Electrical Steel – Massiver Marktbedarf

Rohmaterialverfügbarkeit Ferrosilizium und Dekarbonisierung

21. November 2023 I Berlin, Deutschland I DERA Industriekonferenz Silizium

Marcel Hilgers – thyssenkrupp Electrical Steel Group

engineering.tomorrow.together.

thyssenkrupp

thyssenkrupp Steel

Kennzahlen Geschäftsjahr 2021/2022

Mitarbeitende
26.304

Umsatz[1]
13,2 Mrd €

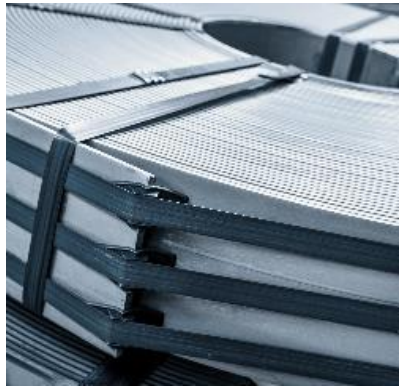
Rohstahlerzeugung[2]
10,5 Mio t

#1 Stahlproduzent
in Deutschland

Automotive

Industry

Precision Steel



Electrical Steel

Packaging Steel

1. Inkl. Hüttennebenprodukten (ca. 1 Mrd € Umsatz) I 2. Inkl. Zulieferungen von den Hüttenwerken Krupp Mannesmann (HKM) I Quelle: Geschäftsbericht thyssenkrupp AG 2021/2022

Electrical steel is the core material for the energy transition and e-mobility

ENERGY GENERATION

Non grain-oriented (NGO)

Non grain-oriented electrical steel for

GENERATORS

ENERGY DISTRIBUTION

Grain-oriented (GO)

Grain-oriented electrical steel for

TRANSFORMERS

ENERGY UTILIZATION

Non grain-oriented (NGO)

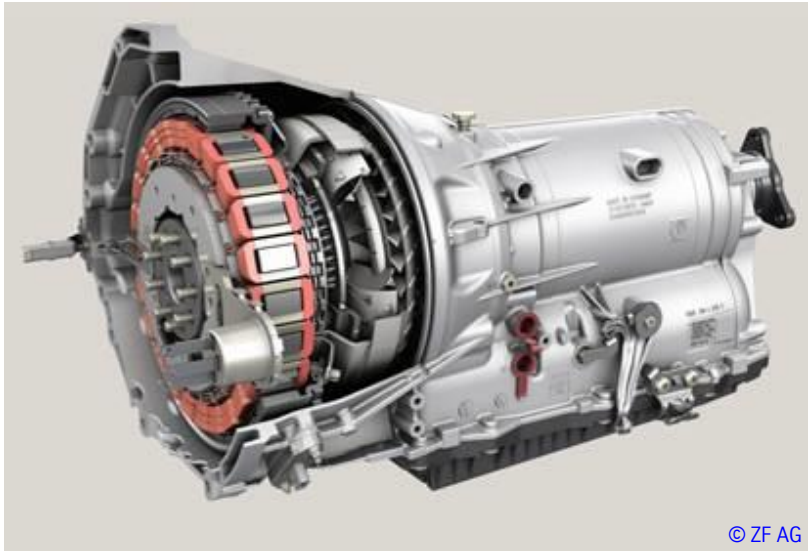
Non grain-oriented electrical steel for

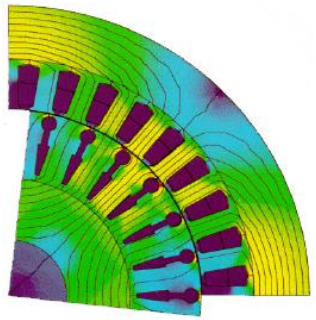
ELECTRIC MOTORS

Grain Oriented and Non Oriented Electrical Steel

Applications

Non Oriented Electrical Steel





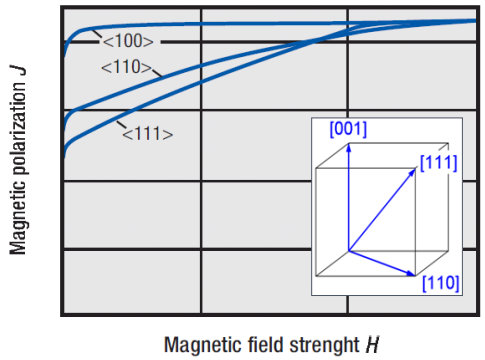
➔ **isotropic** magnetic properties, specialized for motors and generators

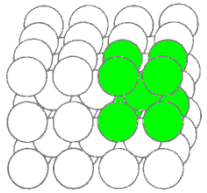
Grain Oriented Electrical Steel

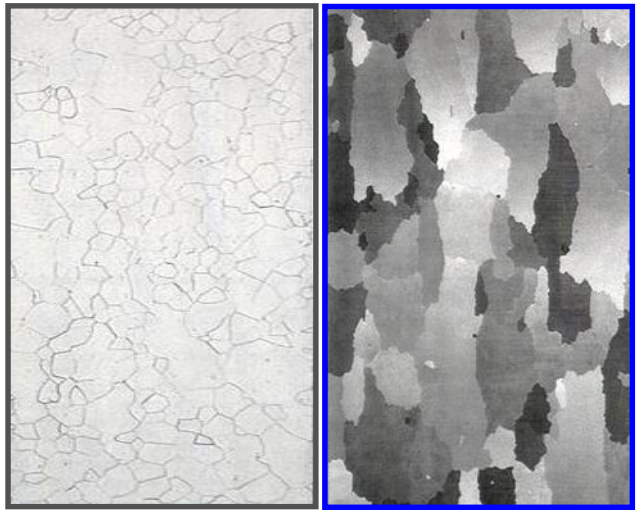
➔ **anisotropic** magnetic properties, specialized for transformers

