



Welcome!



Est. 1863

Future from Tradition



Supply and Demand of Recarburisers

Presented through:

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Structure

- ▶ Company Profile
- ▶ Supply and Demand of Recarburisers
- ▶ Recarburisers – Need for change?
 - ▶ Alternatives in times of increasing scarcity of resources
- ▶ Closing words



JAMES DURRANS & SONS

Who are we?

155 years in
business



1863 - 2018

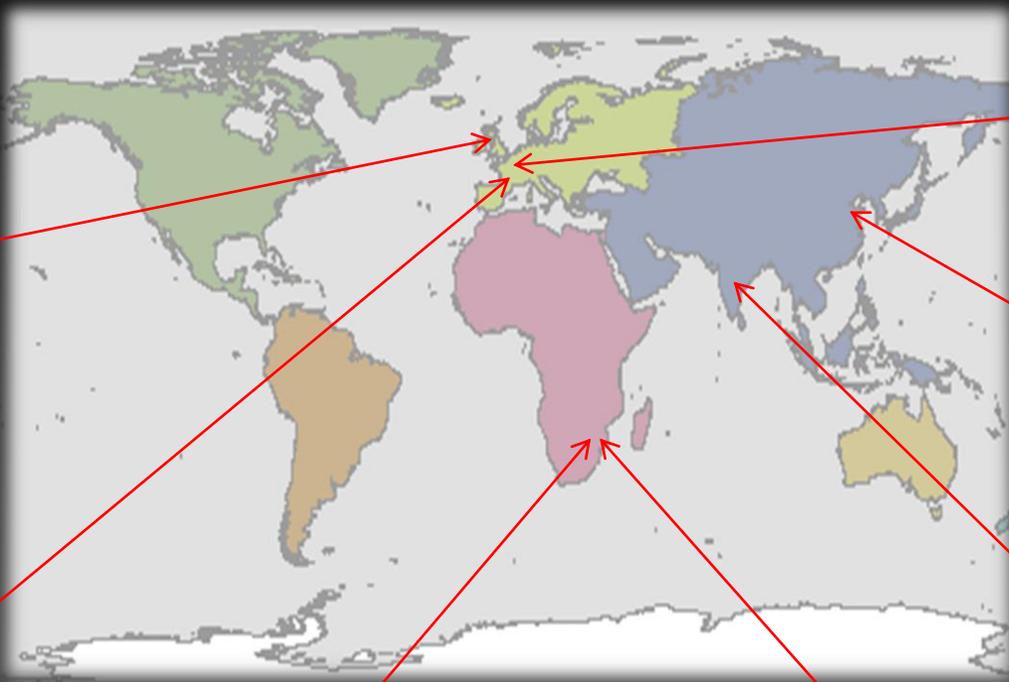
Future from tradition



- Established in 1863 in Penistone, Sheffield, UK
- 100% family owned (6th generation)
- 185 employees
- Turnover of approx. 75M € in 2017
- Producer with 8 production plants
- Sales in more than 40 countries worldwide
 - to branches such as foundries, steel works, chemical sectors, refractory industry, graphite manufacturer, etc.
- Products: Recarburisers, refractory coatings/blackings, Greensand-moulding materials (lustrous carbon/Bentonite), Friction-Carbons, raw materials for TiO₂, Battery Graphite, Refractory, Lubricants, Marconite[®], Cathonite[®], machined Graphite, etc.



Production facilities





Recarburisers: Origin and Formation



Stone Coal

- Anthracite → dried and calcined
- Coking-/stone coal → metallurgical Coke → Pitch → Pitch coke → dried and calcined → Calcined Waxy Coke (Procarb SG)
- Brown coal



Mineral oil → Destillation → fuel → Green Petroleum Coke

- Calcined Petroleum Coke (Needle Coke, Coke for anodes, Shot Coke)
 - Needle Coke → Synthetic Graphite
 - Coke for anodes → Graphitised Petroleum Coke
- carbonized mineral oil from the Acetylene gas production → Acetylene coke (probably available until 2019/2020)



Production of Petroleum Coke

Industry Figures 2017

Green-Petroleum Coke (GPC)	
160 millions of tons (MT)	
40 MT	120 MT

Energy sources
(power generation, cement production,
domestic fuel, etc.)

Calcined Petroleum Coke (CPC)	
32 MT (8 MT loss on calcination)	
6 MT	26 MT

Aluminium-Industry

4,5 MT

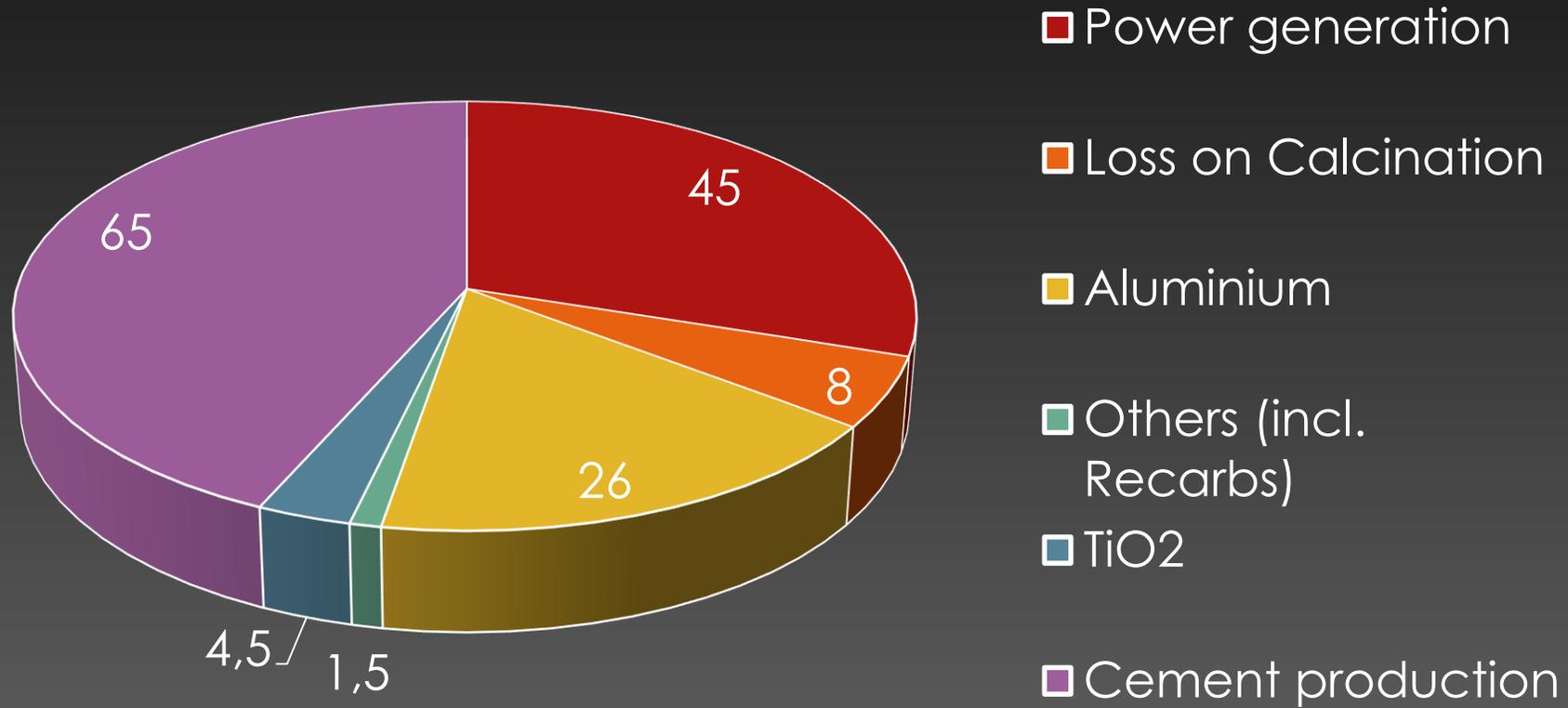
1,5 MT < 1% of the entire raw material ⚠️

TiO₂

Recarburisers, Graphite-electrodes,
Batteries, Friction materials, insulation materials,
Corrosion protection, electrical shielding, etc.



