DANIELI
DIGITAL
ANSWERS
ENGAGE ACCELERATE ACHIEVE

Enrico
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DANIELI
AUTOMATION

SUSTAINABLE DANIELI DIGIMELTER TECHNOLOGY FEATURING Q-ONE FOR LOWER POWER AND ELECTRODE CONSUMPTION, AND

INDEX

Q-ONE DIGITAL ARC CONTROL

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ENGAGE. ACCELERATE. ACHIEVE.

CHALLENGES

FOR GREEN STEELMAKING

The decarbonization path will increase the use of EAF for steelmaking
with Challenges:

FLEXIBILITY IN OPERATION

FLEXIBLE OPERATION, depending on the available charge and the cost of energy.
Possible increase of power IN PHASES.
IMPROVE ARC BEHAVIOUR on different charge

LOW DEPENDANCE FROM ELECTRIC NETWORK

Operation with WEAK ELECTRIC GRID.
HYBRID FEEDING, using also renewable sources.

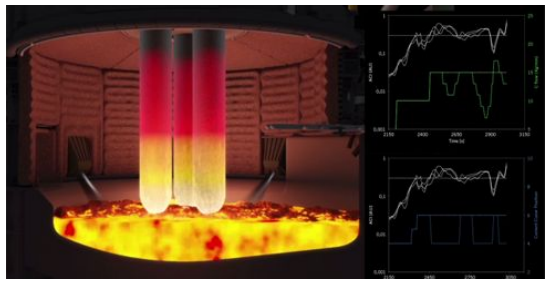
REDUCE CONSUMPTION

MINIMIZE ELECTRIC CONSUMPTION
REDUCE ELECTRODE CONSUMPTION.
MINIMIZE REFRACTORY USE.

Q-ONE SYSTEM

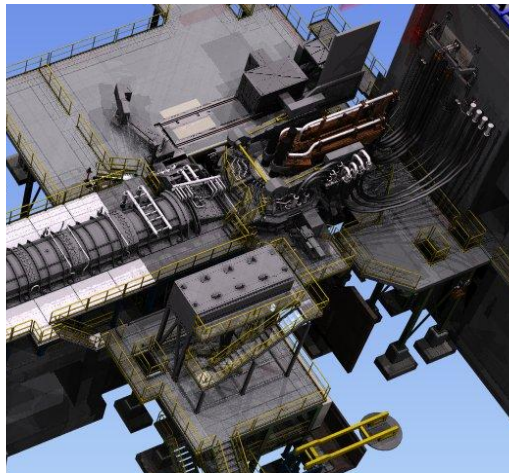
TECHNICAL SOLUTION

DANIELI DIGIMELTER



INTELLIGENCE

POWER



EQUIPMENT

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QONE

Q-ONE IS DANIELI AUTOMATION'S DESIGNED AND PATENTED EQUIPMENT USING LATEST POWER ELECTRONICS TECHNOLOGY TO CONTROL ARC CURRENT AND VOLTAGE IN A MORE FLEXIBLE AND RELIABLE WAY

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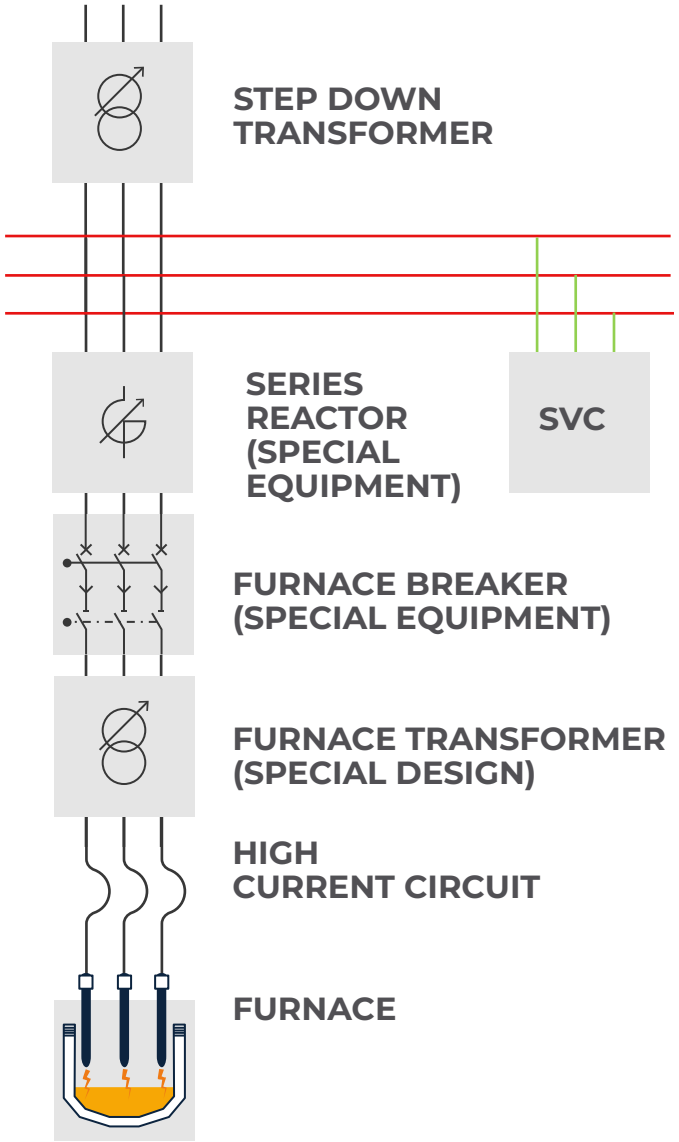
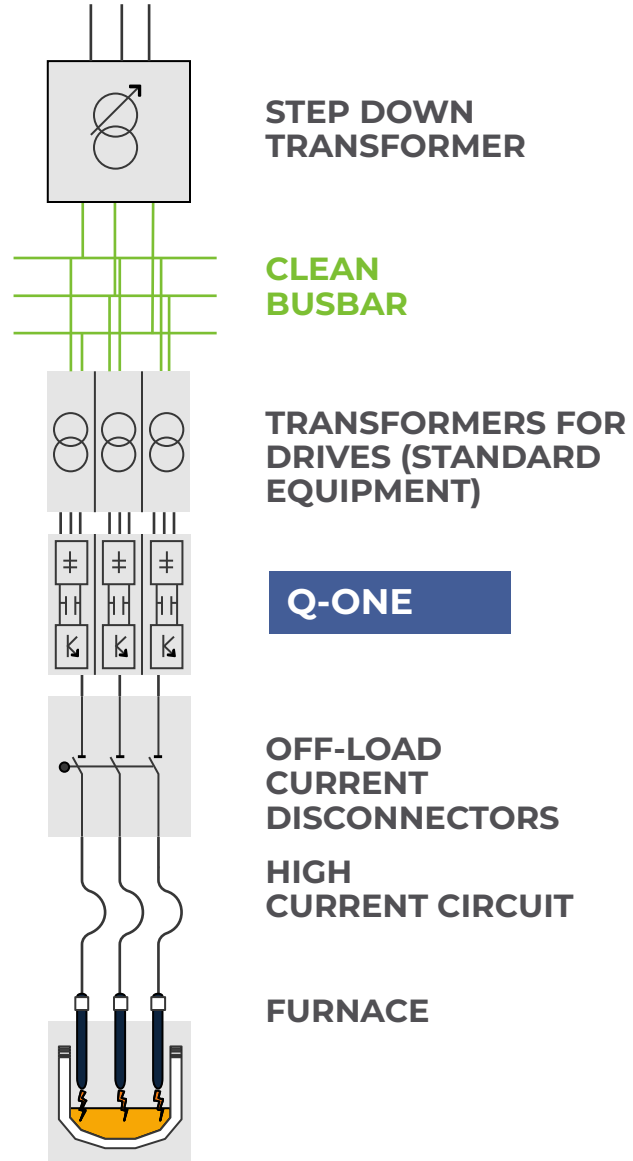
Q-ONE
DIFFERENCES WITH TRADITIONAL SOLUTION