Grain Oriented and Non Oriented Electrical Steel

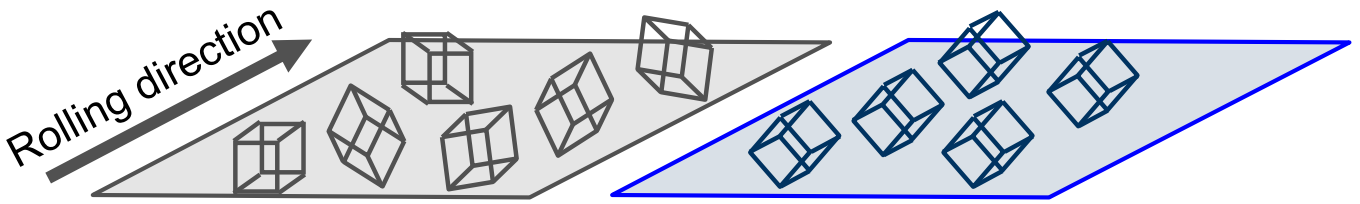
Magnetization curves of body-centered cubic α-iron





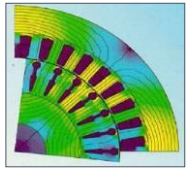


powercore®
Grain oriented electrical steel



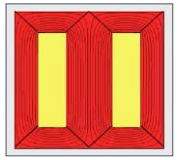
Non Oriented Electrical Steel

isotropic magnetic properties,
specialized for motors and generators



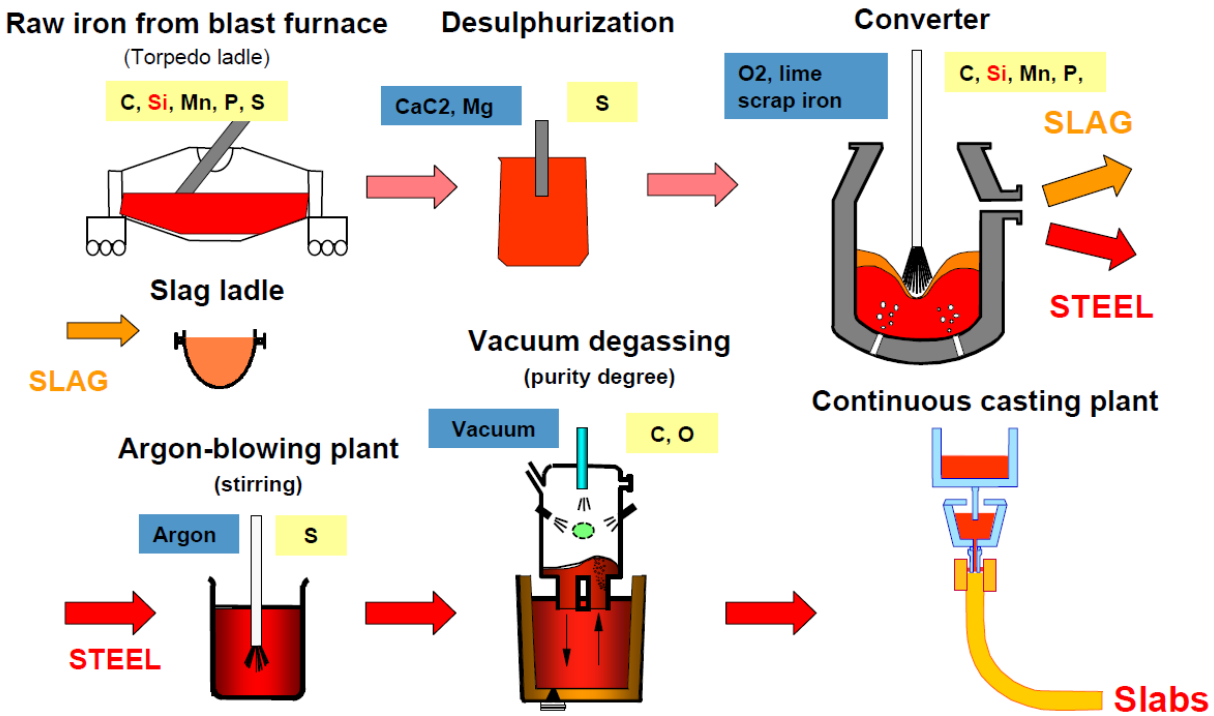
Grain Oriented Electrical Steel

anisotropic magnetic properties,
specialized for transformers



Production of Grain Oriented Electrical Steel

Processing at the steel shop



- One heat consists of 360t with the same chemical analysis
- Due to the fact, that most of the processes in the following processing steps are strongly depending on several elements from the chemical composition, the requirements on the accuracy of the chemical analysis are much higher than for other steel grades
- **Main elements are Si, C, Al**
- Oxidation of Al during this process has to be avoided
- Addition of Mn, Cu, Sn, P, Ti, Cr, S, N mandatory for top magnetic properties

Alloy composition and material thickness with significant influence on magnetic performance

