The Need for Collaborative Approaches:

Securing a Resilient and Sustainable Supply Chain for Transformers

May 2025 | Marcel Hilgers, VP Customers, Markets & Technology
thyssenkrupp Steel | Electrical Steel

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engineering.tomorrow.together.

thyssenkrupp

thyssenkrupp Steel

Key figures for fiscal year 2023/2024

Employees
27,478

Sales[1]
10.7 bn €

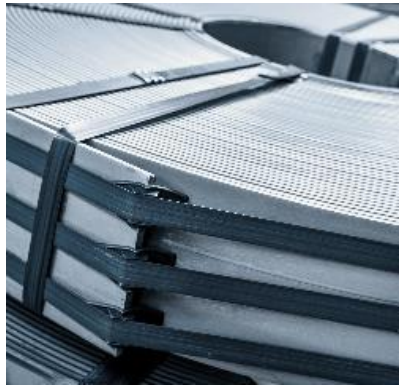
Crude steel production[2]
10.3 m t

#1 Steel producer
in Germany

Automotive

Industry

Precision Steel



Electrical Steel

Packaging Steel

1. Including metallurgical by-products I 2. Including supplies from Hüttenwerke Krupp Mannesmann (HKM) I Source: Annual Report thyssenkrupp AG 2023/2024

Overview

1. GOES – market, demand and supply
2. Green transformation at thyssenkrupp Steel Europe – Short introduction
3. Green steel label & green lead market concept
4. Let us take action now

thyssenkrupp Electrical Steel at a glance

thyssenkrupp AG

thyssenkrupp Steel Europe

thyssenkrupp Electrical Steel

Sold in January 2025

Plant Gelsenkirchen

Employees: 694
Area: 17 ha
Production volume: 75 kt/a

Plant Isbergues

Employees: 520
Area: 11 ha
Production volume: 75 kt/a

Plant Nashik

Employees: 498
Area: 62 ha
Production volume: 45 kt/a

Top grades GOES – further development of low loss grades

Low noise performant GOES

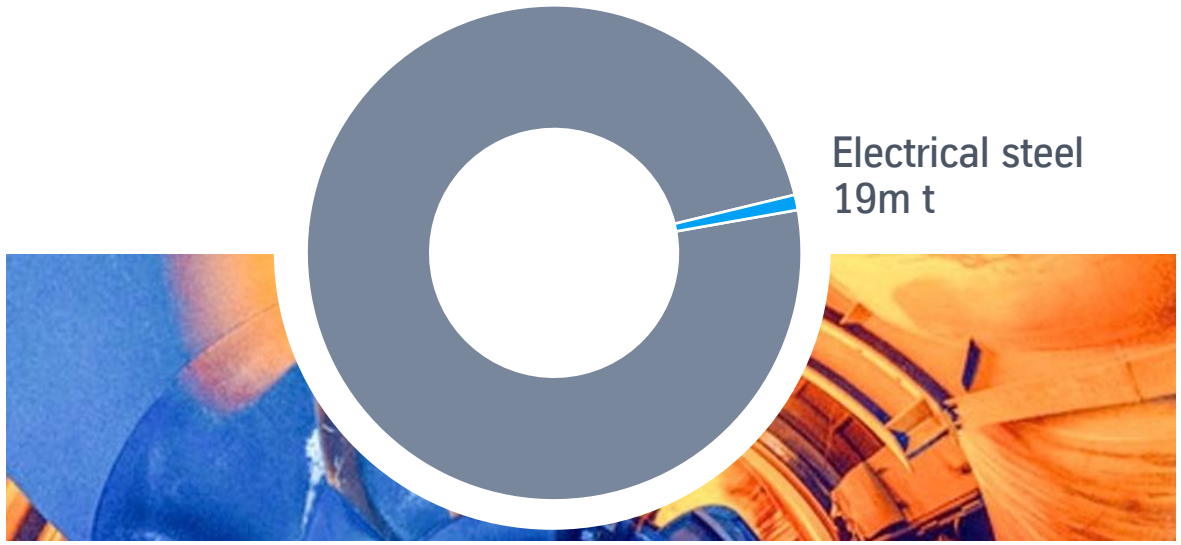
Decarbonization strategy implementation

E-mobility with new drive concepts

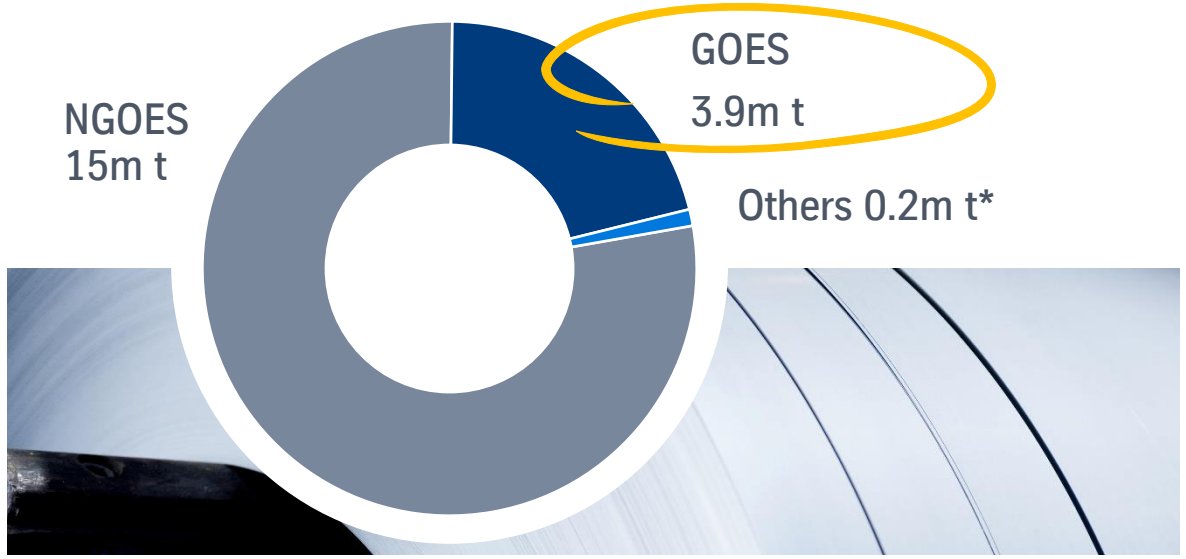
Electrical Steel - a strategic and fast growing niche product

Indispensable material for the electricity value chain - from generation over transmission/distribution to use

Global Steel production 2023 – 1.9b t



Global Electrical Steel production 2023 – 19m t



Non grain oriented electrical steel

Motors, drives

Hydro, wind, power generators

Fans, ballasts

Pump motors

Alternators

Grain oriented electrical steel

Power transformers

Distribution transformers

Wound core transformers

Power generators

Rectifiers

*Powder Ferrites, Cobalt based alloys, Nanocristallyne etc .

Electrical Steel for the energy transition

ENERGY GENERATION

Non grain-oriented (NGO)

Non grain-oriented electrical steel for

GENERATORS

ENERGY DISTRIBUTION

Grain-oriented (GOES)

Grain-oriented electrical steel for

TRANSFORMERS

ENERGY UTILIZATION

Non grain-oriented (NGO)

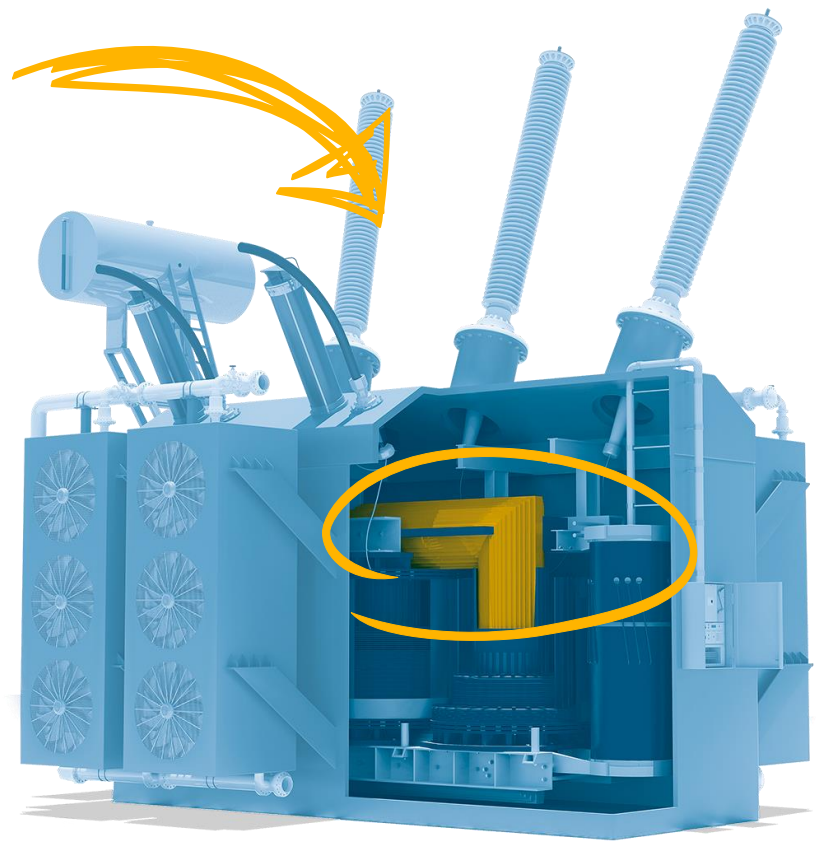
Non grain-oriented electrical steel for

ELECTRIC MOTORS

GOES is required to build transformers and realize the EU Green Deal

We produce transformer cores…

Material for transformer cores



…required to expand the electricity grids and push renewables

"There will be an extreme boom for transformers min. until 2026"

Purchasing Exec. e·on

Jan 2021

"[…] benefiting from the increasing demand for electricity worldwide. […] require expansion and modernisation of power grids. Business prospects are excellent"

C. Bruch, CEO of SIEMENS energy

Feb 2023

"The rising share of renewables and increasing electrification require more robust grids."

