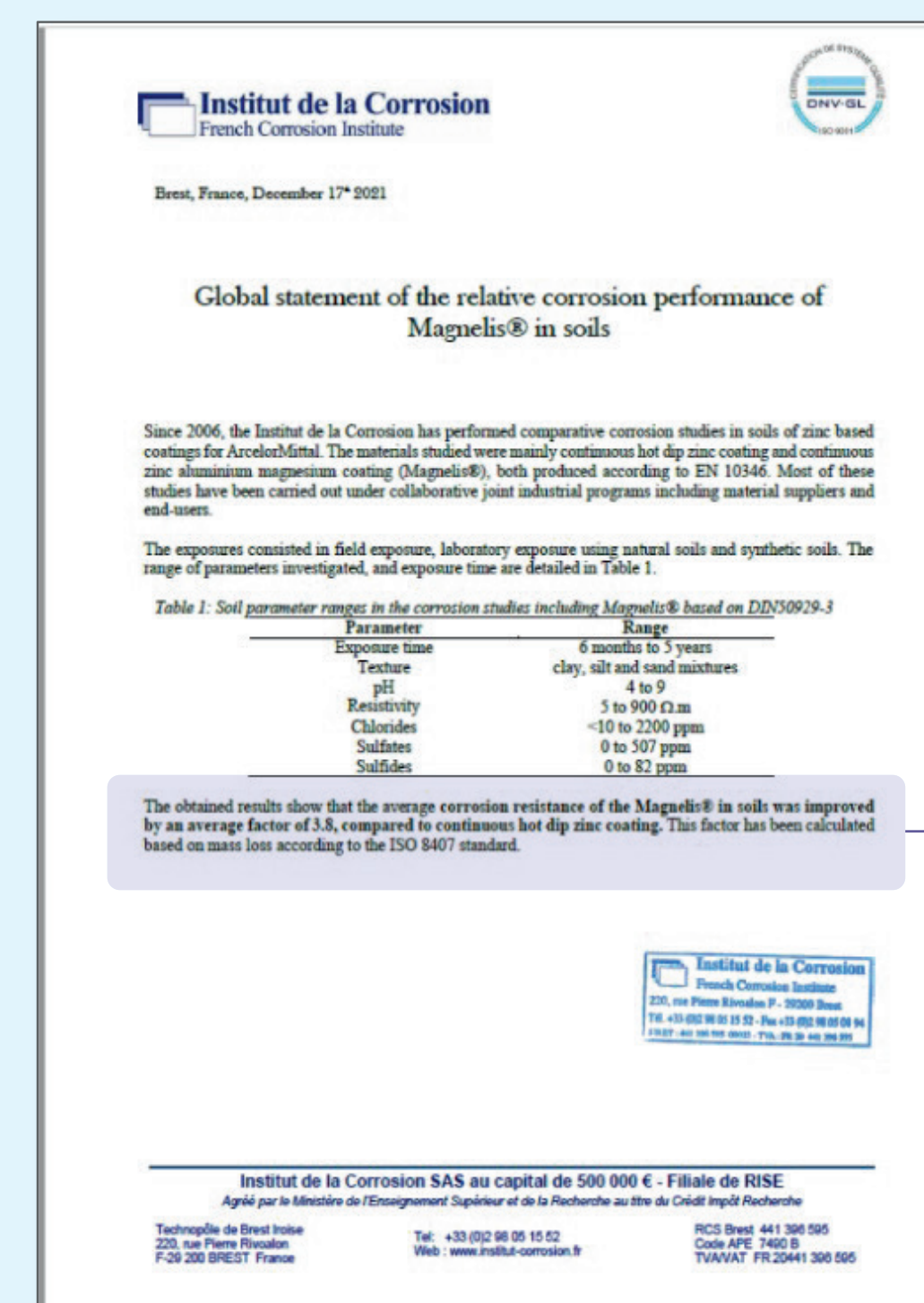
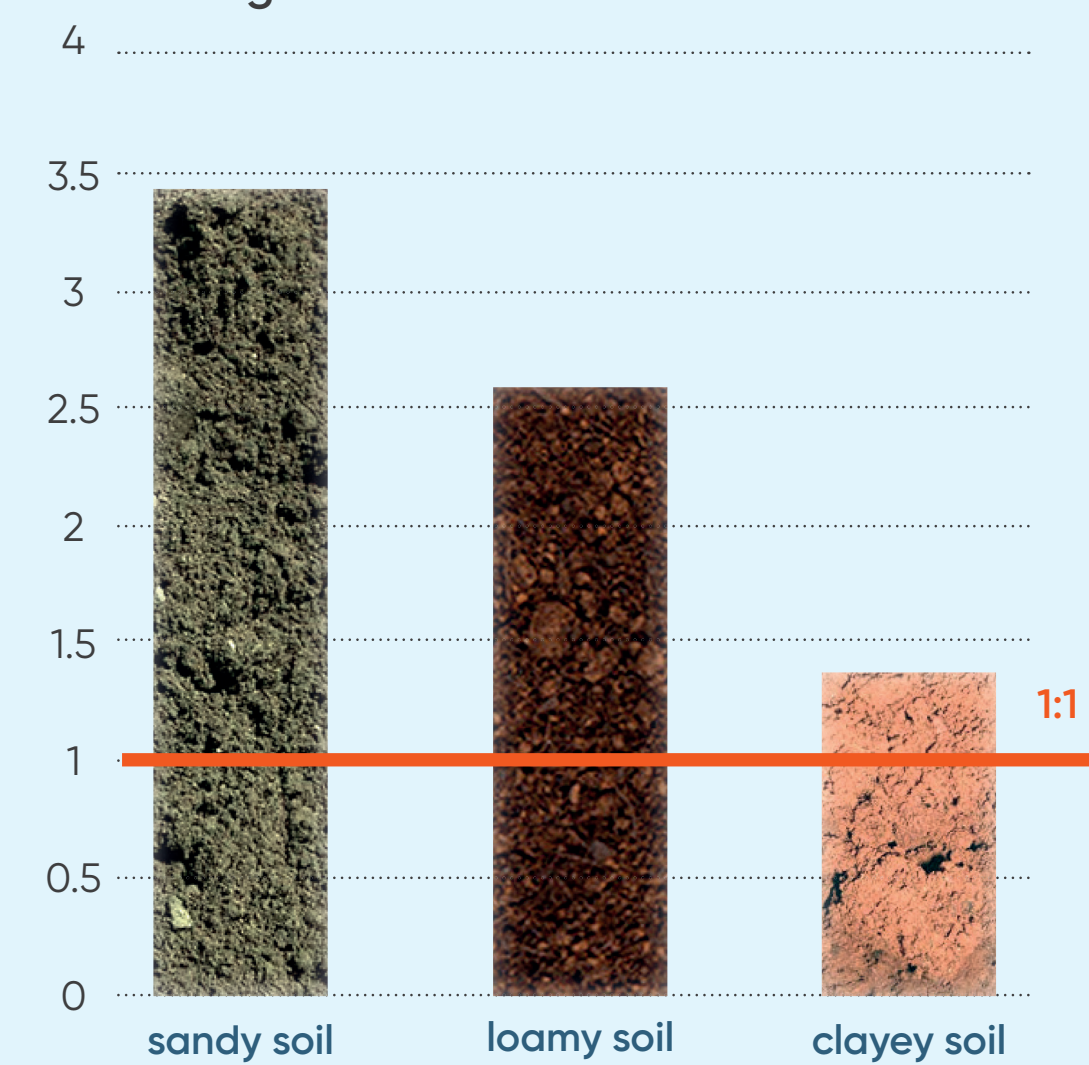
Complex interactions in soils require testing sites to develop deep understanding of soil corrosion