Green-Petroleum Coke Consumption / millions of tons





The production of calcined Petroleum Coke is being driven by the demands of the Aluminium-industry, the largest consumer of this material.

Recent studies conclude that the global Anode Coke production will rise by 2% until 2020 resp. 2.6% until 2025.

Due to the ever-increasing consumption of Aluminium, the global demand for anode coke will rise by more than 10% until 2020. By 2025, the needs are expected to accelerate, whereupon an increase to 30% and more is conceivable.

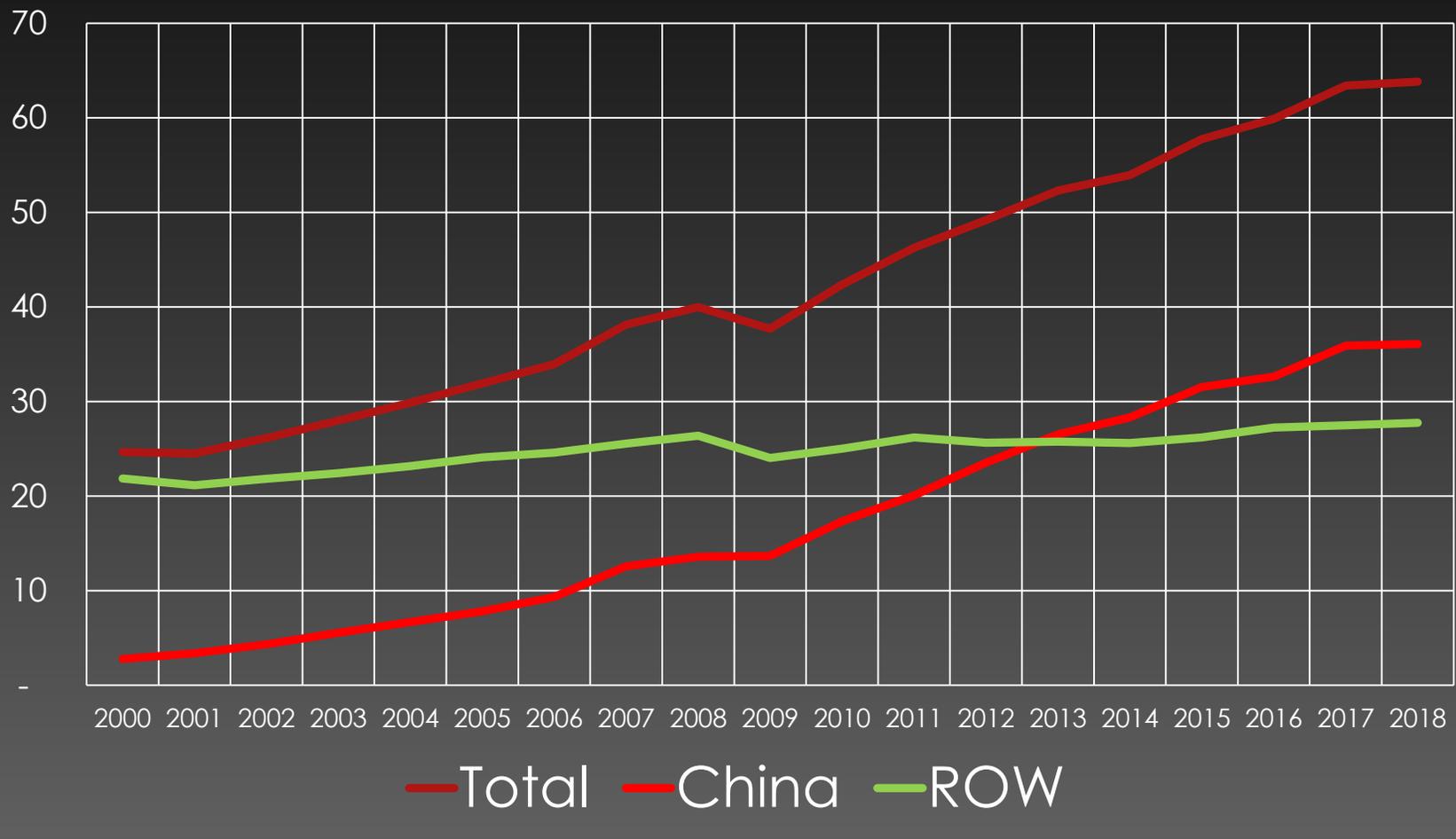
Only around 10% of the U.S. Petroleum Coke production is of anode quality, but approx. the half of the Coke produced in China is used to make anodes.

The lower output in the USA reflects the high degree of processing of very heavy and sulphur rich raw oils from Venezuela, Mexico and Canada.

It is expected that this imbalance could bring considerable opportunities but also challenges for the Refinery-/ Aluminium-Industry.

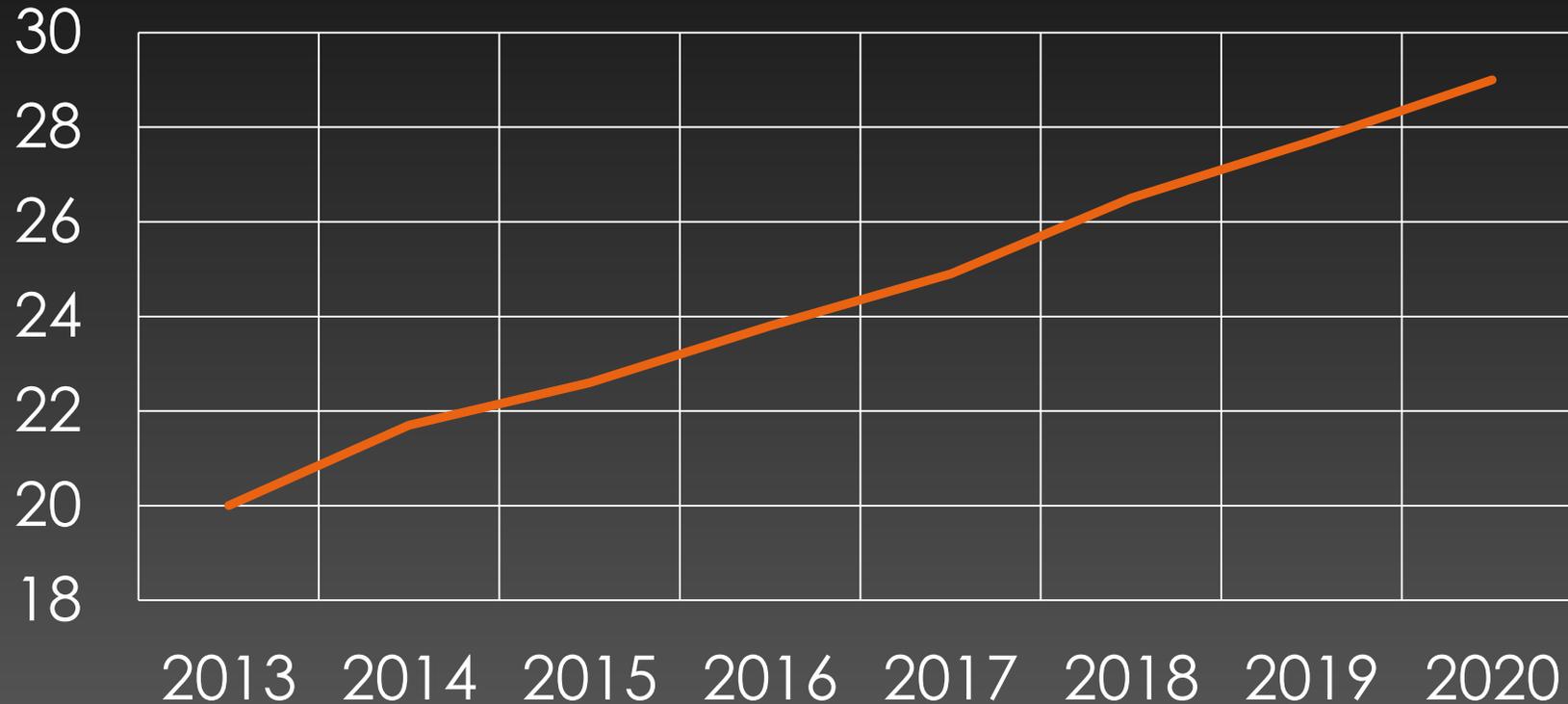


Primary Aluminium Production / MT





Based upon the anticipated increase in primary aluminium production, demand in Anode grade CPC is expected to rise dramatically



The Aluminium industry is expected to need significant additional anode grade CPC!