C. Bruch, CEO of SIEMENS energy

Feb 2023

"In order for the additional green electricity to reach the customer, the expansion of the grids must be given the same priority as the expansion of renewables"

L. Birnbaum, CEO of e·on

Handelsblatt

Jan 2022

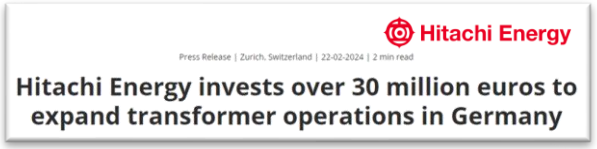
"Grid Technology to grow by 10.5% CAGR 2022-2027"

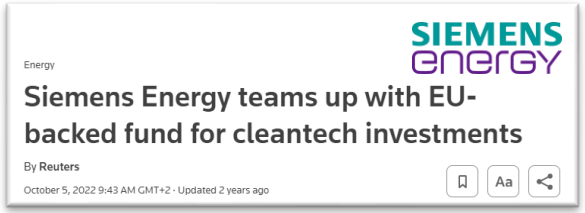
Supplier Collaboration Day SIEMENS energy

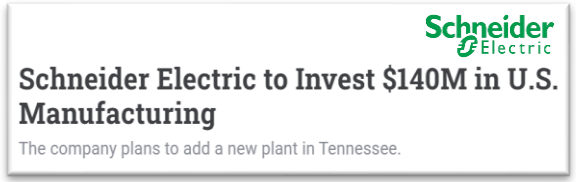
Jun 2023

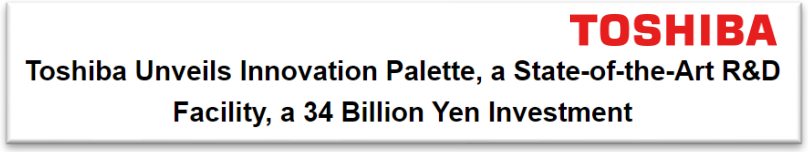
The transformer industry value chain invests heavily – some examples

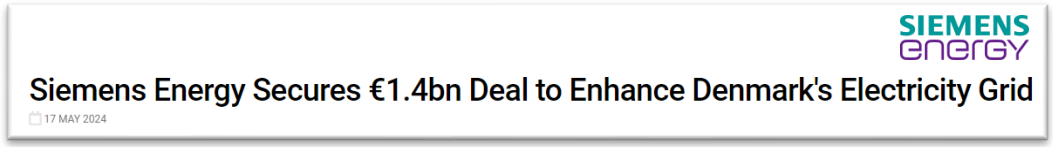
OEMs



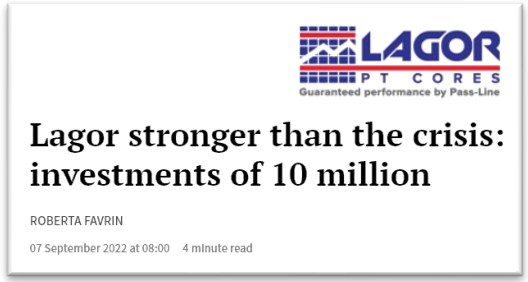


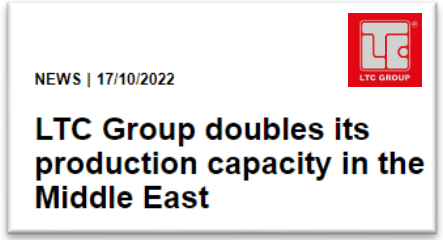






Core cutters / service centers

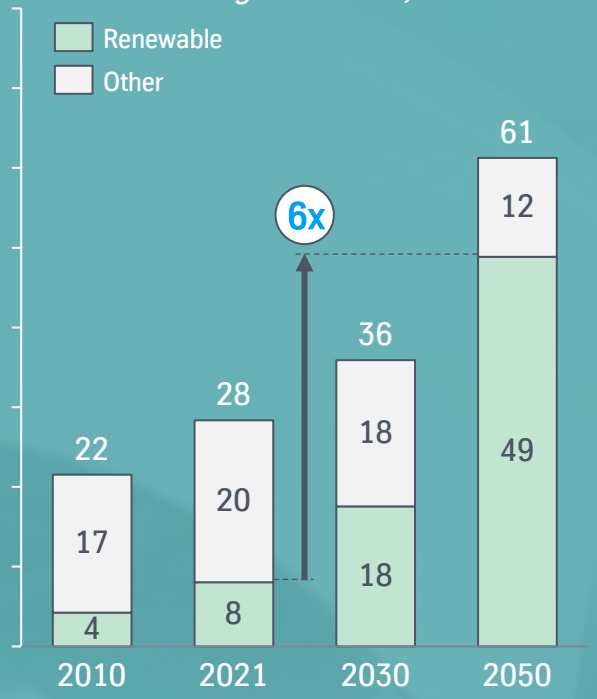




Integration of renewables and a decentralized grid needs more transformers…

Renewable electricity to 6x[1]

Announced Pledges Scenario, in kTWh

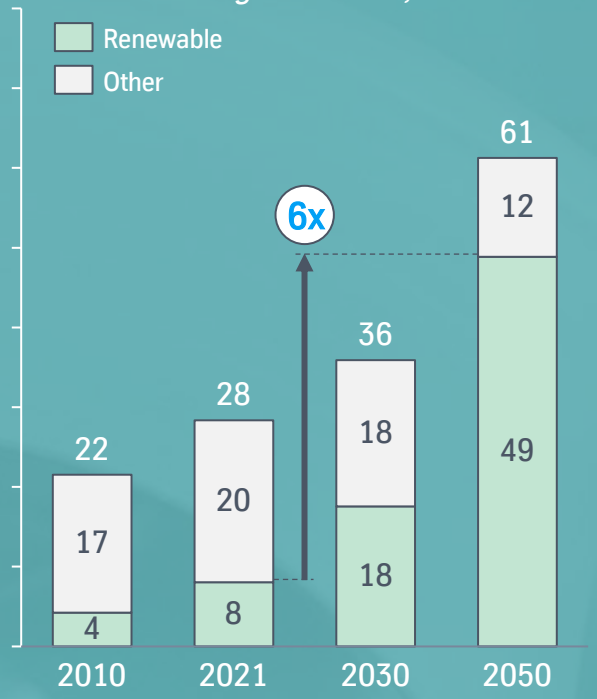


APS scenario („Announced Pledges Scenario") – 1) p. 281 | 2) | 3) p. 317, p. 463, 474-484 | 4) tkES Strategy, IEA WEO 2022 p. 313, 317 | 5) „AE" = Advanced Economies, EMDE = Emerging Market and Developing Economy
Source: IEA WEO 2022

… and additional grid connections, new HVDC and interconnector lines…

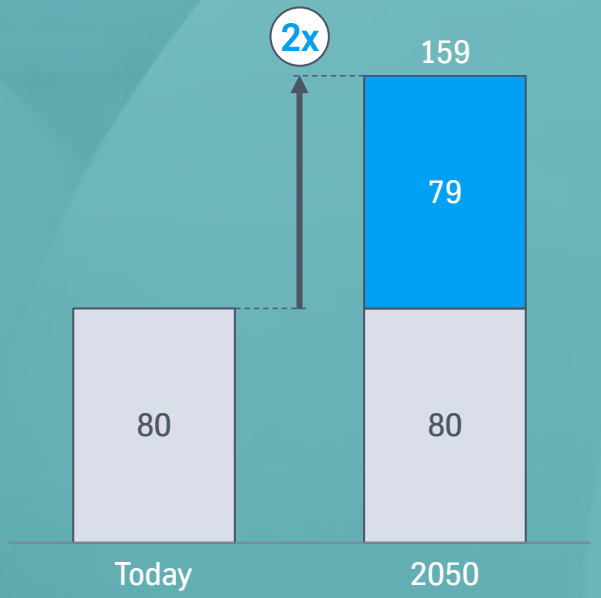
Renewable electricity to 6x[1]

Announced Pledges Scenario, in kTWh



Electricity grid km to double[2]

in million km



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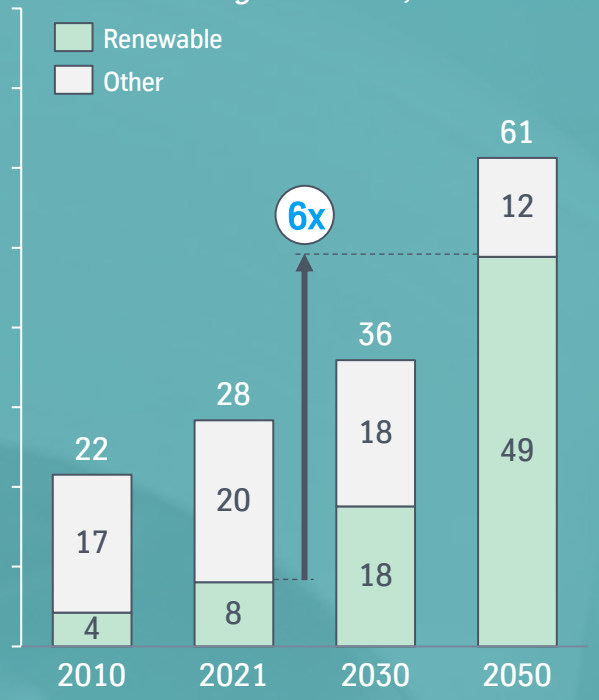
…which will triple the annual invest in electricity grids…

Renewable electricity to 6x[1]

Announced Pledges Scenario, in kTWh



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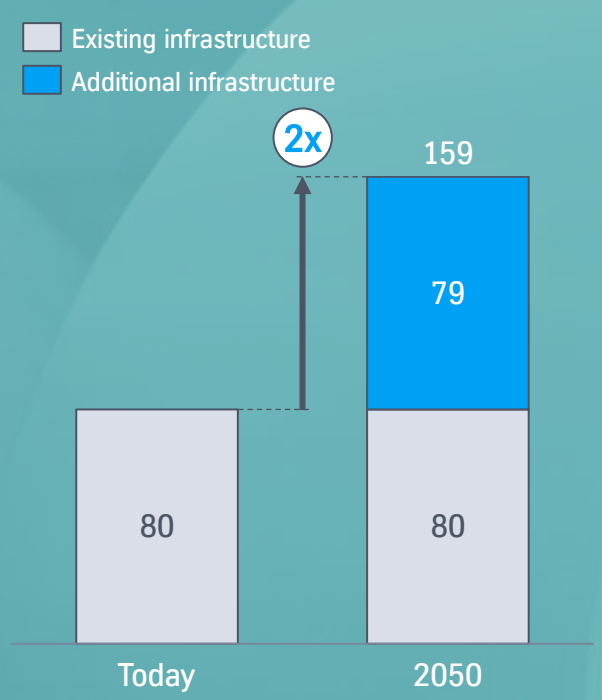
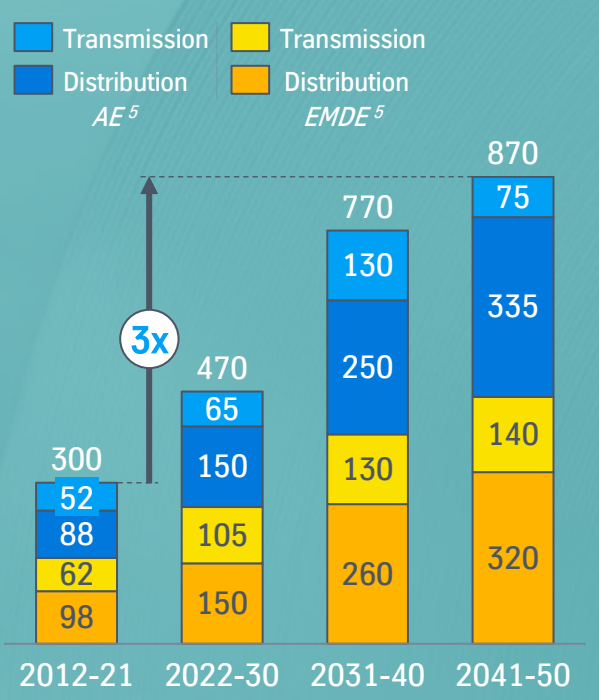