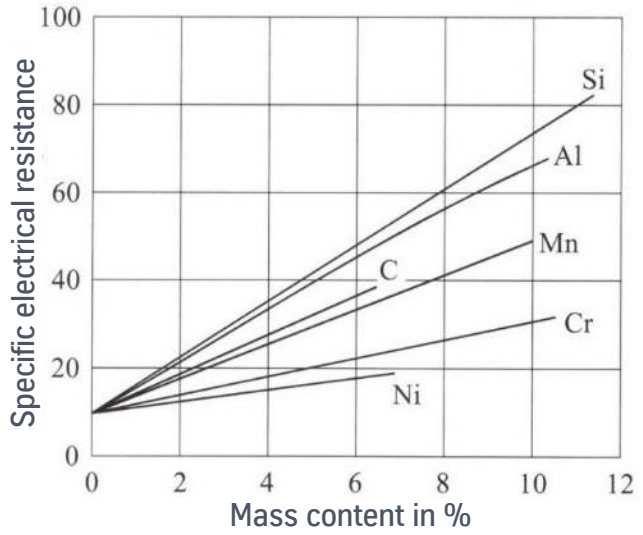
FACTORS THAT INFLUENCE the magnetics

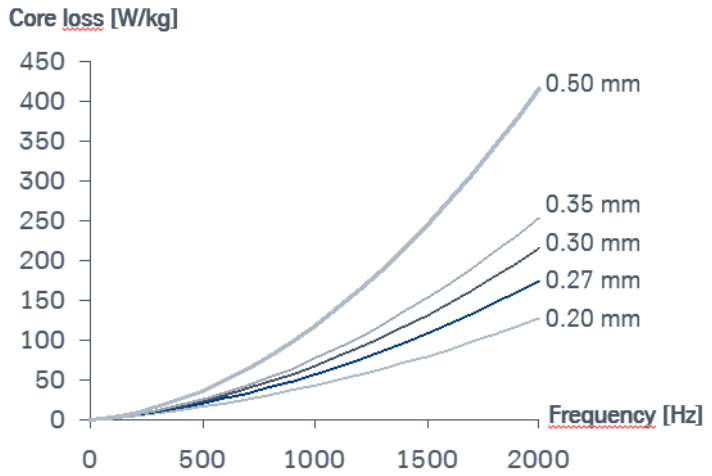
Silicon has the greatest influence on the specific electrical resistance and therefore on the reduction of core losses

Other elements, such as aluminum, also contribute to an increase in the specific resistance
→ negative influence on cold-rolling

The material thickness has a particularly strong influence on core losses

The alloy (Si, Al) in combination with thin material thicknesses present great challenges in the manufacturing of electrical steels





Eddy current losses Abnormal losses

$$W_{tot} = W_{hyst} + \frac{d^2 \cdot \pi^2 \cdot B_m^2}{6 \cdot \rho_{elek} \cdot \rho_{Mat}} \cdot f^2 + C_3 \cdot B_m^{1,5} \cdot f^{1,5}$$

High product requirements as a challenge for production facilities

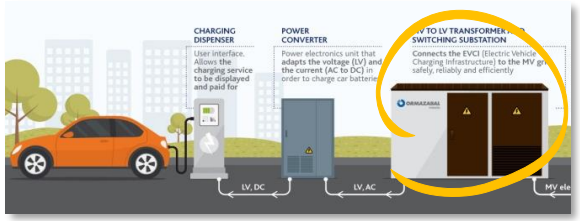
W_{hyst} = Hysteresis losses, d = Material thickness, B_M = Peak value of magn. flux density, ρ_{elek} = Spec. elec. resistance, ρ_{Mat} = Material density, C_3 = Material-dependent constant, f = Remagnetization frequency;
Source Picture left: Bleck, Werkstoffkunde Stahl; right: tkSE

Strong increase in global electrical energy and megatrends have been fueling significant growth in GOES markets – this trend will continue

Overview of megatrends

Decentral & fragmented electrical power infrastructure

Boost of e-mobility

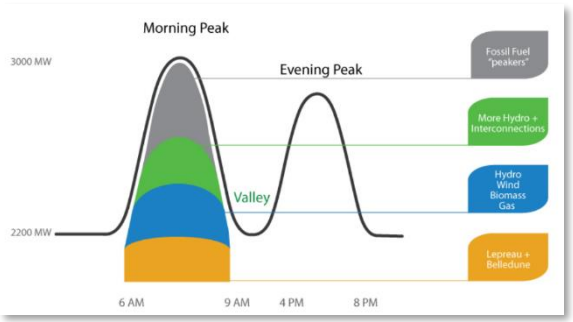


Increase of energy efficiency

powercore®
Grain oriented
electrical steel

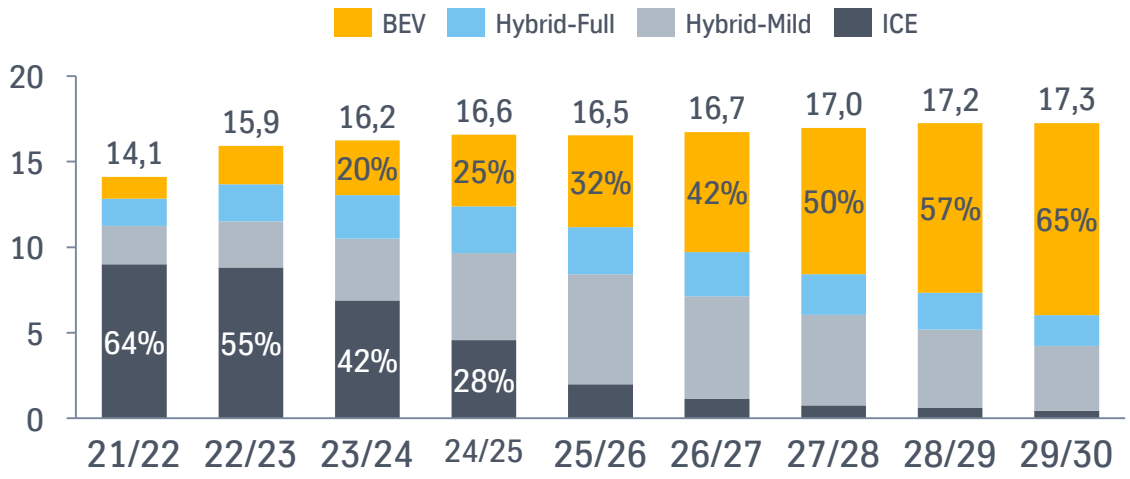
Substitution of fossil energy

Smart grid (volatile demand & supply)