Expected need of Anode-CPC from the Aluminium-industry!

Primary Aluminium-production
Forecasts vary between 70 and 75 MT





Calcined Petroleum Coke and the Aluminium-industrie

Calcined petroleum coke has been used for the production of carbon anodes in the Hall-Héroult aluminum smelting process for over 120 years.

Prebaked anodes are produced with 55–65% CPC, 13–15% coal tar pitch binder, and 20–30% recycled anode butts.

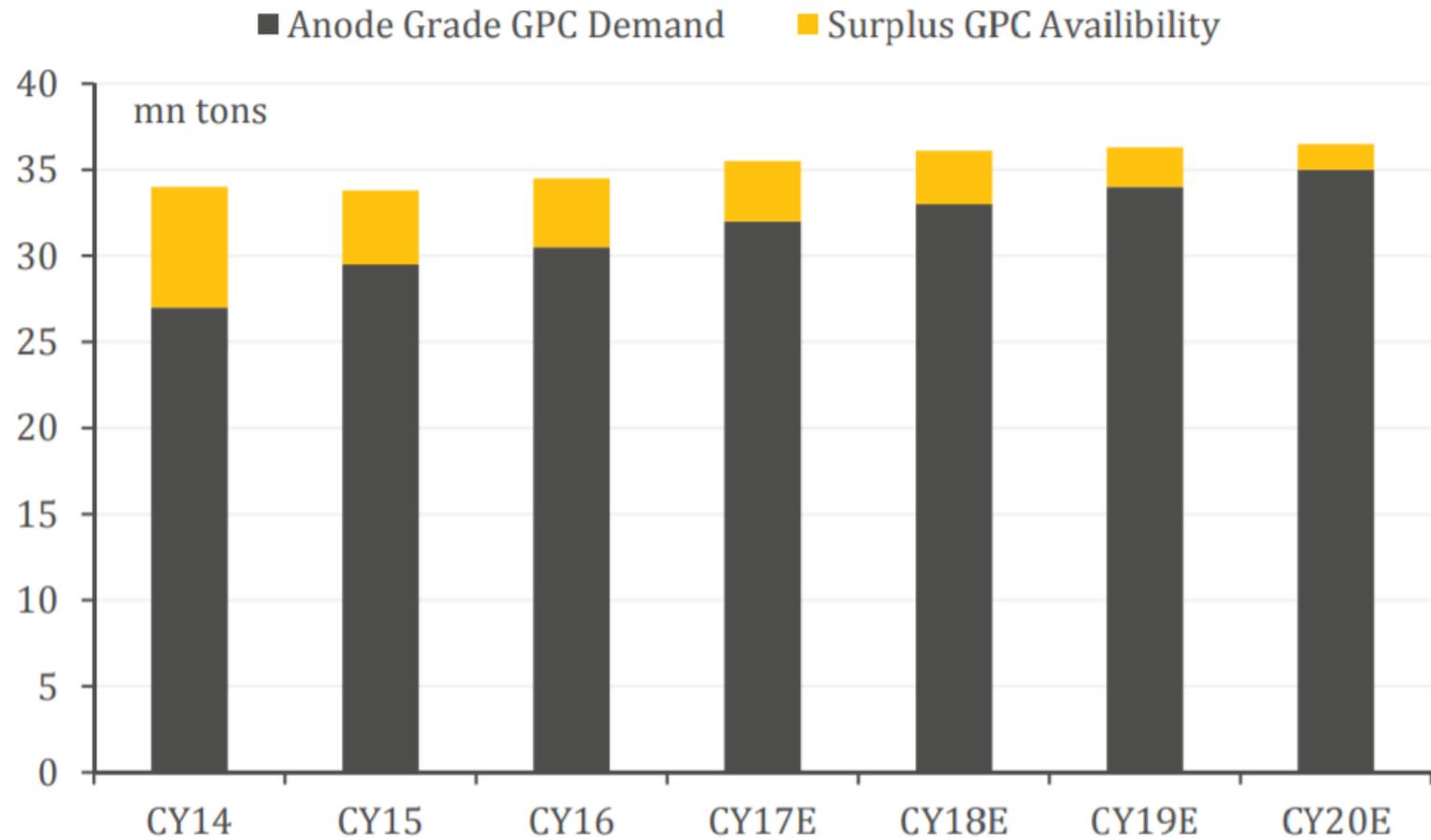
The anodes are consumed at a net consumption rate of approximately 400 kg carbon/ton aluminum produced according to the following reaction:



An anode of an earlier generation from the Alcoa Tennessee smelting plant, approx. 1926.



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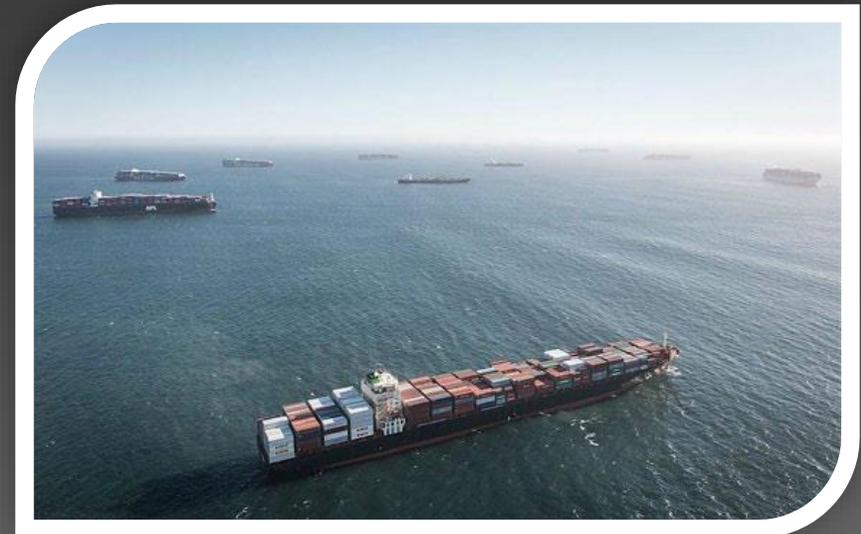
What compounded the weakness of a low sulphur GPC?

- A comprehensive consolidation in the oil industry with less companies - ExxonMobil, BP, Chevron, Royal Dutch Shell etc.
- Many new oil fields contain heavier, more sour raw oils, which are traded as slightly sweet oils at discount prices.
- Considerable investments at refineries, enabling them to convert heavy raw oils.
- New refineries, which have been built in China, the Middle East and India, are usually on the level to convert heavy raw oils.
- The rapid increase in the production of shale oil is the final plan to influence the US-raw oil- and refining industry.



IMO changes to bunker fuels – How they impact on CPC?