Annual grid investments to 3x[3]

in billion USD



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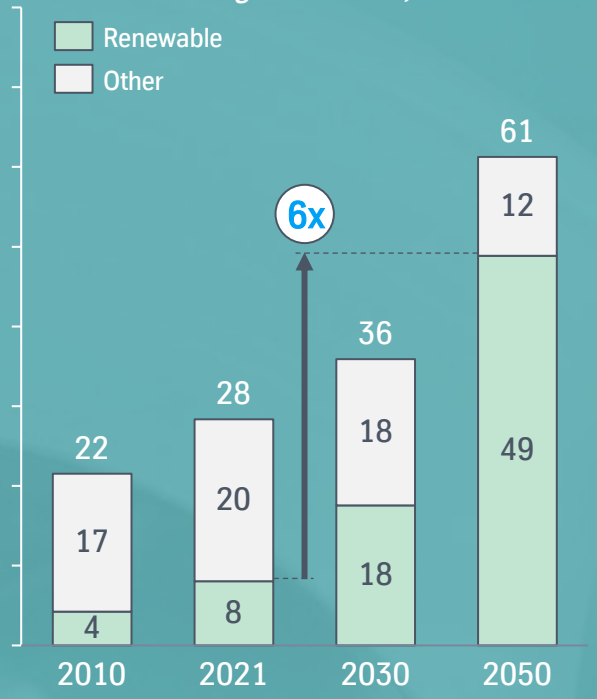
Source: IEA WEO 2022

…and leads to a massive increase in transformer- thus GOES demand

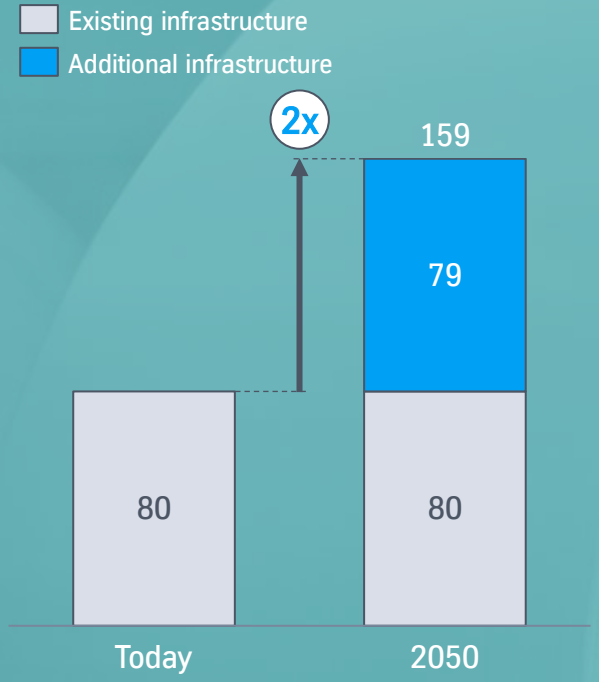
Renewable electricity to 6x[1]

Announced Pledges Scenario, in kTWh



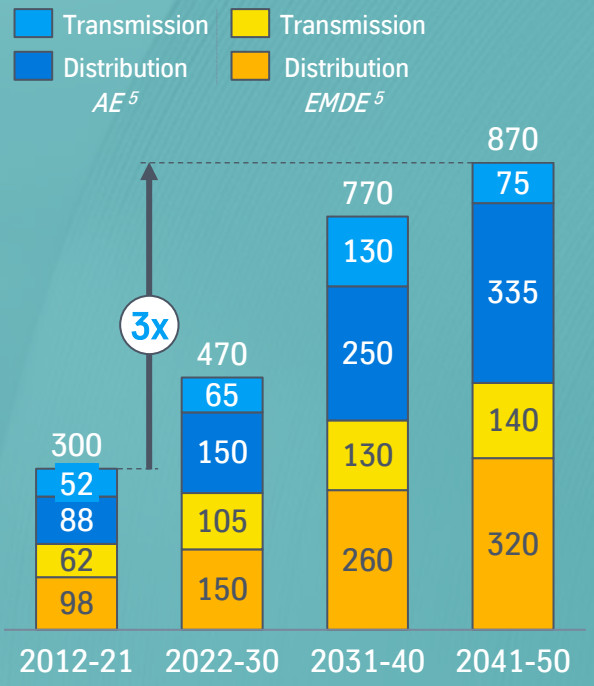
Electricity grid km to double[2]

in million km



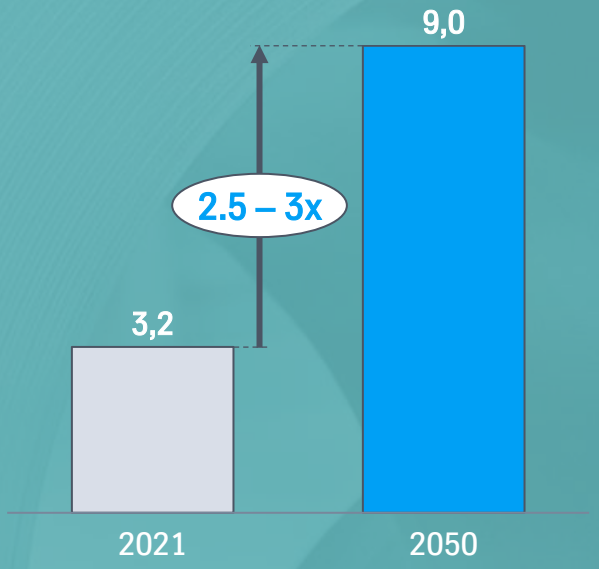
Annual grid investments to 3x[3]

in billion USD



Global GOES demand to ~2.5-3x[4]

in million tons



✓Global megatrends fuel growth: shift to (decentral) renewable energy generation requires massive electricity grid investments
✓Global GOES demand is expected to grow 2.5x – 3x until 2050
✓EU GOES demand is projected to increase significantly

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Source: IEA WEO 2022

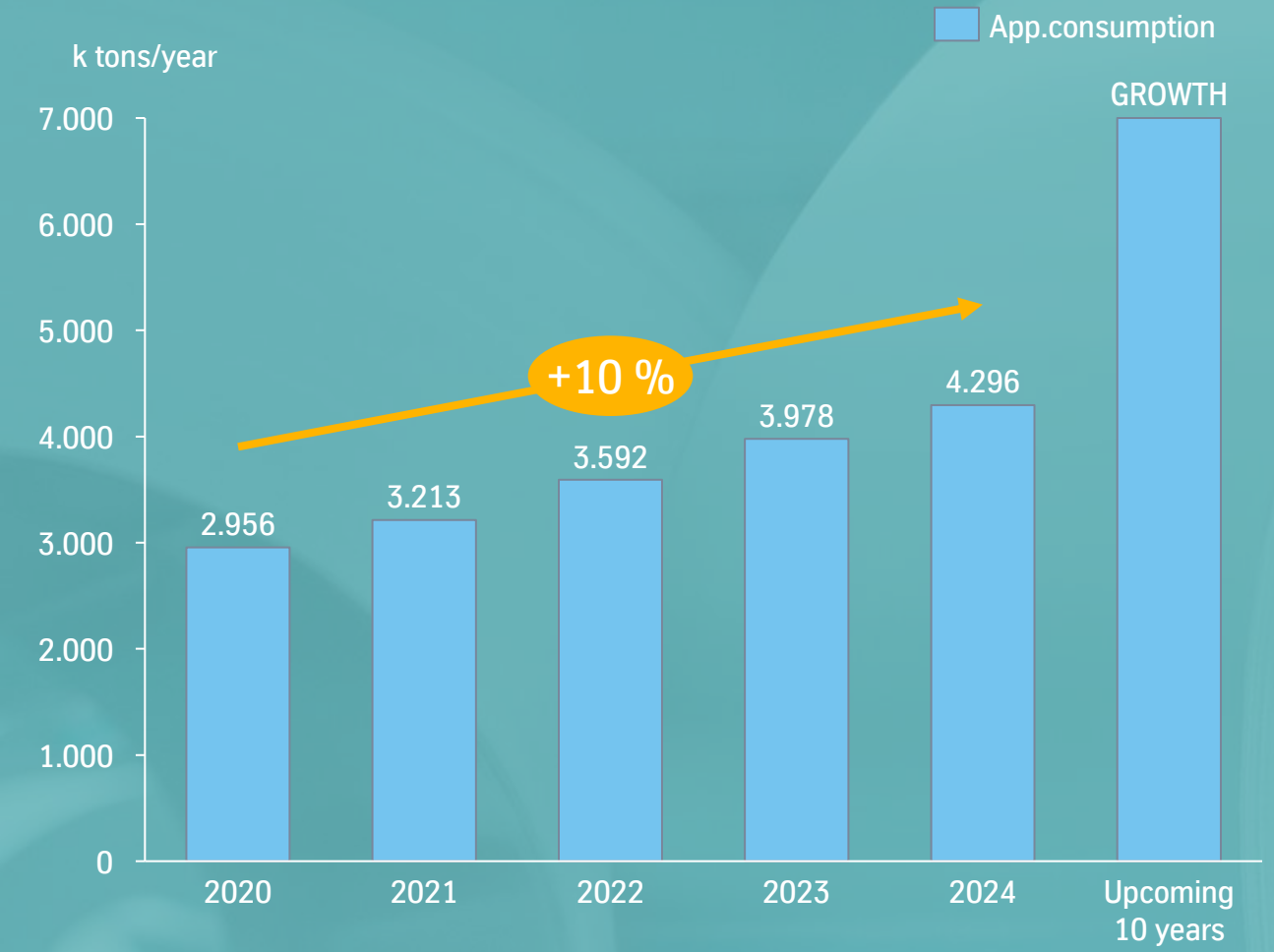
CAGR X% of growth since CY20, especially strong in NAFTA, EU, and Latin America

GOES apparent annual consumption[1]

1. Annual comsumption : Operative production capacity + imports – exports
Source: Wv Stahl- tk Steel Duisburg, tkES_EU(A010)