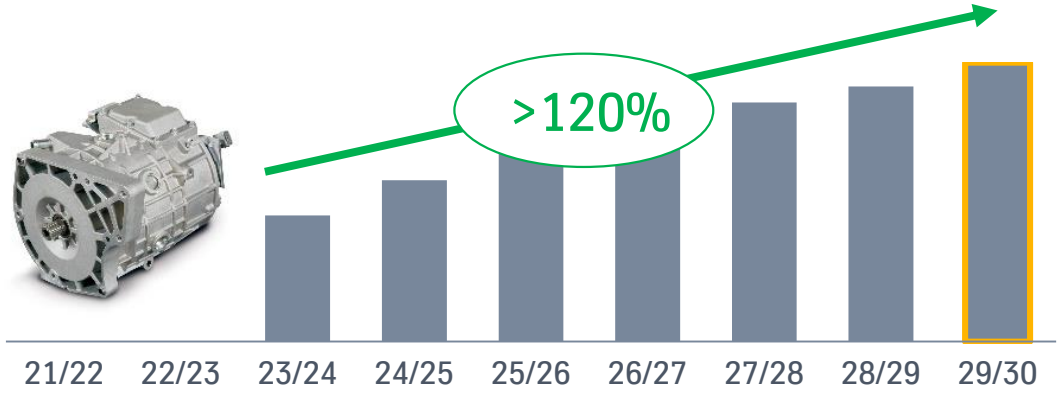


Strong demand for NGO electrical steel and Silicon due to shift from ICE to BEV

IHS forecast according to type of drive [mn. vehicles]



Demand development E-Mob [mn. t], as of Dec.´22



- Increase in absolute production of passenger cars and structural shift from ICE to BEV lead to high demand for NGO electrical steel in the next years
- Currently a BEV-share of 65% expected in 2030

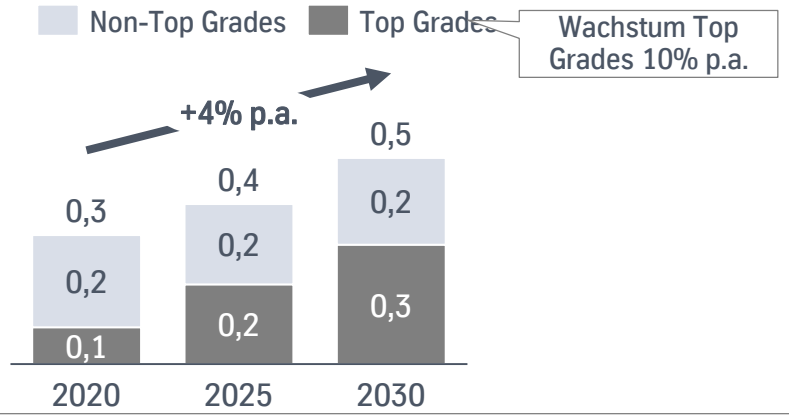
Klar absehbares Marktwachstum benötigt in der EU und global Ferrosilizium

Nachfragetreibende Megatrends

Marktnachfrage Europa, in Mt

A KO

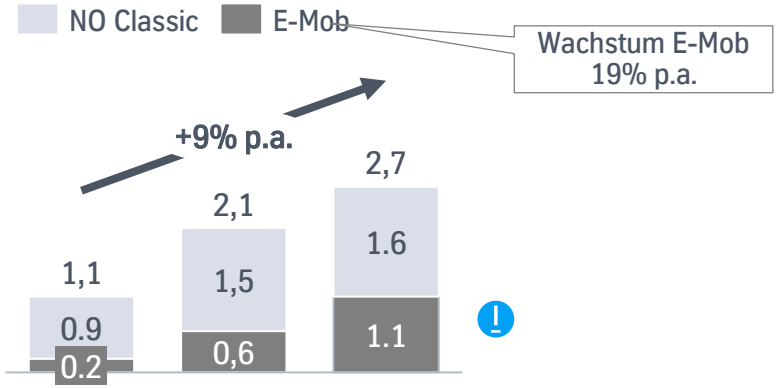
Netz-ausbau



B NO

Elektro-Mobilität

Strom-erzeugung



Implikationen

- KO Elektroband: Bis 2030 wächst der Bedarf an Ferrosilizium in der EU um

  +65%

- NO Elektroband: Bis 2030 wächst der Bedarf an Ferrosilizium in der EU um

  +150%

Currently, 80 mn km of global transmission/distribution lines which will minimum double by 2050

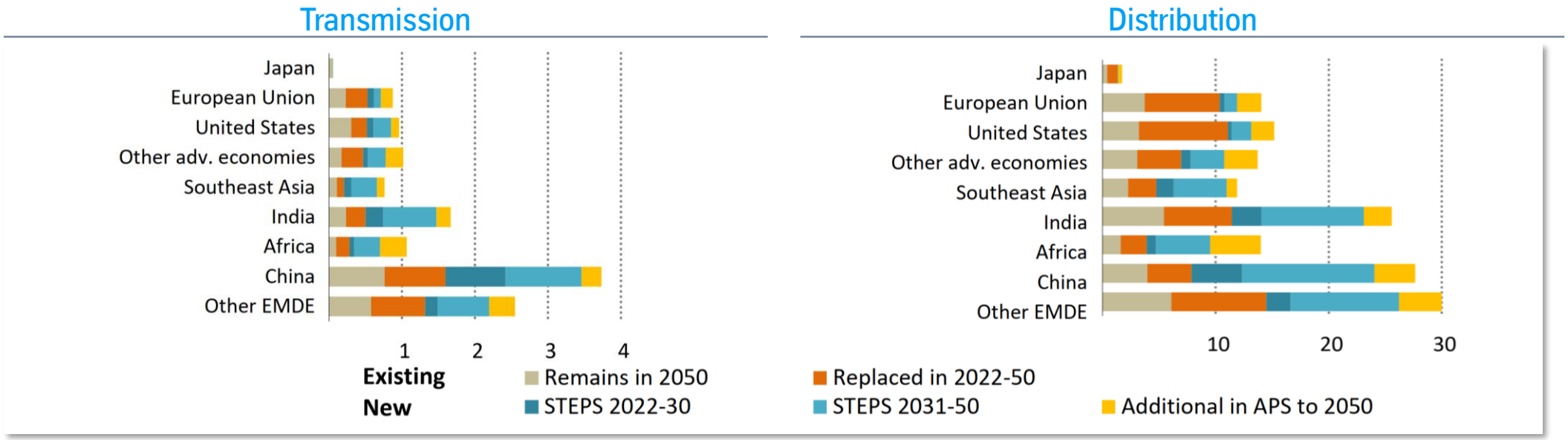
Global energy grid/lines [mn km]