- On 27th October 2016 the International Maritime Organization announced a maximum Sulphur level of 0.5% on marine fuels starting from January 1st 2020.
- Crude feedstocks used for the production of Anode-CPC have a lower Sulphur content than petroleum coke for fuels. The surge in demand for low Sulphur bunker fuels and even for blends is likely to impact on anode grade CPC suitable feedstock availability.
- In addition, the demand for marine fuels is expected to increase from the current level of 300 MT to 320 MT by 2020.
- It is estimated that 20.000 ships consume approx. 80% of the heavy bunker fuel, whereby less than 500 ships are equipped with appropriate scrubbers, which are required by the statutory regulations.

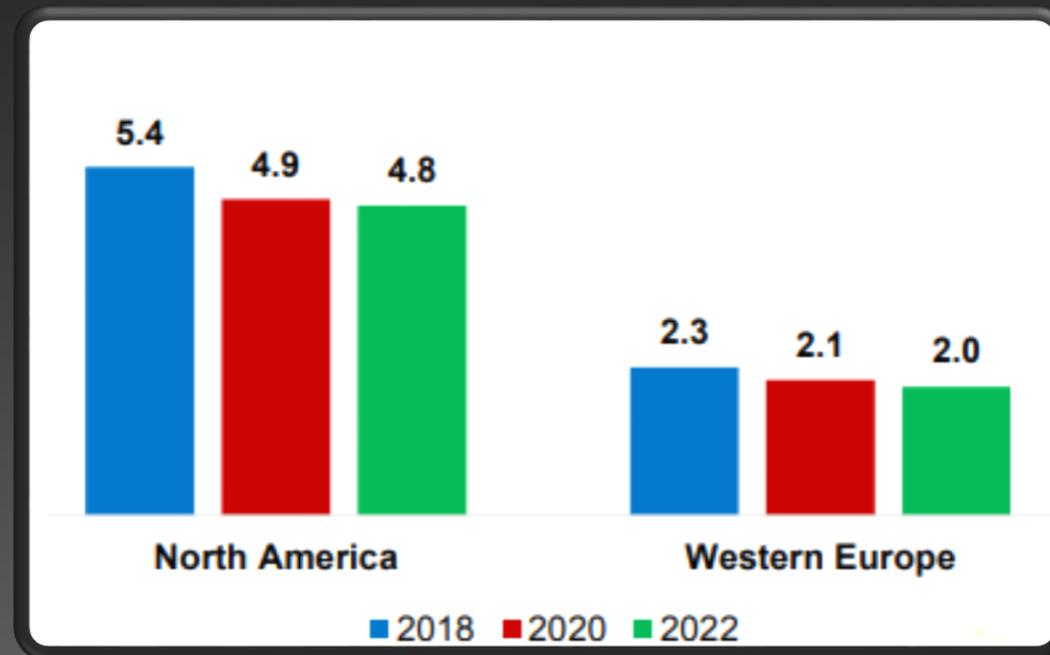




The new regulations, providing for a lower Sulphur content into marine fuels, will create increased incentives to refineries for the processing of sour crude oil. However, this will have a negative impact on the production of high-quality-GPCs.

The above development is predicted to result in a reduced availability of calcineable high grade GPC, with expected 900,000 t at Western operations.

GPC-availability (million t)



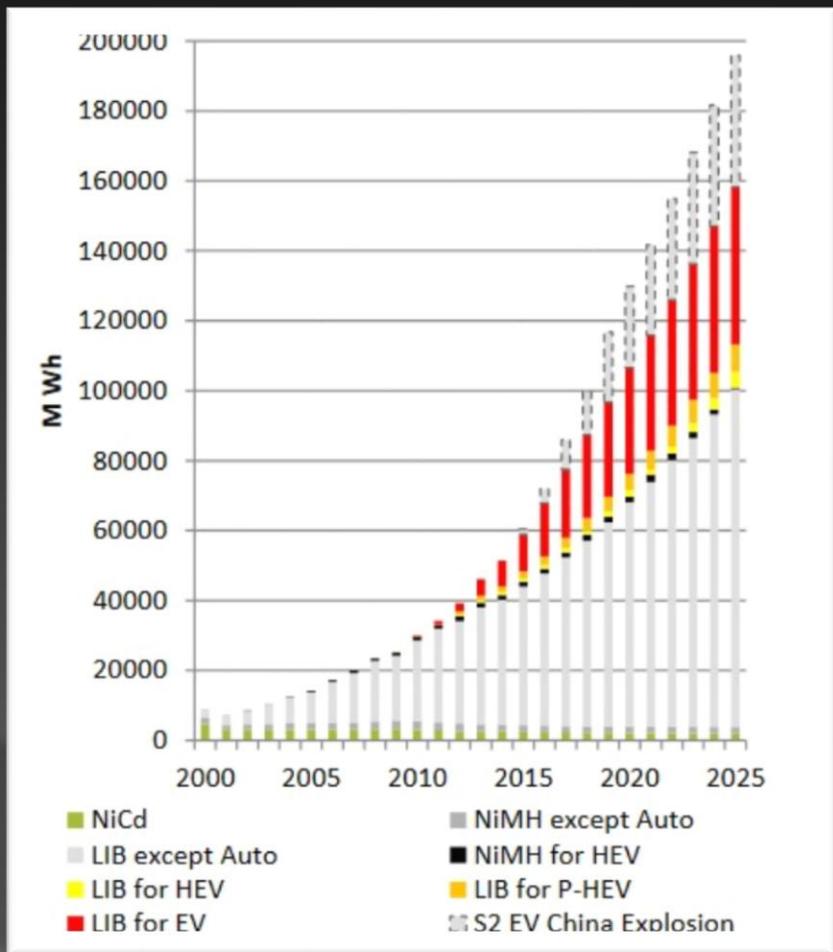
■ 2018 ■ 2020 ■ 2022

North America

Western Europe



Growth in the market of Lithium-Ion Batteries: The effect on the petroleum coke industry:



It is expected that the production of Lithium-Ion- and other batteries will increase from around 60,000 MWh in 2015 to 160,000 - 195,000 MWh by 2025.



Lithium-batteries usually contain approx. 1kg Graphite per kWh. For example, the battery pack for the Tesla S-class contains about 85kg of Graphite.

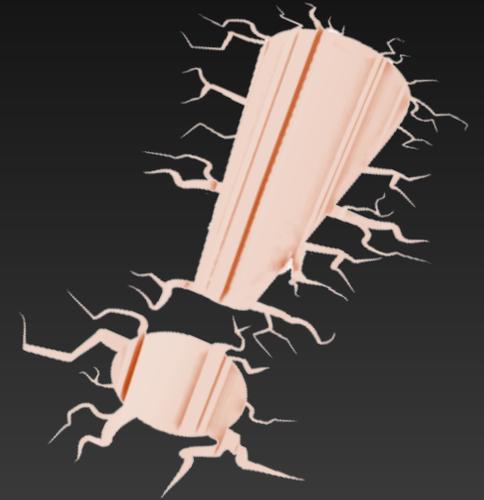
The choice of the Graphite used for these batteries increasingly falls on synthetic materials.

Finally, synthetic graphite is a highly refined and processed calcined petroleum coke. The increased demand for these materials will also have an effect on the availability of CPC.



Challenges of the Petroleum Coke Industry

- At the moment, the market is difficult for everyone. The price for anode-Graphite is driven by the GPC-price. But the prices for low sulphur containing GPCs are not coupled with the fuel-coke and energy prices.
- The challenge for the CPC-industry will not be to increase the capacity of calcination over the next 5 years, but rather, procuring the correct GPC due to the higher demand for crude oils.
- Finally, the consequences of the Chinese environmental policy and also the new laws (of the biggest CPC-producer) prohibiting the production as well as the import/export of „unqualified“ petroleum coke, will have a major impact on the industry.





Recarburisers – Need for change?