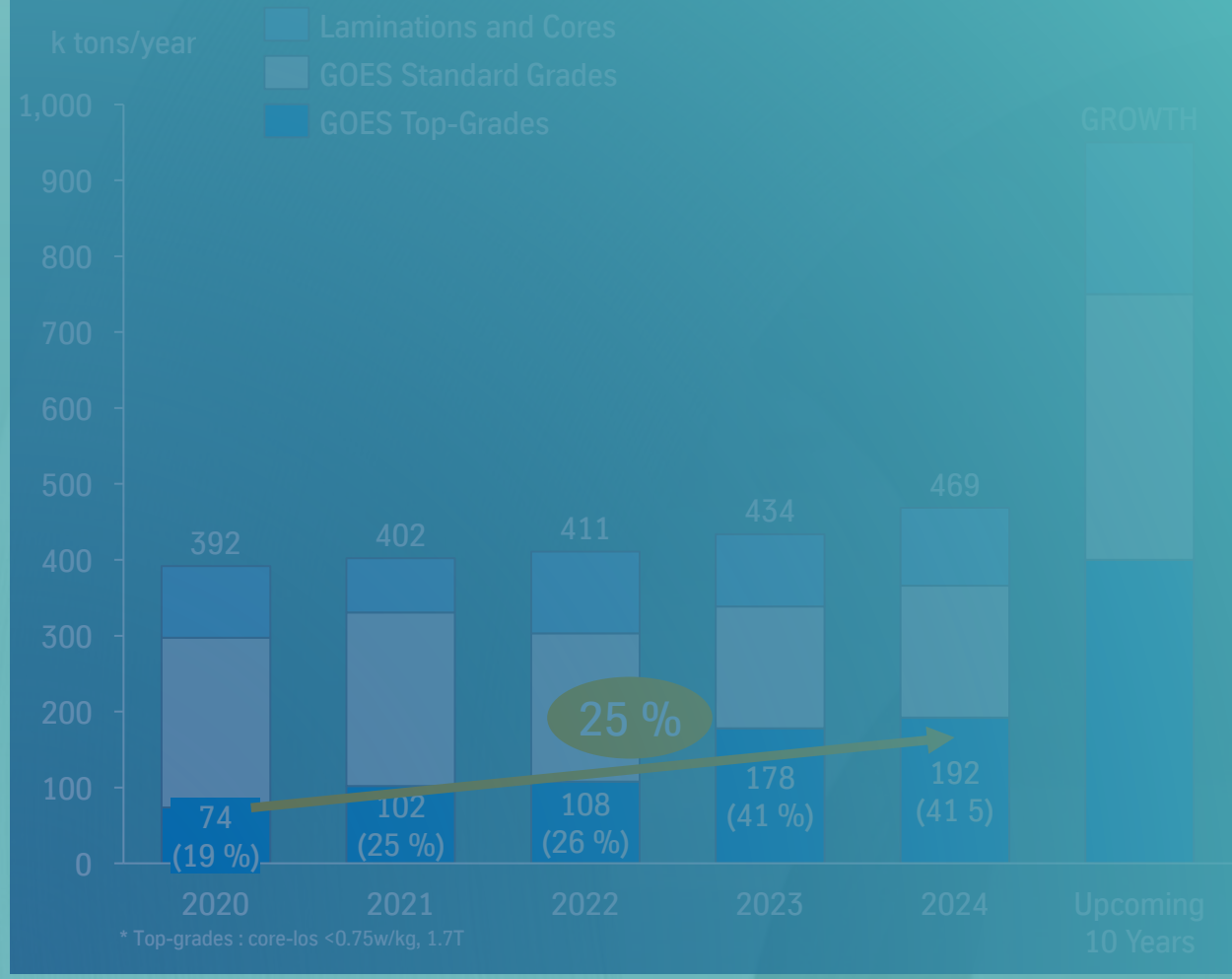
Demand for transformers and thus GOES is growing fast…