Today

STEPS 2030

STEPS 2050

APS 2030



~80 mn km
(total of transmission + distribution)

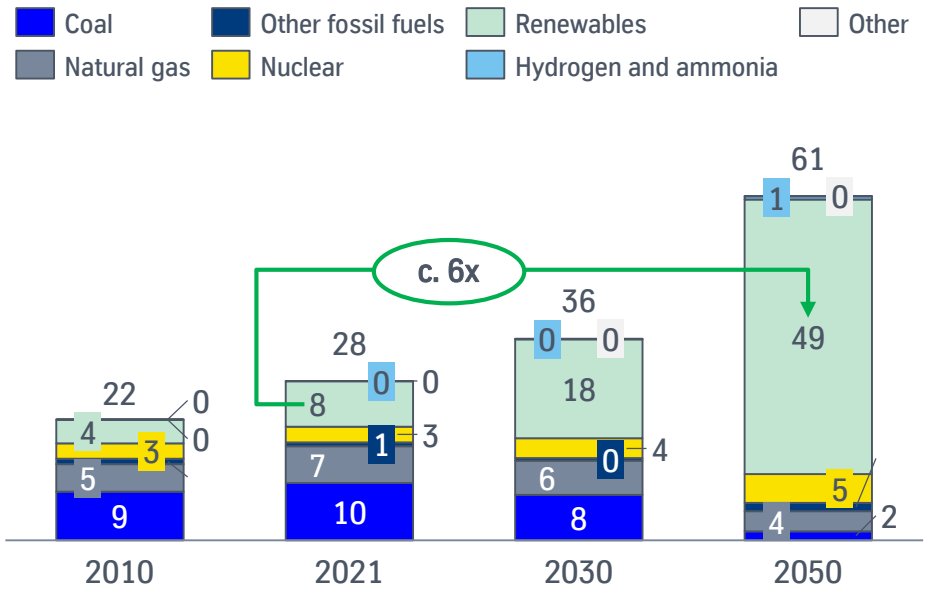
+13 mn km
+45 mn km
+14 mn km
Σ +72 mn km

+1.6 mn km
+4.0 mn km
+1.8 mn km
Σ +7.4 mn km

Sources: World Energy Outlook 2022

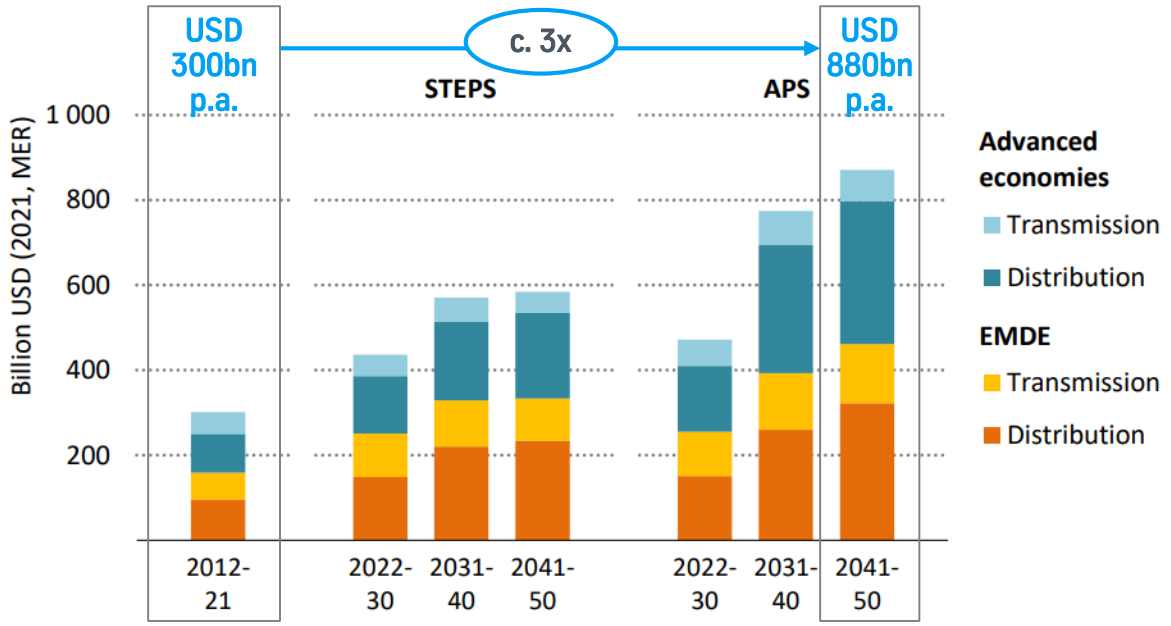
Significant investments in electricity grid investments (transmission and distribution lines) driven by c. 6x increase of renewable electricity supply

Global electricity supply growth - APS scenario *(in kTWh)*[1]



- Global electricity supply is supposed to increase from 28.3k TWh in 2021 to 61.3k TWh in the APS scenario until 2050
- The importance of fossil electricity decreases drastically. Renewable electricity supply grows by c. 6x, accounting for ~80% of total supply