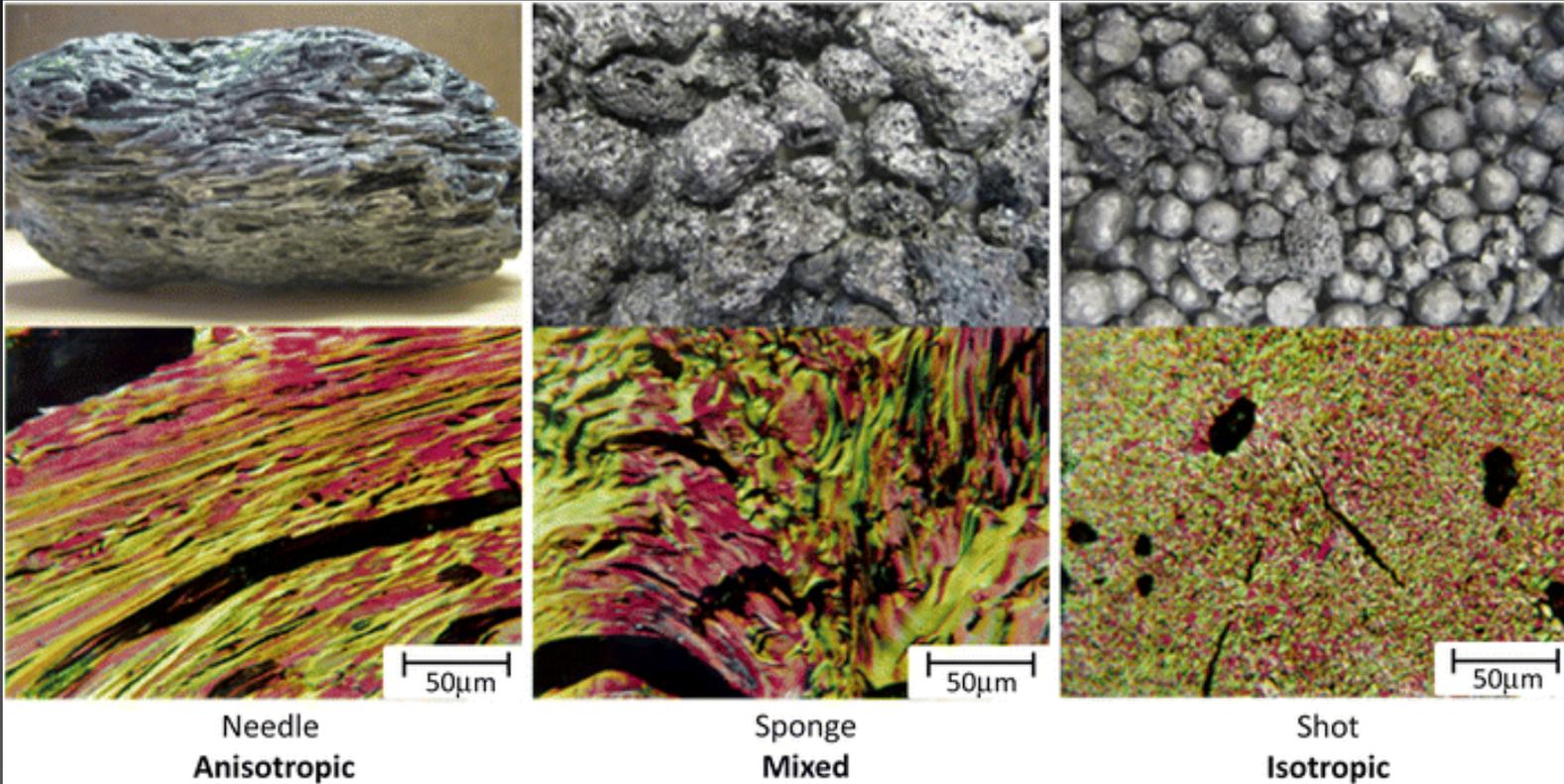
What alternatives are there in case of an increased shortage of Recarburisers for SGI?

- Development of new sources
 - i.e. „Waxy Coke = Procarb SG“
- Review and adjustment of the S-limit value into the Recarburiser
 - i.e. raw material mix made of homogenous solubly Carbons, tailored to the specific requirements of the customer
- SGI basic iron desulphurisation with pure-MG
 - Keywords: +GF+ Converter / Mg-wire
- Adaption of the charge
 - Low-sulphur pig iron instead of steel scrap





Calcined Petroleum Coke – Physical Forms





Technical Data Sheet PROCARB SG

REV. 2018-09-11 AJ

Low S und N
Recarburiser

PROCARB SG is a granular carbon for various applications.

Physical and technical properties

Raw material:	Waxy coke from coal to fuel processing	
Size gradings:	0.20 – 10.00 mm	
Bulk density:	0.85 – 0.95 g/cm ³	

Chemical composition

Weight (%):				Ash: < 2.50 Moisture: < 0.20 Volatiles: < 1.00
	Carbon	Sulphur	Nitrogen	

Application

Typical uses: Basic- and corrective **carburisation** of all iron- and steel alloys in electric furnaces. Suitable for the **carbon correction** of cupola furnace iron. Negligible sulphur and nitrogen pick up by the melt.

Key benefits:

High solubility

High carbon yield

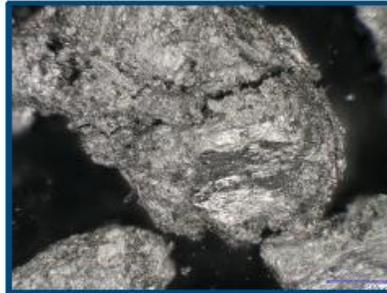
High chemical purity



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Visual examination via 3D-mikroskopy

E-Graphite



Procarb SG





The current value chain of Procarb SG

Sasol – James Durrans – SG Iron Foundry

Raw material:

Green Waxy Coke exclusively manufactured by...



..... one of the one of the world's largest energy groups, who specializes in liquifying of coal.....
..based on the...