Global - GOES apparent consumption



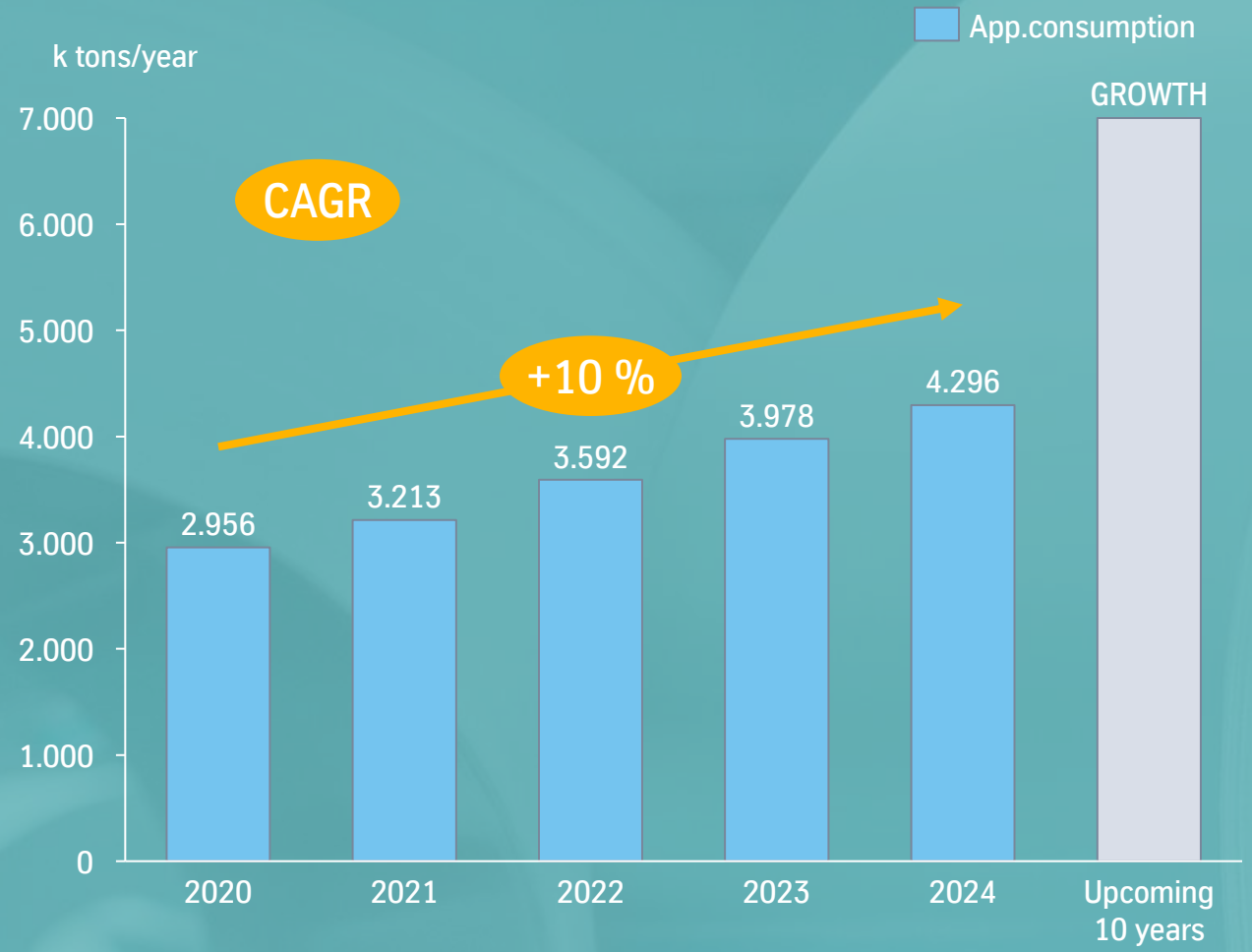
Source: Wv Stahl, tkES

EU – GOES apparent consumption

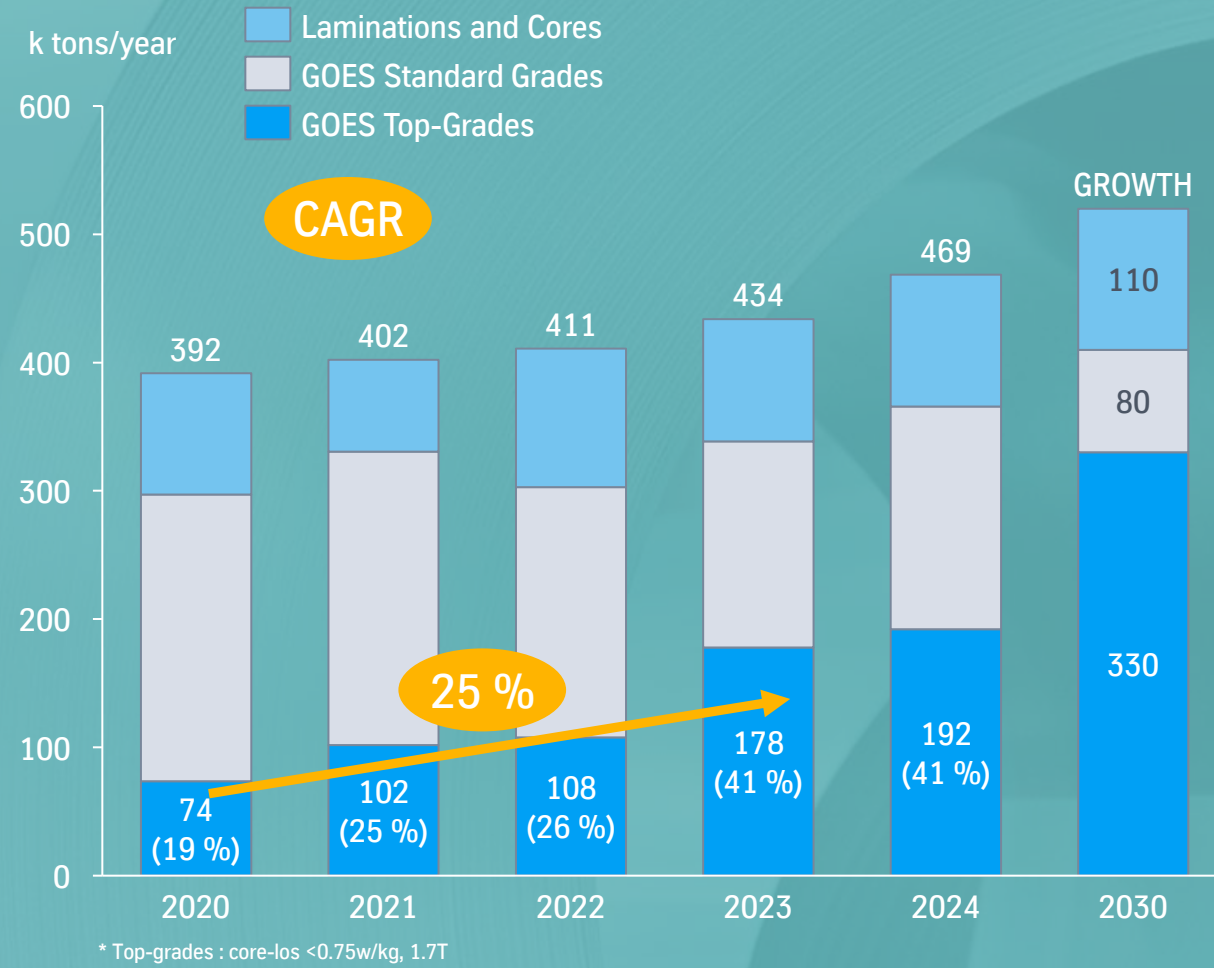


…especially Top Grades with CAGR 25 %+

Global - GOES apparent consumption



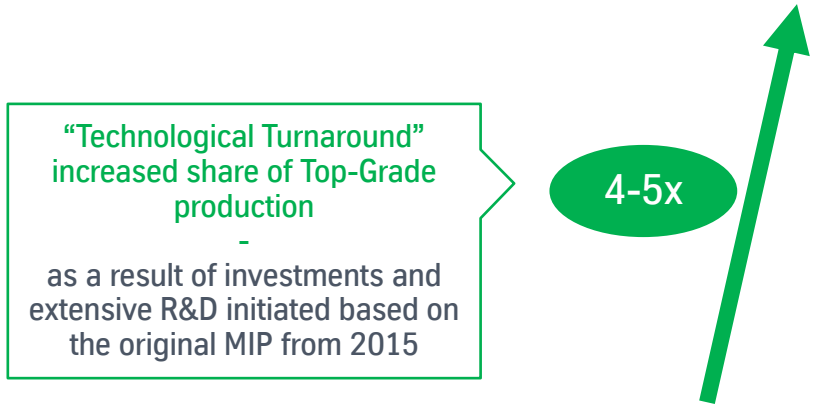
EU – GOES apparent consumption



* Top-grades : core-los <0.75w/kg, 1.7T

Source: Wv Stahl, tkES

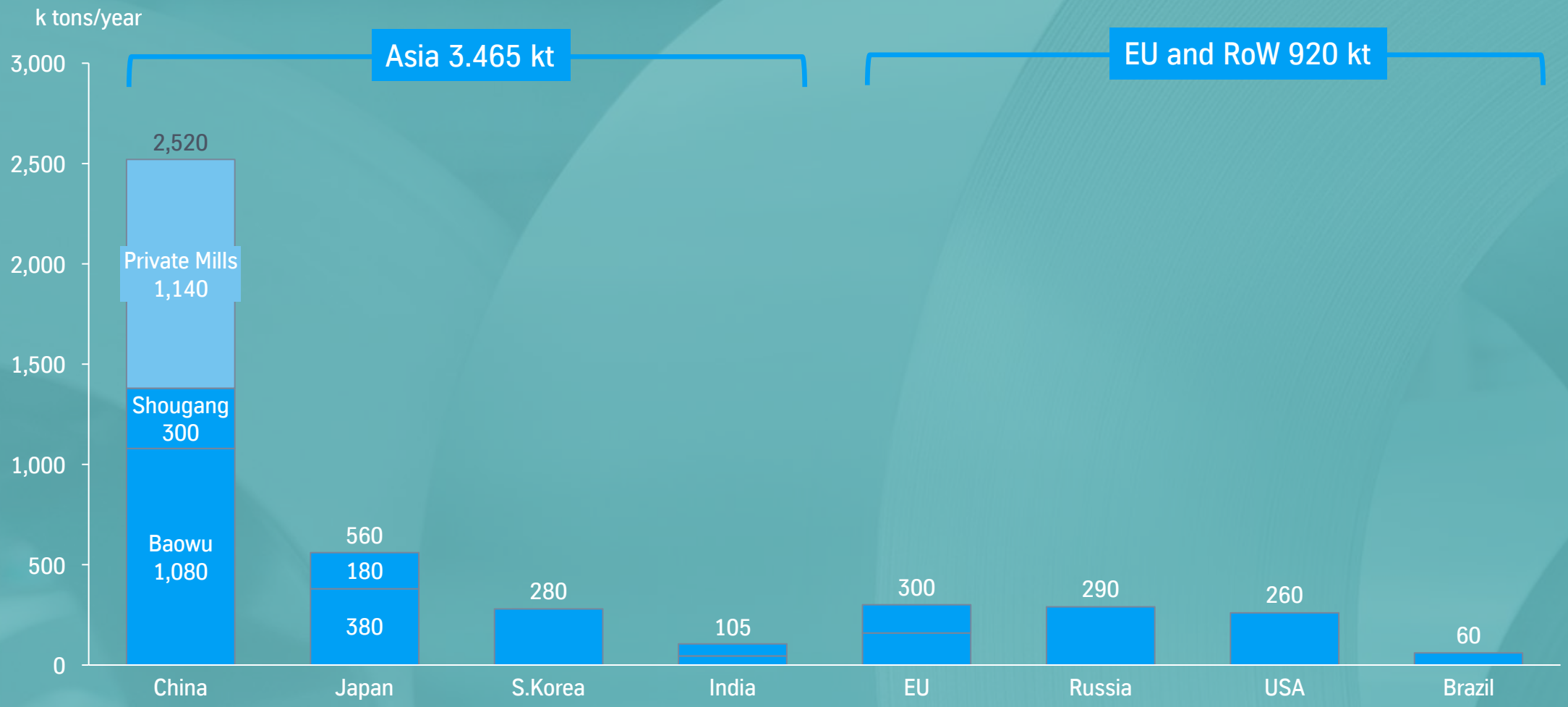
Due to investments and innovation, we have increased the share of Top-Grade Production by 4-5x and achieved the technical turnaround



Details available – please contact the author

China dominating GOES capacity – a resilient and sustainable supply base?

GOES production capacity per country in 2023

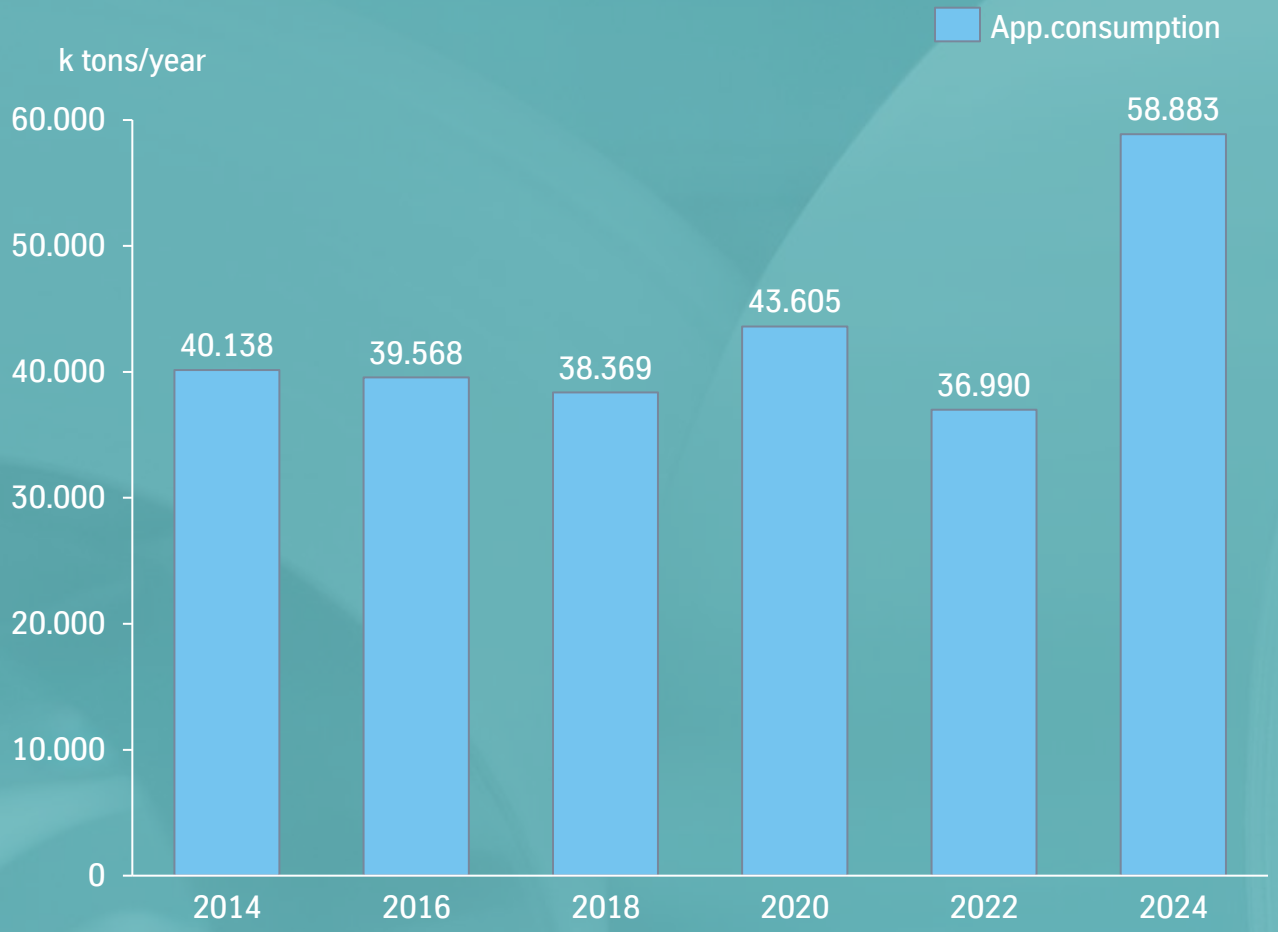


Source: Wv Stahl, tkES

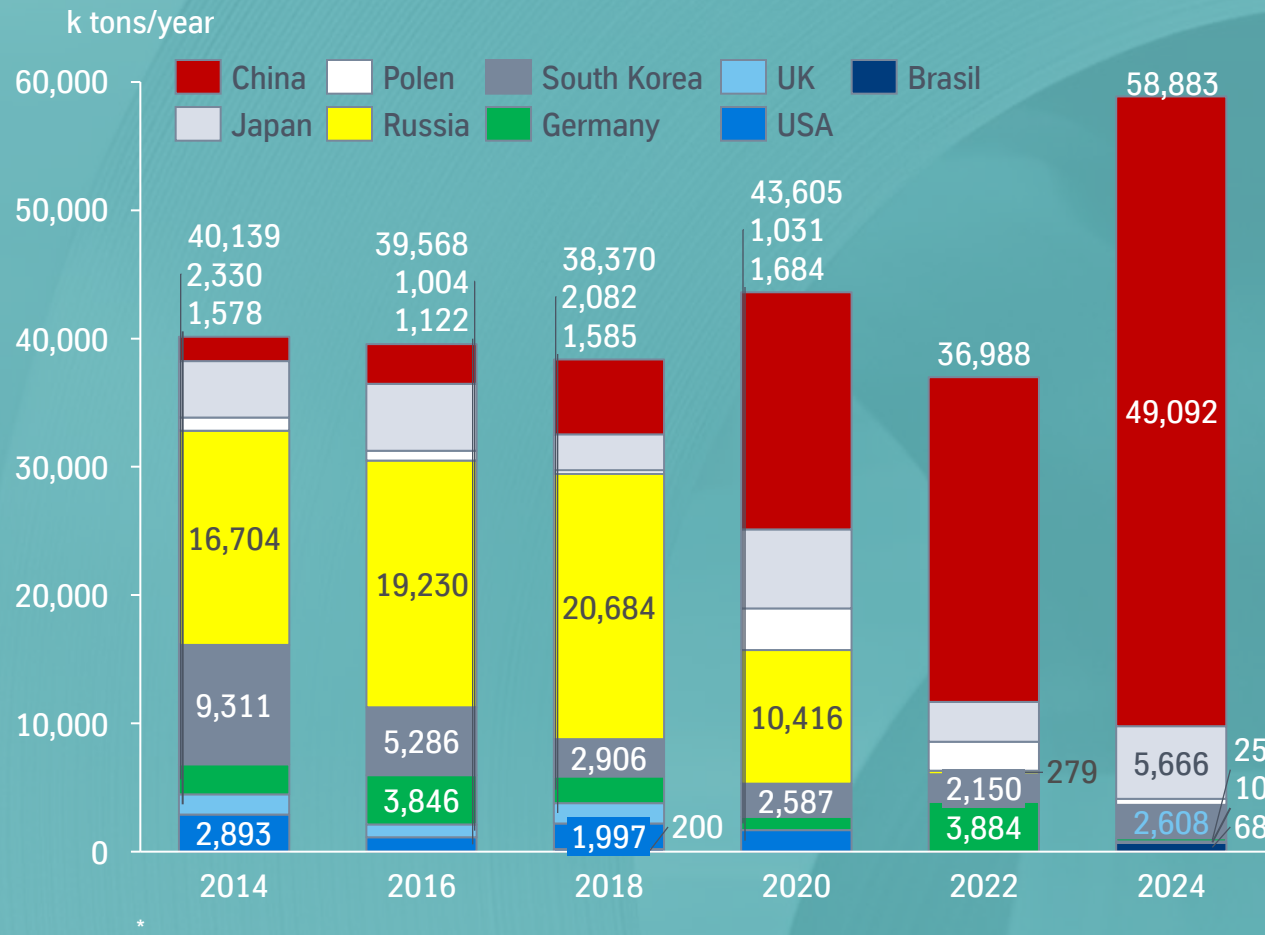
Growing threat of dependency in many countries