Annual electricity grid investments under STEPS & APS *(in USDbn)*[2]

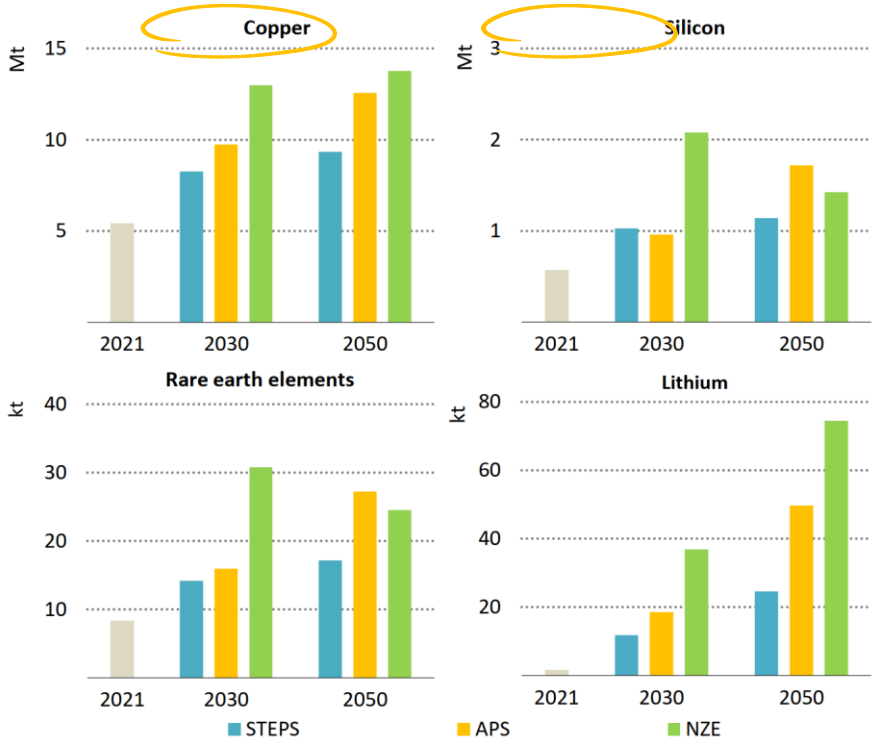


- To realize this huge demand, average annual electricity grid investments need to increase from USD 300bn (2012-2021) to over USD 880bn (2041-50) with a boost in the period 2031-40[2]

Source: 1) IEA WEO 2022 page 281 2) IEA WEO 2022 p. 317, details APS p. 463, 474-484

Demand for critical minerals is growing fast – driven by installation of renewable energy

Annual demand for selected critical minerals used in electricity supply, storage and networks [Mt]



Critical mineral inputs

- Solar PV x 6
- Onshore wind x 9
- Offshore wind x 13

vs gas fired powerplant

- Nuclear x 4

Grüne Transformation

Herausforderungen und Chancen

~419 kg
Stahl pro Kopf & Jahr

~5 %
CO_2-Anteil Stahl

~7 %
CO_2-Anteil Stahl

~2,5 %
CO_2-Anteil tk in D

~25 %
CO_2-Anteil tk im Ruhrgebiet

2030 6 Mio. t CO_2-Einsparung
Umstellung von 3 Mio Autos auf Elektroantrieb

tkSE Bedarf[1]: ~ 14 TWh 2030
Entspricht 120 % Strombedarf der Stadt Hamburg

H_2 Bester Wechselkurs
1 t H_2 spart 28 t CO_2

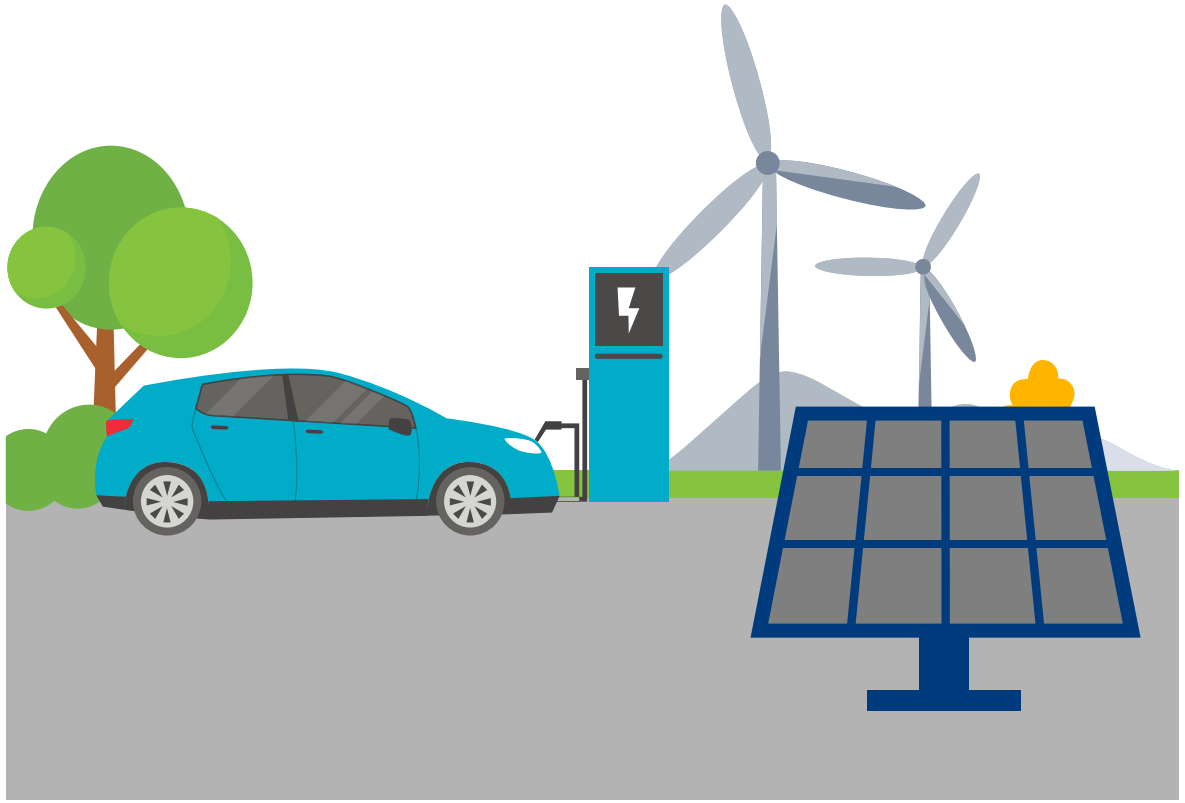
Unser Ziel bis 2030
>30 % Reduktion der CO_2-Emissionen (-6 Mio Tonnen)