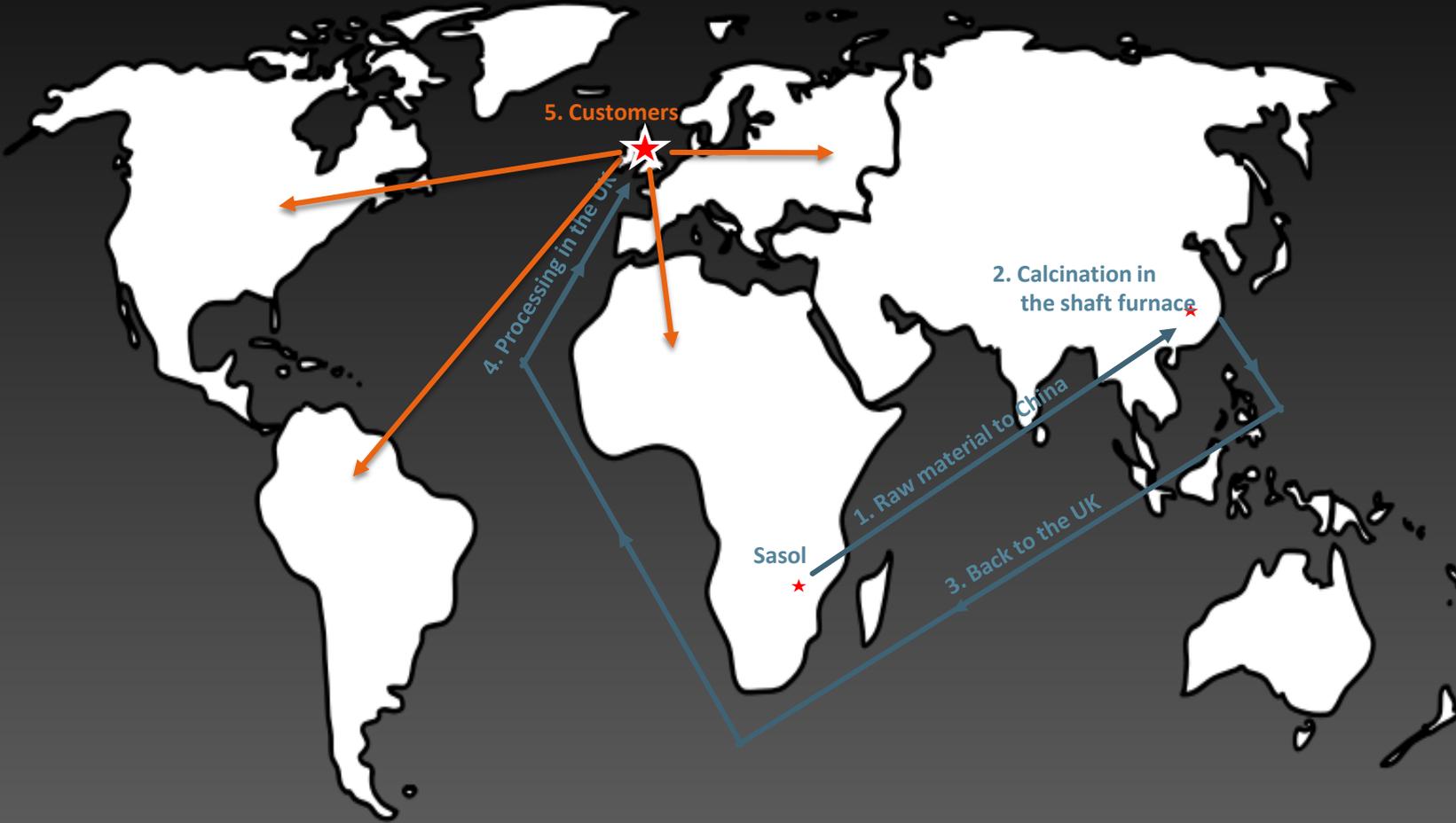
[Fischer-Tropsch-Synthesis](#)

.....Calcination of *Green waxy coke* by James Durrans -> **Procarb SG**

This new cooperation with Sasol enables James Durrans Group to offer our clients a completely new range of products with the backing of an established global energy company.

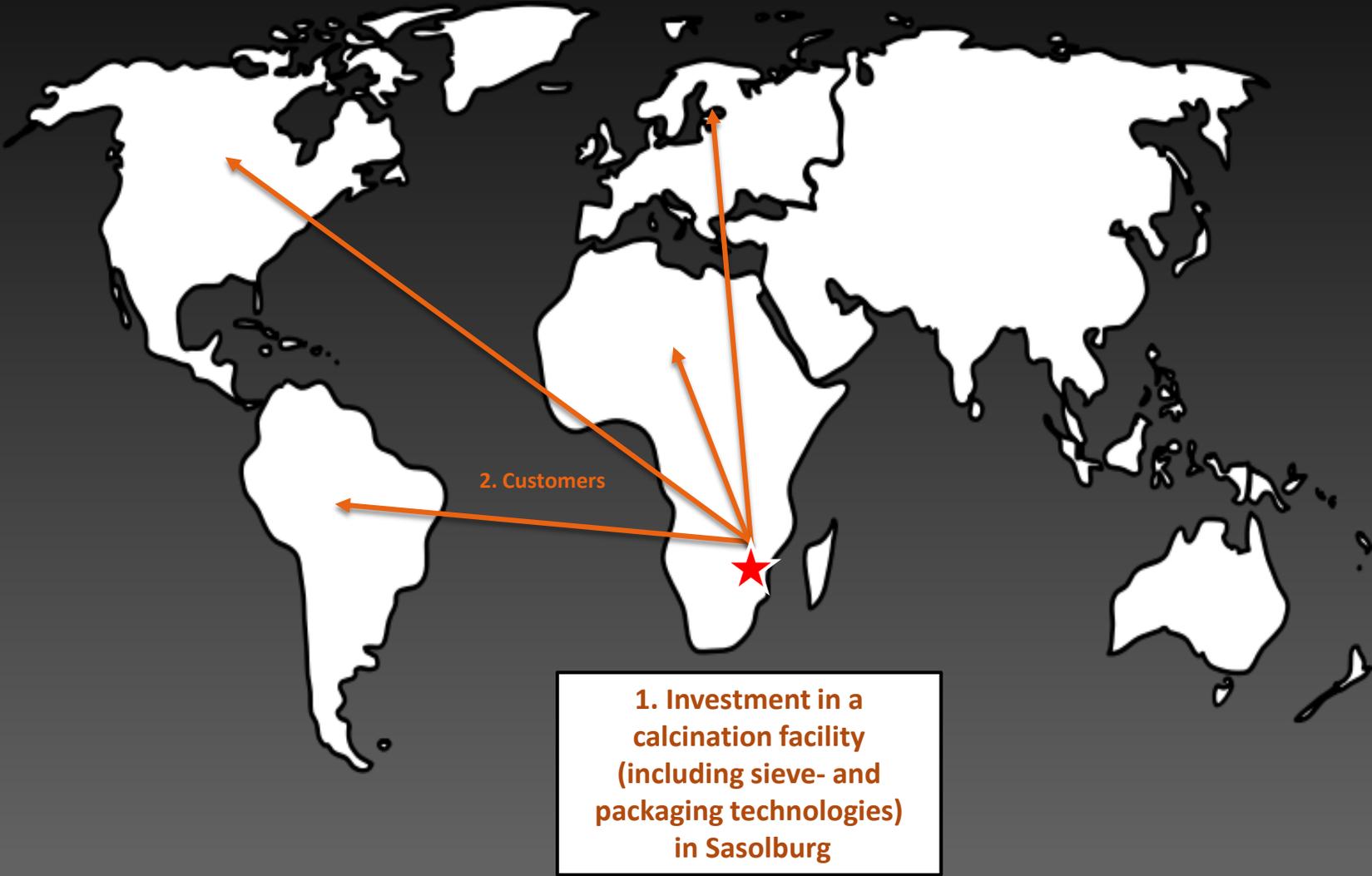


Current value chain of Procarb SG





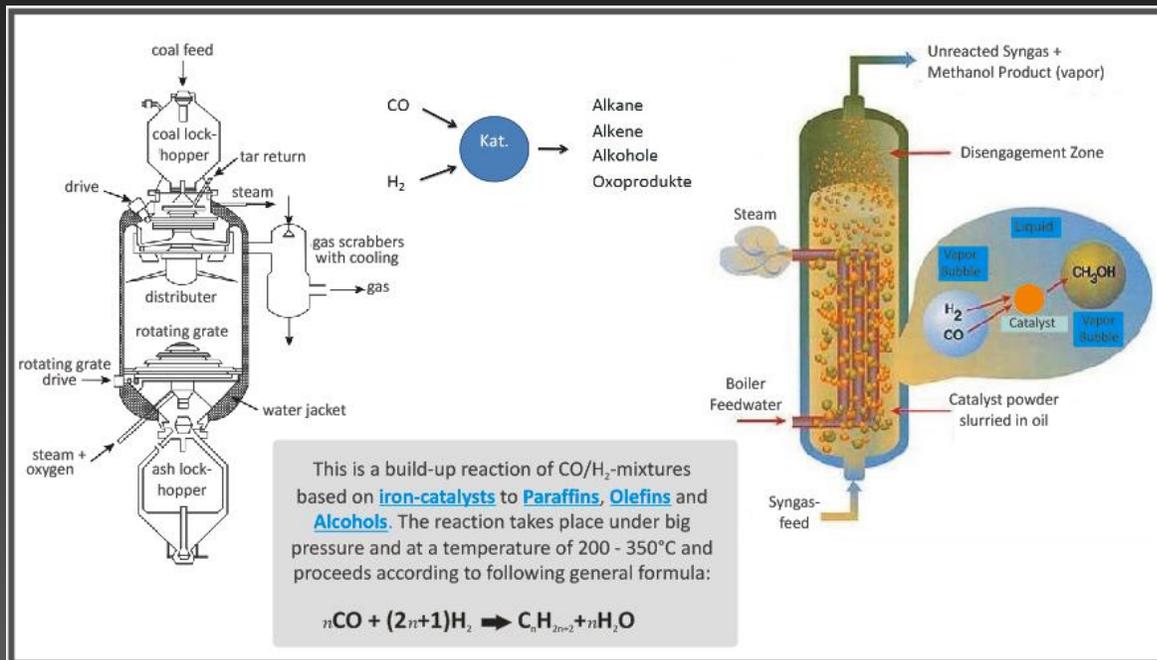
New value chain of Procarb SG, scheduled for the end of 2018