Example: U.A.E

U.A.E- GOES imports



Origin

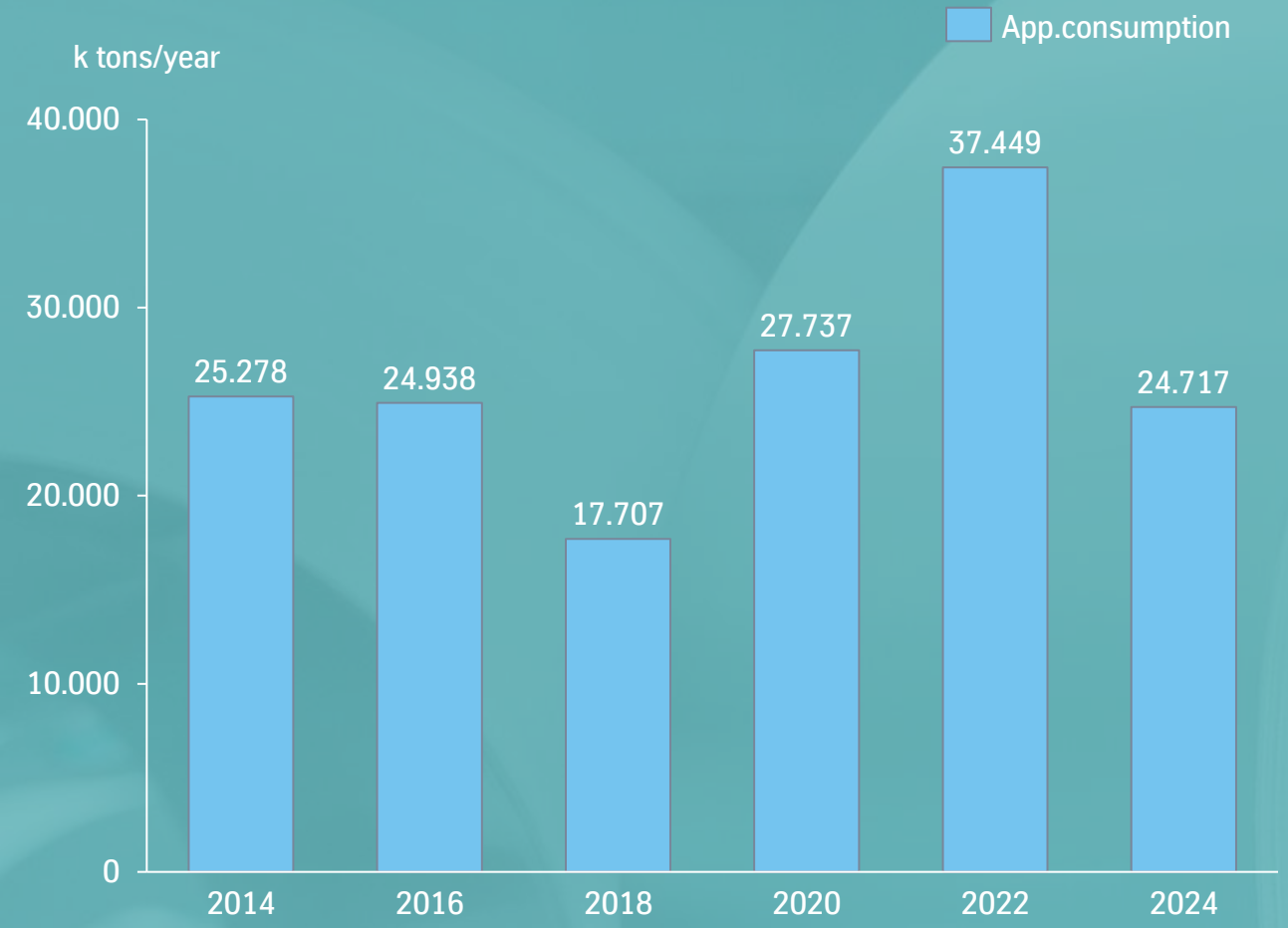


Source: Wv Stahl, tkES

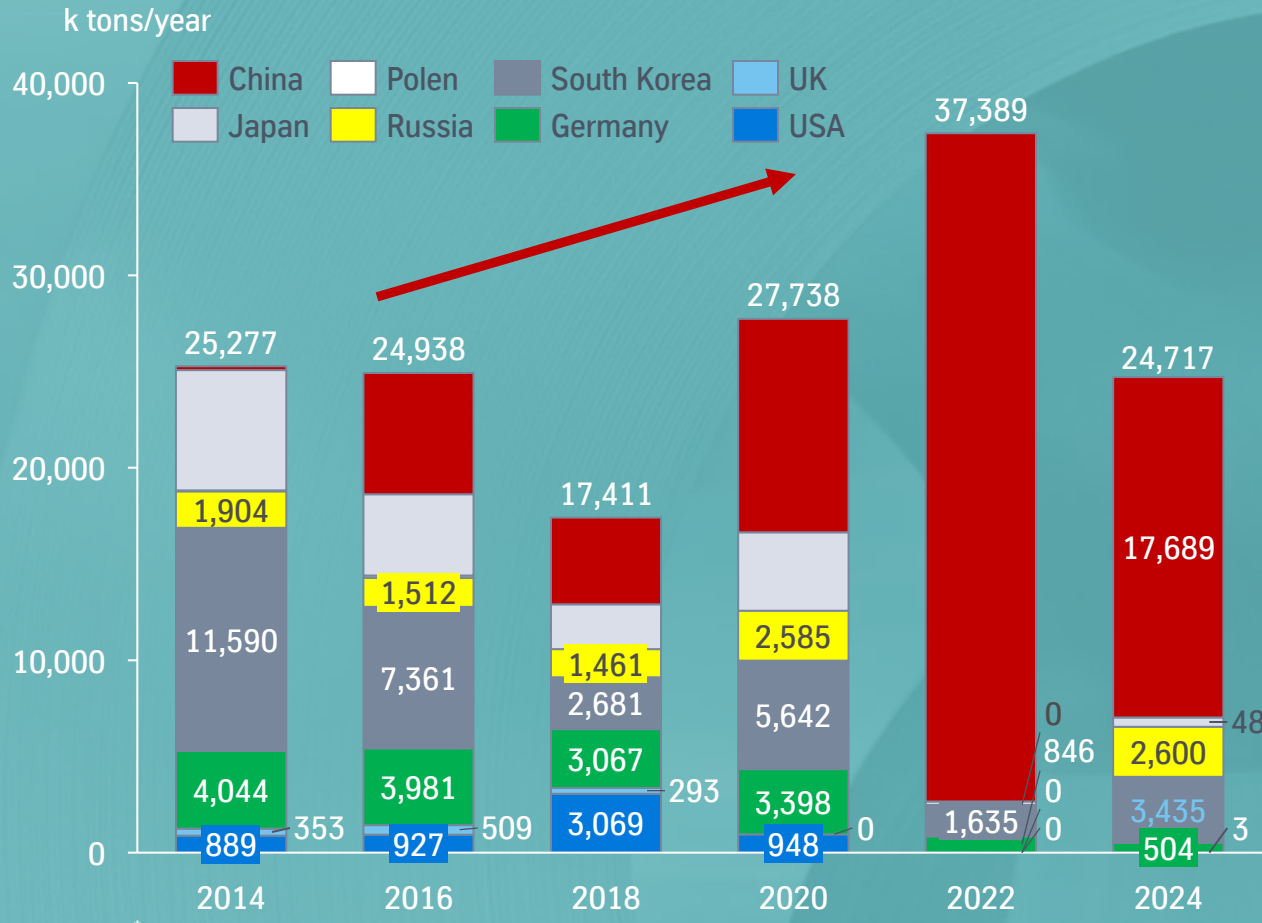
Growing threat of dependency in many countries