Field outdoor testing at ArcelorMittal Global R&D center (OCAS Belgium)



Corrosion rate improvement with Magnelis® versus batch galvanized steel in OCAS field corrosion site



"Corrosion resistance of Magnelis® in soils was improved by an average factor of 3.8 compared to continuous hot dip zinc coating".

- Average mass loss comparison over time (25 months) at ArcelorMittal's OCAS (Belgium) Research Center.
- Overall, Magnelis® has lower corrosion rate compared to batch galvanized in all soils and by a ratio of close to 3.5 in the most corrosive soil.
- Based on these ratios, the performance of 100 µm batch galvanize would be equivalent to a 30 to 70 µm of Magnelis® (depending on the soil type) or inversely with the availability of Magnelis® ZMM620 (50 µm) and ZMM800 (65 µm) would be equivalent to 70 to 170 µm and 90 – 220 µm of batch galvanized, respectively.

In contact with soils, Magnelis® produces a protective film (like the film formed during atmospheric corrosion) which covers the steel surface. This dense film reduces the contact between the steel and soil, dramatically slowing the progression of Magnelis® corrosion vs. galvanized steels in soils.

## Outcomes

Compared to batch and continuous galvanized coated steels, Magnelis® (Zinc Aluminum Magnesium) metallic coated steels have shown **superior atmospheric and soil corrosion protection with corrosion rates 2.2 to 4.4 times less for atmospheric corrosion and 1.4 to 3.8+ times less for soil corrosion.** Lower corrosion rates can result in longer service life and lower maintenance costs, making Magnelis® coated steels a great choice for the fabrication of solar mounting structures, electrical cabinets/cable trays, and transmission towers used for fixed ground, tracker, rooftop, and floating solar panel installations.



For additional information, please visit ArcelorMittal's booth #7033 in the second floor ballroom.