Procarb SG – Origin and production

The origin of **Procarb SG** lies on the Fischer–Tropsch–process, which is a collection of **chemical reactions**, that converts **coal** or **natural gas** through a mixture of **carbon monoxide** and **hydrogen** into **liquid hydrocarbons**.



During a further distillation step of the waxy oil, various waxy oil materials are to be collected, including the so-called Green Waxy Coke.

This Green Waxy Coke is then subject to a final calcination process to produce our **Procarb SG** product, which only needs to be screened and packed before use.



Sasolburg / South Africa – Construction of a calcination facility to produce Procarb SG







Procarb SG – environmental benefits

SG Iron foundries need reliable and consistent sources of low sulphur re-carburiser!

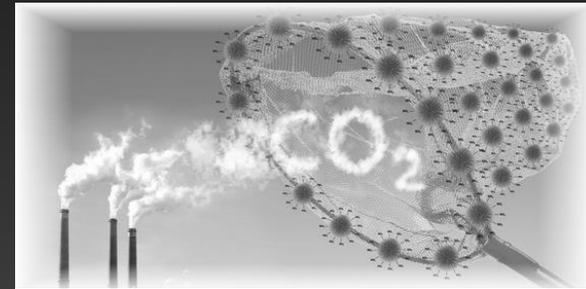
- To date the only real choice for a highly soluble and low S Carbon raiser was energy intensive graphitised petroleum coke (GPC)

Procarb SG provides a step change in technology as:

- It is a highly soluble ultra low sulphur carbon
- Its environmental impact is much lower than the GPC alternatives.

WHY?

- Typical GPC products are made from crude oils with sulphur contents of 4%
- Procarb SG is manufactured from the already low in sulphur 'waxy coke' material
- Unlike GPC, there is no need to be electro-thermally heat waxy coke $> 2.000^{\circ}\text{C}$ to volatilise off the entrapped Sulphur
- Removing this production step reduces the overall energy consumption, typically 0.5 vs 2.5 MWh/t, representing an 80% improvement!



This dramatic improvement reduces the foundries environmental foot print whilst enabling them to still utilise the highly soluble and ultra low sulphur materials critical in the production of SG Iron.



Procarb SG – environmental benefits

This means the production of ProCarb SG:

- reduces the CO₂ - emissions compared to producing GPC by approximately 95%
- No emissions of SO₂
- No demand of electricity for the heating

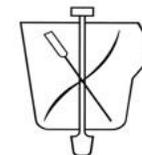
Another step forward on the way to a „green“ foundry!





TECHNISCHE UNIVERSITÄT
BERGAKADEMIE FREIBERG

Die Ressourcenuniversität. Seit 1765.



Project: Comparison of Carbon Raisers (Part 2)

Requested by: James Durrans GmbH



www.gi.tu-freiberg.de

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www.gi.tu-freiberg.de | Dr. Claudia Dommaschk

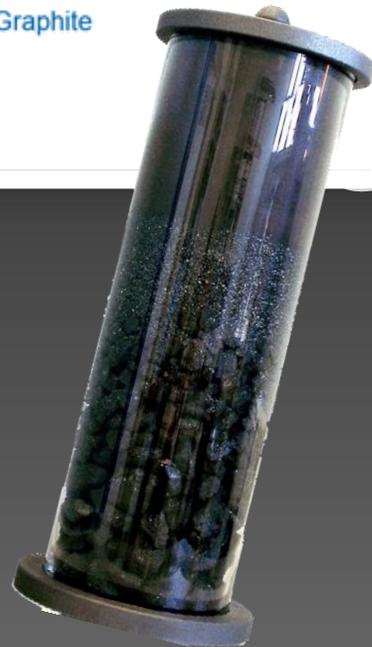


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Analysis of the charge make-up components

	% C	% Si	% Mn	% P	% S
Steel scrap	0.115	0.404	1.63	0.0150	0.0051
Armco-Iron	0.0027	< 0.0015	0.032	0.0055	0.0067

- Recarburisation with Procarb SG resp. E-Graphite
- Si with FeSi75
- Inoculation with 0.3% FeSi75



Base Iron Carbon Content %C

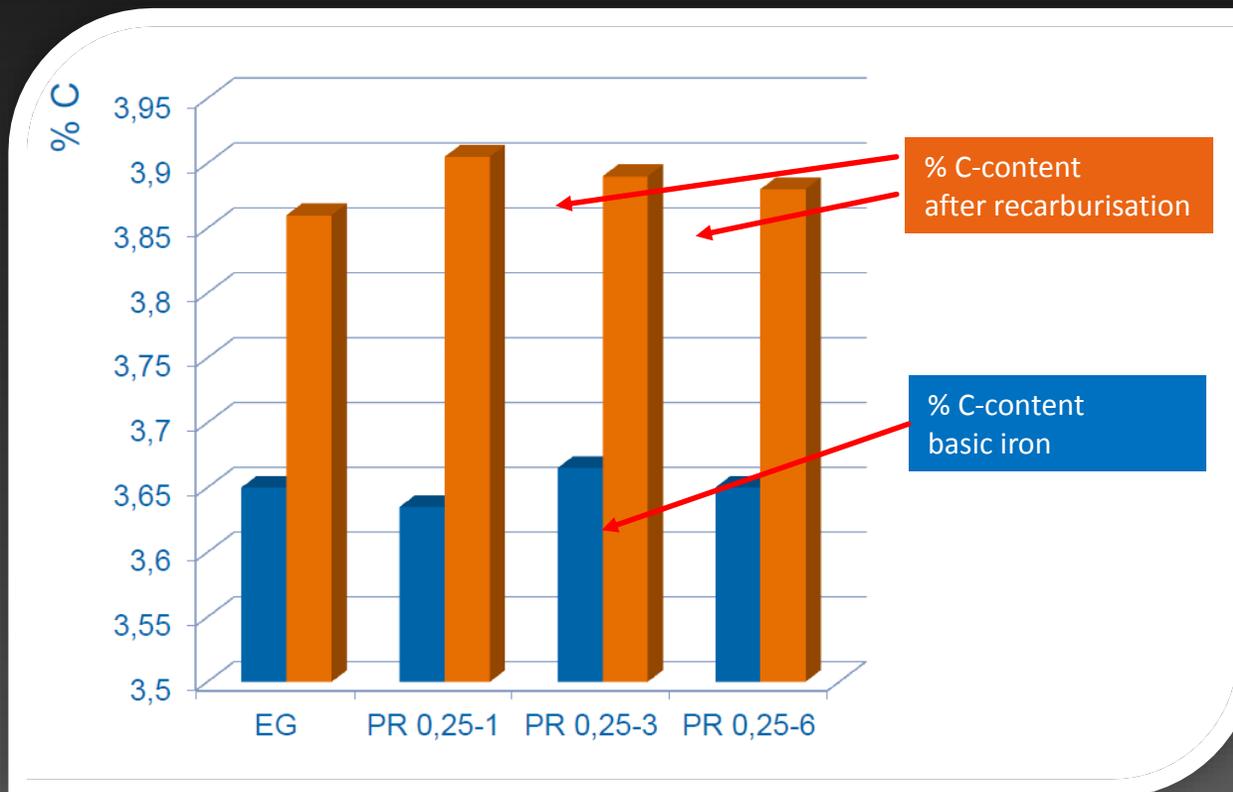
	GJL-200 100 % scrap	GJL-200 100 % Armco	GJL-200 50 % return scrap 50 % scrap	GJS / Rep. 100 % Armco
E-Graphite	3.45% C	3.49% C	3.54% C	3.65 / 3.65% C
<u>Procarb SG</u>	3.38% C	3.45% C	3.47% C	3.62% C