Example: Saudi Arabia

Saudi Arabia - GOES apparent consumption



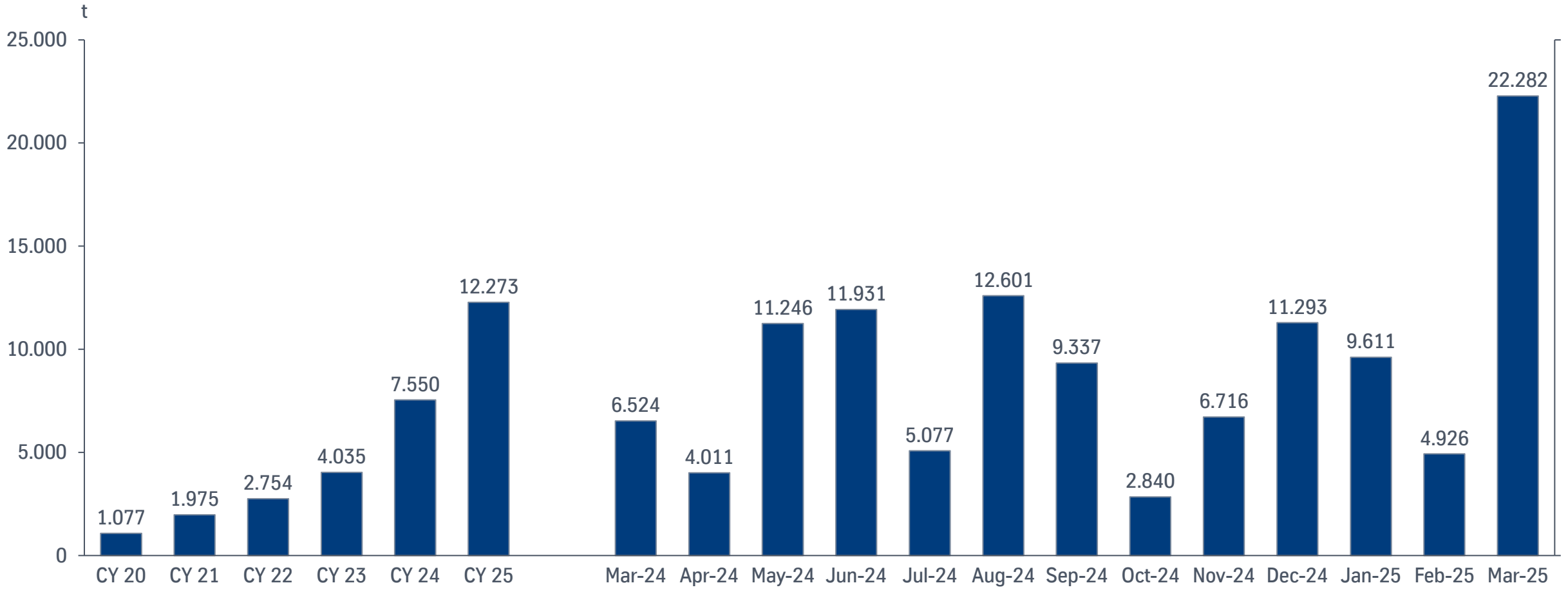
Origin



Source: Wv Stahl, tkES

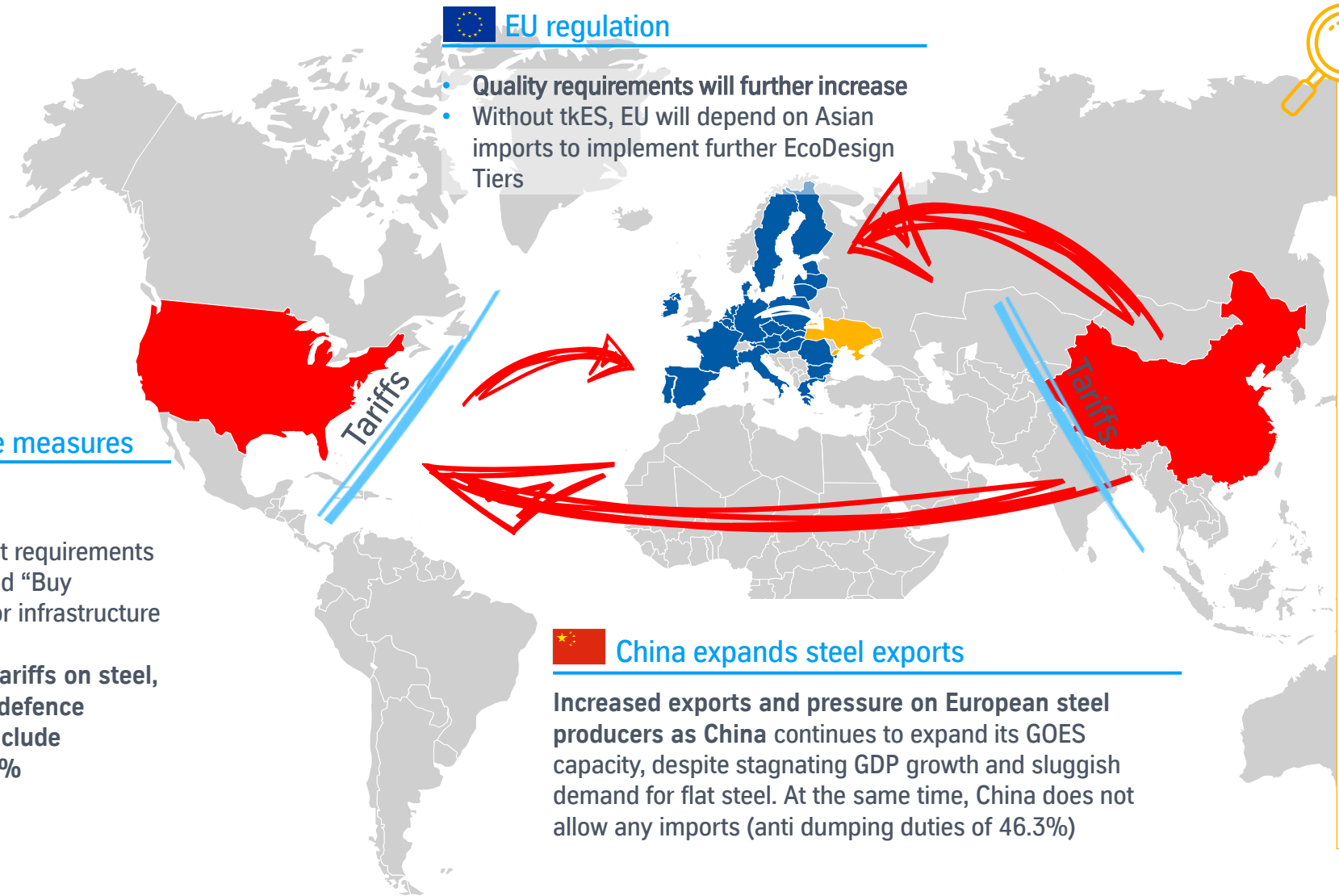
China is flooding the EU market – Are we ending up like the PV panel industry?

GOES import – All grades, China



Source: Eurofer, Euro stat, Wv Stahl- tk Steel Duisburg

A resilient local value chain is required for the energy transition and grid expansion planned – let us not end up like the solar industry



EU regulation

- **Quality requirements will further increase**
- Without tkES, EU will depend on Asian imports to implement further EcoDesign Tiers

US trade measures

- Local content requirements in the IRA and “Buy American” for infrastructure projects
- **Up to 50% tariffs on steel, some trade defence measures include tariffs >100%**

China expands steel exports

Increased exports and pressure on European steel producers as China continues to expand its GOES capacity, despite stagnating GDP growth and sluggish demand for flat steel. At the same time, China does not allow any imports (anti dumping duties of 46.3%)

Letter from Chairman of the Board of LLC “Ukrelektroaparat” to tkES

„[W]e have **produced over 600 transformers for Ukraine using electrical steel manufactured by tkES.** This has enabled hospitals, schools and social institutions to function. (…) [T]he country’s economy is being revitalized. Hundreds of thousands of people have regained access to electricity in their homes. (…) Despite the incredibly challenging working conditions, our collaboration with EU companies has enabled us to continue operations. **One of our key partners is undeniably tkES. (…) [O]ur electrical steel orders are (…) critically important for the production of our goods“**

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thyssenkrupp Steel Europe takes responsibility and has set itself clear targets

Our goal by the year 2030[1] (outside SBTi validation)

>30 %

Our goal by the year 2032[2] (SBTi-compliant)

-38 %

Our goal 2045 at the latest[3] (SBTi-compliant)

Net-Zero

GHG emissions in the entire value chain

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

THE NET ZERO STANDARD
APPROVED NET-ZERO TARGETS

Responsible Steel standards & certification

CDP
DISCLOSURE INSIGHT ACTION

Stiftung KlimaWirtschaft

1. -30 % CO_2 emissions in 2030 relates to absolute scope 1 and scope 2 emissions (reference year 2018) - target set outside SBTi validation
2. includes a reduction of GHG emissions in scope 1, 2 and 3 that fall under the iron and steel industry core boundary by 38% per tonne of hot-rolled steel by 2032 compared to the base year 2018 and a reduction of all other GHG emissions in scope 1 and 2 by 58.8% and all other GHG emissions in scope 3 by 35% within the same period.
3 - 93 % absolute reduction in Scope 1, 2 and 3.

Planned transformation path to climate-neutral steel

tkH2Steel

Gefördert durch:
Bundesministerium für Wirtschaft und Klimaschutz
aufgrund eines Beschlusses des Deutschen Bundestages

Gefördert durch:
Ministerium für Wirtschaft, Industrie, Klimaschutz und Energie des Landes Nordrhein-Westfalen

since 2021

Increasing quantity bluemint® Steel along the transformation

from 2027

Commissioning and ramp-up of the first 100% hydrogen-ready DR plant with melting units (SAF)
This means replacement of two coal-based blast furnaces

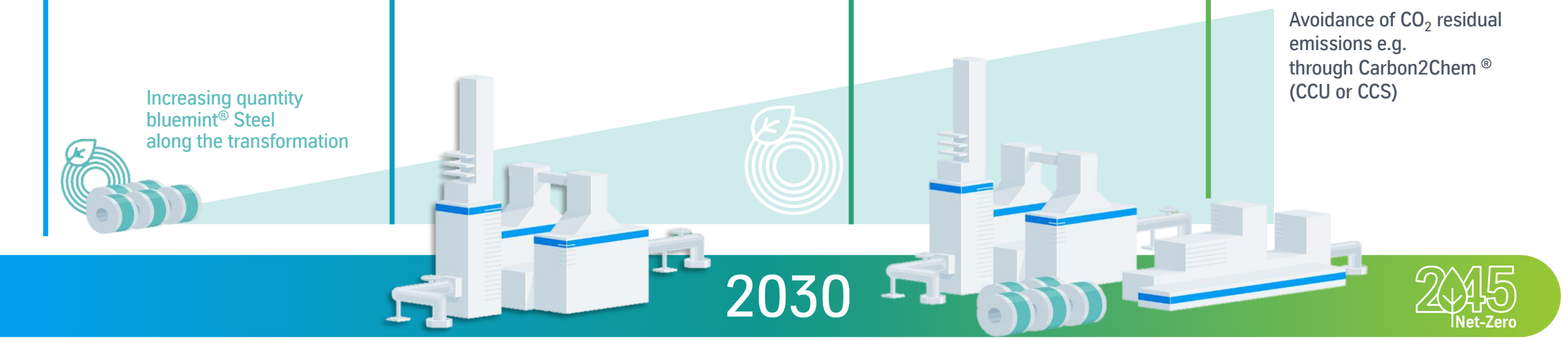
from 2030

Replacement of another coal-based blast furnace with alternative technology[1]

before 2045

Full implementation of transformation, net-zero steel production incl. decarbonization of the downstream

Avoidance of CO_2 residual emissions e.g. through Carbon2Chem ® (CCU or CCS)



-30% CO_2

SBTi validated

1 Decision on the second transformation step strategically and technologically open on the basis of the applicable framework conditions, EAF scenario under evaluation

Construction site of the direct reduction plant

tkH2Steel
Gefördert durch: Bundesministerium für Wirtschaft und Klimaschutz aufgrund eines Beschlusses des Deutschen Bundestages
Gefördert durch: Ministerium für Wirtschaft, Industrie, Klimaschutz und Energie des Landes Nordrhein-Westfalen

Execution of foundation works

Construction of the electrical substations

Comparison of the Impact of Additional Costs for Green Steel on Product Prices

Examples with an assumed additional cost for green steel of 200-400 €/t and the additional costs according to the BCG study:

	Tinplate Can	Climate-Neutral Car (VW ID.3):	Steel Bathtub	Washing Machine	Transformer
					
tkSE-Assumption	+ 0,02€	+ 234€	+ 13€	+ 8€	
	Vegetables Can 2,01€ i/o 1,99€ 1% add. costs[2]	VW ID.3 30.134€ i/o 29.900€ 0,8% add. costs[3]	Kaldewei Premium Series 912€ i/o 899€ 1,4% add. costs[4]	Miele Washing Machine 1211€ i/o 1199€ 1% add. costs[5]	Power Transformer Distribution Transformer
BGC	< + 0,05€	< + 250€	n.a.	<+ 12€	~ 0.8 – 4%

2) For 1 ton of green steel: 9434 tinplate cans of 100 g each, diameter 10 cm, height 12 cm, approximately 6% scrap for a 2-piece can.
3) With an average empty weight of 1600 kg and 800 kg steel content, with 46% scrap, i.e., 1168 kg.
4) For 100% Kaldewei steel-enamel bathtub in the premium segment, weight 50 kg steel and 20% scrap, i.e., approximately 16 bathtubs per ton.
5) Average weight 96 kg, assumption tkSE steel approximately 40 kg including scrap. 25 washing machines with 1 ton of green steel.

The transformation will succeed if policymakers create framework conditions

Fair competitive conditions

Effective protection against dumping imports and overcapacity.

Reform CO_2 border adjustment

Expansion of the area of application and solution for steel exports.

Establish green lead markets

Incentivising demand for CO2-reduced products through public procurement, support mechanisms and B2B initiatives.

Lower energy prices

Introduction of a bridge electricity price, reduction of grid fees and expansion of renewable energies.

Promoting the hydrogen economy

Extension of European infrastructure and flexible use of hydrogen

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Environmental Product Declarations (EPDs) currently not suitable as a tender criterion for the green transformation

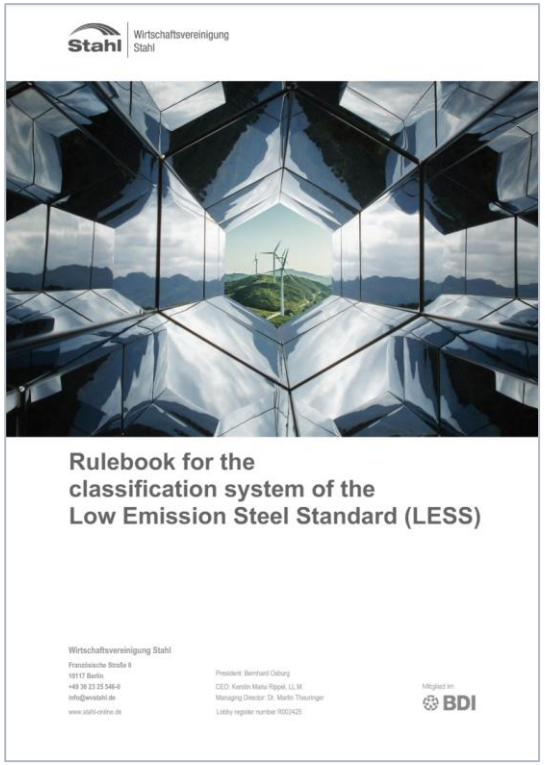
- EPDs are the most important standard for assessing the environmental impact of construction projects in Europe today

Ongoing discussion

- Eco Platform rejects any form of balancing of materials in EPDs - including mass balancing.