Unser Ziel spätestens 2045
-100 % CO_2-Emissionen (-20 Mio Tonnen)

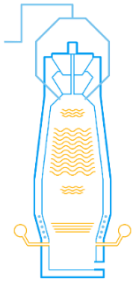
-30 % CO_2-Emissionen im Jahr 2030 bezieht sich auf Scope 1 und Scope 2 Emissionen (Referenzjahr 2018); 1: Strombedarf zur Wasserstoffherstellung

Steel is an essential component for a sustainable and successful energy transition …

… which is why we are converting our production to "green" to meet this requirement



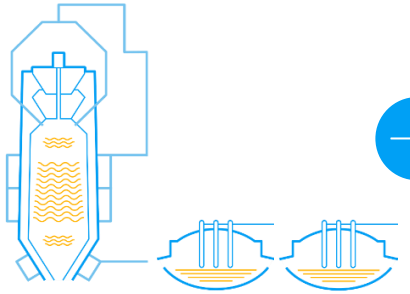
Today



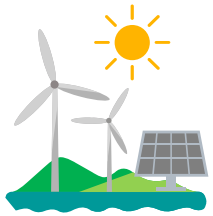
Blast furnace

Iron ore & coking coal

Tomorrow



Direct reduction plant with melting units

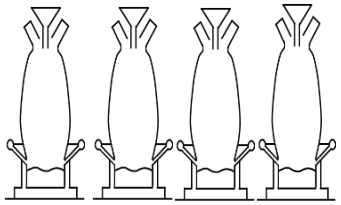
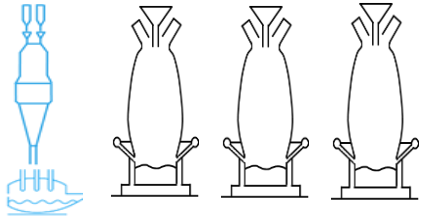
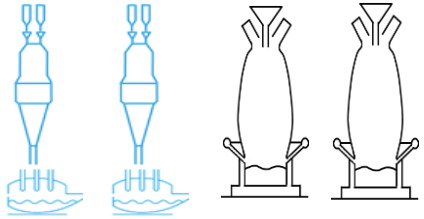


Iron ore, hydrogen & green electricity

Unser Transformationspfad – Klar definierter Masterplan zur Senkung der CO_2-Emissionen

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

Einsparungen im Hochofenprozess → Schrittweiser Ersatz der Hochöfen durch DR-Anlage + Einschmelzer

	heute - 2025	ab 2026	bis 2030	bis 2045
				
CO_2-Einsparung	2 %	~20 %	> 30 %	100 %
Output bluemint® Steel	50-500 kt/a	~3 Mio t/a[1]	~5 Mio t/a[1]	11,5 Mio t/a[1]

1. Menge nach Anlagenhochlauf

ESG is becoming increasingly relevant – consequently companies are committing to specific decarbonization targets

And they have announced ambitious targets…

IBERDROLA

-86%
Emission in three decades

-43%
Scope 1, 2 and 3 emissions by 2030

Net Zero
Globally before 2050

Commitment to invest 150bn EUR in renewables, storage and grids[1]

78% of all emissions accout to Scope 3

CLIMATE GROUP
STEELZERO

Iberdrola joined international initiative SteelZero and announced commitment to using 50% low emission steel by 2030[2]

SCIENCE BASED TARGETS

Targets approved by the Science Based Target initiative in December 2020, in line with 1.5°C

…as well as other leading organizations

acciona — "60% of Scope 1 & 2 and 47% of Scope 3 by 2030"

RWE — "50% per kWh of Scope 1&2 and 30% of Scope 3 by 2030"

e·on — "Net zero by 2040, 75% of Scope 1&2 and 50% of Scope 3 by 2030"

enel — "80% per kWh of Scope 1 by 2030, Net Zero by 2040"

1. In this decade; 2. Net Zero by 2050

Impulse durch Selbstverpflichtung globaler Unternehmen zur Dekarbonisierung im Rahmen der First Movers Coalition (FCM) und SteelZero erwartet

Ziel ist die Schaffung von Märkten für innovative saubere Technologien – Eine Einschätzung