Base Iron Sulphur Content %S

	GJL-200 100 % scrap	GJL-200 100 % Armco	GJL-200 50 % return scrap 50 % scrap	GJS / Rep. 100 % Armco
E-Graphite	0.0052% S	0.0110% S	0.0190% S	0.0073 / 0.0068% S
<u>Procarb SG</u>	0.0062% S	0.0065% S	0.0073% S	0.0073% S



Comparison of Carbon recovery: Final Trim Addition of pure Electrode Graphite vs. **Procarb SG**



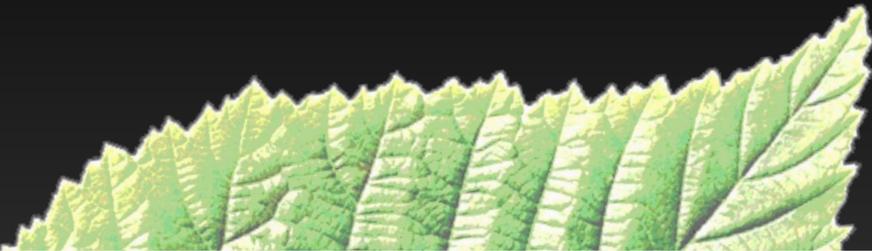


Comparison of Carbon recovery: Final Trim Addition of pure Electrode Graphite vs Procarb SG

	Prior to recarburation C [%] Spectro	After recarburation C [%] Spectro	Prior to recarburation C [%] Leco	After recarburation C [%] Leco
1 E-Graphite	3,65	3.86	3.65	3.86
2 Procarb SG (0.25 – 1.00 mm)	(3.83)	3.87	3.635	3.905
3 Procarb SG (0.25 – 3.00 mm)	3.70	3.90	3.665	3.89
4 Procarb SG (0.25 – 6.00 mm)	3.64	3.90	3.65	3.88



Procarb SG and its benefits



Demand for a low-sulphur Recarburiser (i.e. 500t)

	Procarb SG	GPC	Note
So2 emission - t	0	approx. 50	With an unsuitable desulphurisation, SO precipitates as acid rain
Co2 Emission - t	approx.38	approx.1341	
Electricity Consumption MWh	0	approx.1300	approx. 2,6 MWh/t for the electro-thermal heating



The raw material, a so-called „Green Waxy Coke“, is based on sulphur-free hard coal and offers even without the energy consuming graphitising-process, a very low sulphur content of 0.03%.

That means for the production of ProCarb SG :

- Only about 3% of CO2-emission compared to conventional GPC
- no emission of SO2
- No energy needs for the graphitising-process

Due to the porous structure, Procarb SG has an excellent solubility, too, which is comparable to a crystalline carbon.



Myth max. 0,05% Sulphur and Nitrogen into the Recarburiser for SGI

Rule of thumb:

The more returns the caster can do, the more sulphur may be into the Recarburiser!

With 50% returns and a Recarburiser containing 0.15% sulphur, you will achieve a calculated value of 0.011% sulphur.

SGI-Charge with 0.15% S into the Recarb	Percentage	C-content in %	S-content in %
Steel scrap	23.50%	0.10	0.100
Returns	50.00%	3.80	0.008
Pig iron	23.50%	4.20	0.015
FeSi	1.19%	0.00	0.000
SiC 70	0.47%	27.00	0.100
Recarburiser	0.80%	98.5	0.150
Total	99%	3.8254	0.11

0,011%



Myth max. 0,05% Sulphur and Nitrogen into the Recarburiser for SGI

Also with a 3/3 charge, a sulphur content of 0.15% is still not critical.

Here another Recarburiser with 0.15% sulphur content and an addition of about 1%.
The calculated sulphur value into the basic iron lays at 0.012% and thus meets all the requirements given by the literature.

SGI-Charge with 0.15% S into the Recarb	Percentage	C-content in %	S-content in %
Steel scrap	31.00%	0.10	0.100
Returns	35.00%	3.80	0.008
Pig iron	31.00%	4.20	0.015
FeSi	1.19%	0.00	0.000
SiC 70	0.47%	27.00	0.100
Recarburiser	1.04%	98.50	0.150
Total	100%	3.81	0.12

0,012%



Myth max. 0,05% Sulphur and Nitrogen into the Recarburiser for SGI

Thesis:

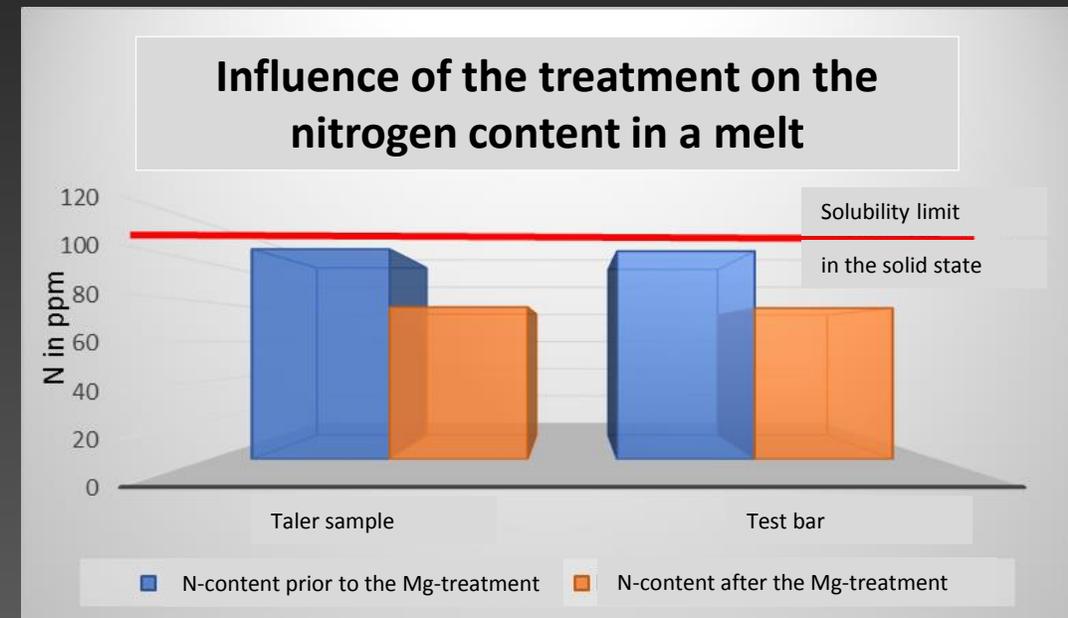
An increased Nitrogen content into a SGI-melt, prior to the Mg-treatment, isn't critical as this leads to a denitrification.

Trial:

In cooperation with the Technical University Freiberg a melt (SGI 400) was produced by adding of a good 100 ppm Nitrogen. The N-content was evaluated before and after the Mg-treatment. Taler samples and test bars were used for that trial.

Result:

Through the Mg-treatment, a significant reduction of the N-content can be caused.





We welcome you to contact us, if any questions or concerns come up!

Your Durrans-Team