- Risk of transformation projects being stalled
- Without mass balancing, there is no supply of CO_2-reduced primary steel and therefore no potential for CO_2 savings in the procurement of high-quality flat steel products

Labelling system LESS - the foundation for CO2-reduced lead markets



LESS
LOW EMISSION STEEL STANDARD

Classification
Certified according to: LESS-Rulebook
Certificate no.:

Near Zero | Low emission: A | B | C | D

Scrap share XXX %

Product Carbon Footprint
Certified according to:
Certificate no.:
XXX kg CO_2e /t product

LESS
LOW EMISSION STEEL STANDARD

Classification
Certified according to: LESS-Rulebook
Certificate no.:

Near Zero | Low emission: A | B | C | D

Scrap share XXX %

GWP-total according to EPD
Certified according to:
Certificate no.:
XXX kg CO_2e /t product

Labelling for CO2-reduced steel supports the transformer supply chain by…
- ✓ creating **transparency** and **comparability** of manufacturing processes and products
- ✓ forming the basis for the creation of **lead markets**

Overview

1. GOES – market, demand and supply
2. Green transformation at thyssenkrupp Steel Europe – Short introduction
3. Green steel label & green lead market concept
4. Let us take action now

Concept of lead markets for CO2-reduced raw materials announced!

NEWS

Letzte Aktualisierung: May 23, 2024

Green lead markets: How German wants to help green steel and cement achieve a breakthrough

Minister Robert Habeck wants to use new labels to drive demand for climate-friendly raw materials from the steel, cement and chemical industries. (EPA)

Read in Climate.Table how Germany plans to introduce new labels for more green raw materials and which areas it will cover.

German Economy Minister **Robert Habeck** wants to ensure that new regulations boost demand for green raw materials from the steel, cement and chemical industries. On Wednesday, he presented a corresponding

The BMWK's initiative to create lead markets for climate-friendly basic materials is an approach that integrates innovation, regulation, and collaboration to drive the transition to a sustainable economy.

- ✓ Connectivity on EU and global level
- ✓ Basis to foster collaboration between various stakeholders
- ✓ Encouragement of formation of strategic partnerships in the industry to share knowledge, drive innvoation and coordinate efforts in promoting climate-friendly materials

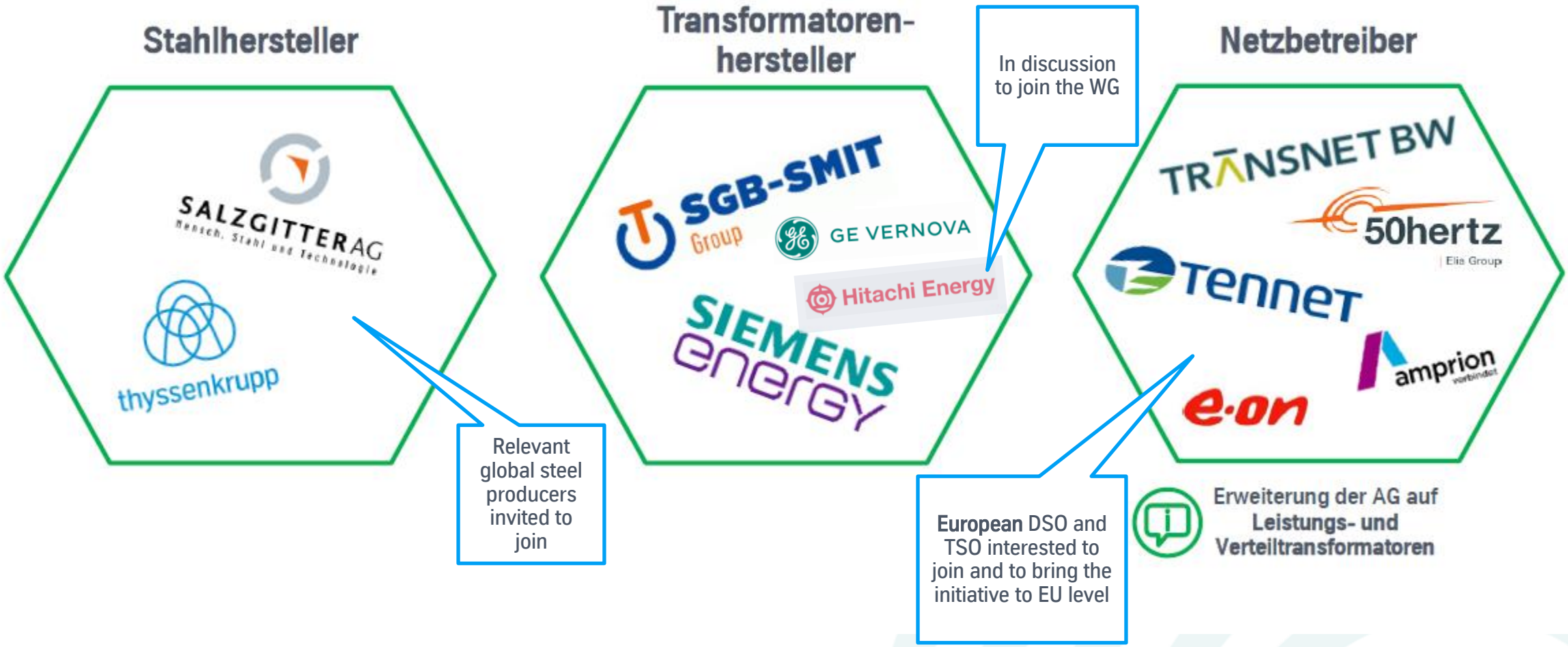
Workshop on sustainable transformers – Paving the way to create the first green lead market

Joint event with Siemens Energy and TSOs/DSOs to prepare the path for sustainable transformers with the example of Green Steel in the Supply Chain:

Starting from Blast Furnace (future DRI) to Electrical Steel via transformer producers to the national grid infrastructure

We need more of these discussions and they need to be followed by actions.

The Working Group “Lead Market for CO2 reduced steel in transformers in the German Transmission Grid” has started



Four key aspects are elaborated across the participants of the working group

Definitions

- Definiton of **„CO2-reduced steel“**
- Definition of representative **power and distribution transformers**

What is CO_2-reduced steel?

Quantity

- Scenarios for the **number of transformers** required in the period from 2025 to 2045, including the commissioning dates.
- Effects on **investments in the value chain**

How many transformers are needed and how much investment is required?

Costs and Benefits

- Estimate of the **additional costs** of a green lead market. Per transformer and for all transformers.
- **CO2 savings potential**

What are the costs and benefits of a Green Lead Market?

Implementation

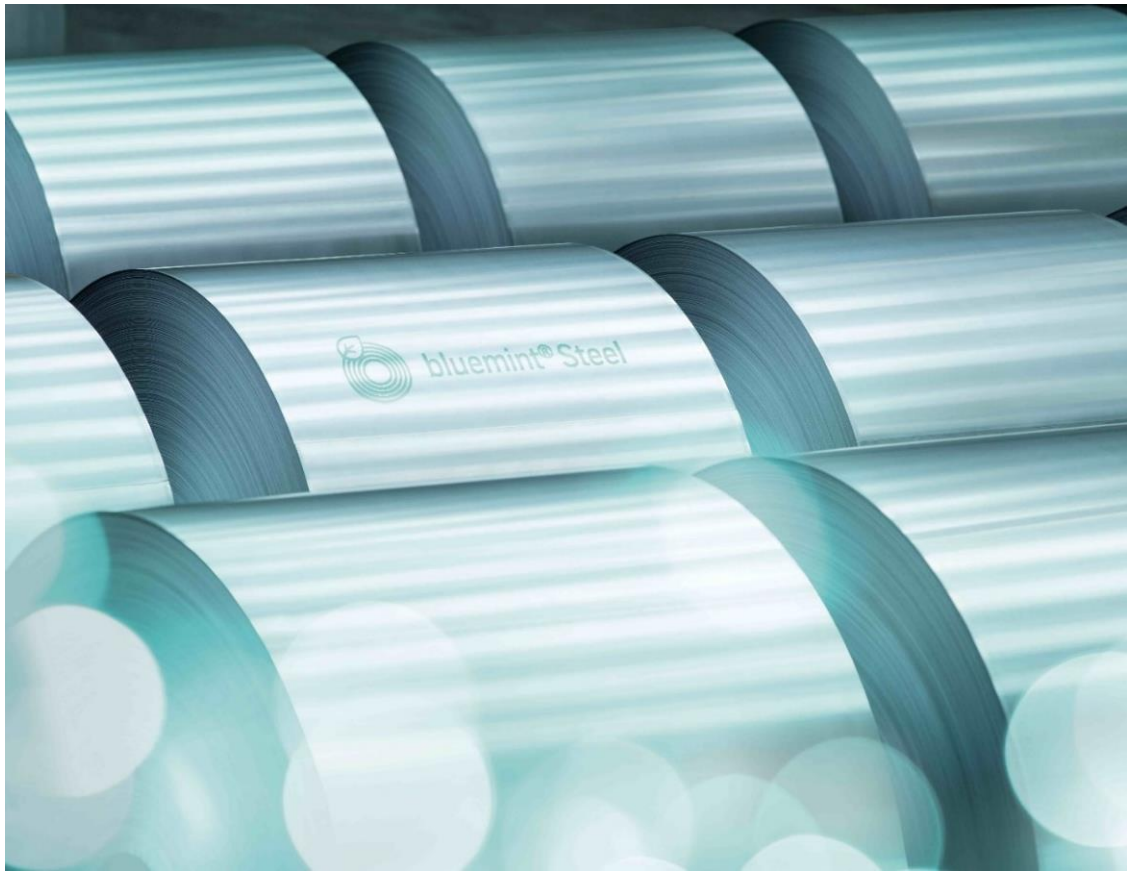
- Formulation of a **proposal for the use of CO2-reduced steel** in public tenders
- Options for **incentives**
- Approach and **distribution of additional costs**

How are incentives created for the use of CO2-reduced steel?

What needs to be done next with the green lead market working group?

Green lead markets need to happen on a European and global level

There are numerous opportunities to get involved today - let's start now!



Implementation of pilot projects with CO2-reduced transformer core laminations

Change in tender processes with (proportion of) green material as an award requirement

- Tender criteria
- Green steel label system (LESS)
- Initiatives for green lead markets (BMWK)
- High efficiency to minimize losses over the life cycle

Cooperation with the regulatory authority to support investments in green infrastructure

We have started the co-creation of the world´s first green lead market… join us and be on board!


Thank you for your attention
Let us discuss!
engineering.tomorrow.together.
thyssenkrupp