	First Movers Coalition	CLIMATE GROUP STEELZERO *** In partnership with Responsible Steel
Die Anforderungen an CO_2-reduzierten Stahl sind anspruchsvoll	• Rohstahl aus Produktionsanlagen mit bahnbrechender Technologie inkl. CCUS/CCS • Near zero steel: <0,4 - <0,05 t CO_2/t Rohstahl; abhängig vom recycled content (0-100%) • Methodik gemäß IEA Guidance*	• Responsible Steel Standard V2.0 → hollistischer Ansatz, geht über CO_2-Betrachtung hinaus • Near zero Steel: <0,4 - <0,05 t CO_2/t Rohstahl; abhängig vom recycled content (0-100%) • Low emission steel: <1,4 - <0,2 t CO_2/t Rohstahl
Die Freiwillige Selbstverpflichtung für Stahleinkäufe ist ambitioniert	• "Mindestens 10 %** des gesamten jährlich eingekauften Stahls werden bis 2030 nahezu emissionsfrei sein“	• bis 2030 „50% low emission steel“ • Bis 2050 „100% zero steel“
Vergleichsweise geringe Beteiligung globaler Konzerne STBi mit 1000+ Unternehmen	• Aktuell 89 Mitglieder • Bisher kein dt. OEM, jedoch Kunden wie z.B. Volvo Group, Ford, General Motors, Scania und Zulieferer wie ZF sind Teil der Initiative • Außerdem: Rio Tinto, BHP Group, Fortescue Metals	• Aktuell 42 Mitglieder • z.B. Siemens Gamesa, Volvo Group, Volvo Cars, Iberdrola, Vattenfall

Die Schaffung von spürbaren Nachfrageimpulsen in den nächsten Jahren abhängig von weiterer Entwicklung der Initativen

* Scope1,2 und 3 upstream (Erze und Kalk), vgl. IEA Bericht; ** Nach Volumen; Quelle: WEF_FMC_Sector_One_pagers_2023.pdf (weforum.org); *** Quelle: Building demand for net zero steel | Climate Group (theclimategroup.org)

Grüne Leitmärkte sind der einzige Weg – und die Industrie ist bereit voranzugehen

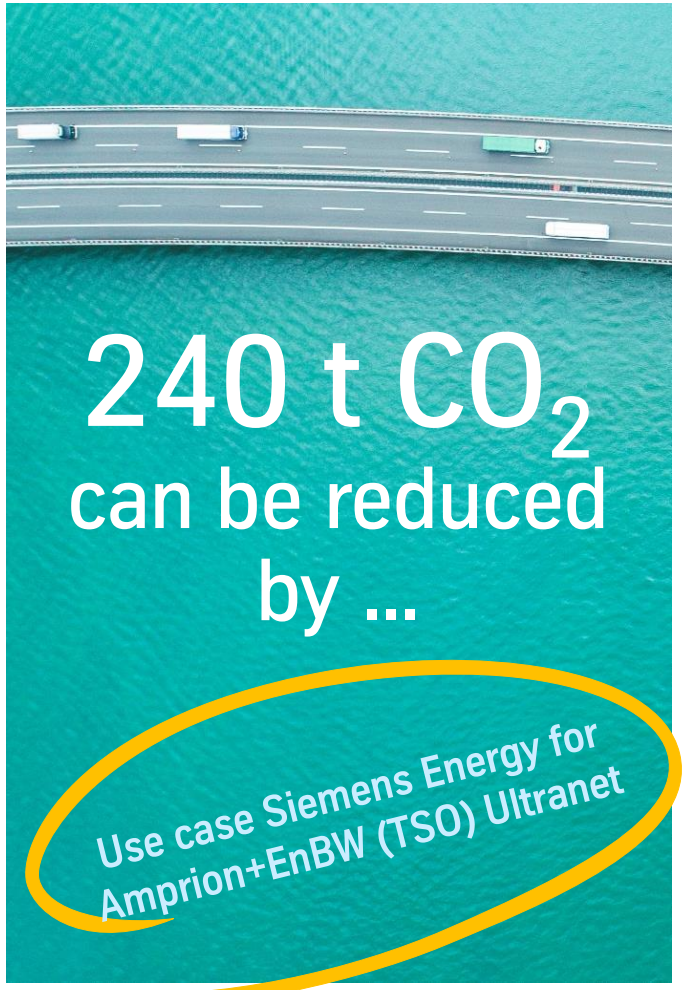
Industriestrategie des BMWK (veröffentlicht am 24.10.2023)

„Schaffung grüner Leitmärkte“

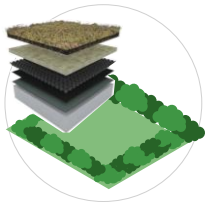
Ziel: Unternehmen soll ermöglicht werden, ihre klimafreundlich hergestellten Produkte zu einem höheren Preis zu verkaufen

- 1. Schritt: Definition von Anforderungen, nach denen Produkte als klimafreundlich angesehen werden (Ergebnisse sollen noch 2023 vorgestellt werden)
- 2. Schritt: Einführung einer freiwilligen Kennzeichnung (Label) zur standardisierten Bezeichnung wird geprüft
- Berücksichtigung weiterer Kriterien neben dem Preis, z.B. CO_2-Intensität, bei der öffentlichen Vergabe „sollte (zukünftig) möglich sein“
- **Kein** Hinweis auf z.B. verpflichtende Quotenregelung

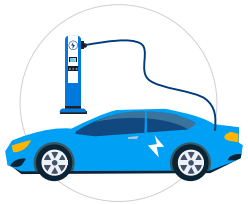
bluemint® is a major lever for reducing CO_2 emissions



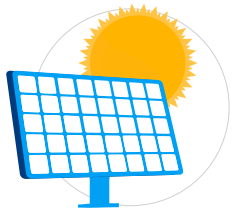
Switching ~9,600 light bulbs to LED



Greening roofs of >790 transformer houses (functioning for 10 years)

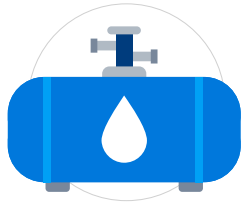


Driving 1.4m km with electric vehicles instead of combustion engines (~36x around the earth)



Installing ~48 solar PV panels operating for 25 years

Replacing ~84 transformers to more energy efficient models



Sourcing ~2.4mn MJ biomethane instead of natural gas (heating ~83 single-family homes for one year)

Producing 1 Power transformer (135t core weight) with bluemint® powercore®

Thank you

for your attention

engineering.tomorrow.together.

thyssenkrupp