AC FURNACE STANDARD SOLUTION



Q-ONE BASED INNOVATIVE SOLUTION



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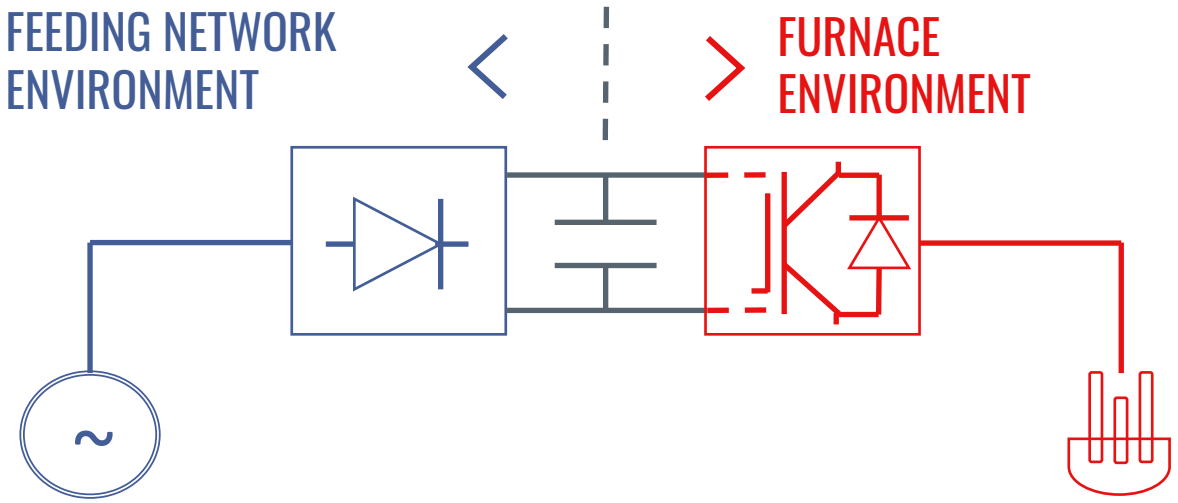
Q-ONE
NETWORK IMPACT



VERY LOW FLICKER	• REAL TIME CONTROL OF ARC CURRENT • NO NEED OF SVC
POWER FACTOR > 0,96	• ALL CONDITIONS, ALL FREQUENCIES
THD < 1%	• 18 PULSES CONVERTER

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No longer needed

SERIES REACTOR
>SPACE IN SUBSTATION
>MAINTENANCE

FURNACE TRANSFORMER
>SPECIAL COMPONENT
>MAINTENANCE

SVC
>CAPITAL INVESTMENT
>SPACE IN SUBSTATION
>MAINTENANCE

FURNACE BREAKER
>SPECIAL COMPONENT
>PERIODIC MAINTENANCE

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Q-ONE MODULES

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Q-ONE
SUMMARY OF BENEFITS

Q-ONE FEATURES		BENEFITS
POWER FACTOR	HIGH (0.97)	> NO SVC > Higher ACTIVE POWER AVAILABLE for the melting process
CONTROL CYCLE	500 µsec	> Extremely stable power level □ FASTER MELTING > More stable current □ LOWER ELECTRODE CONSUMPTION
OPERATING FREQUENCY	20 Hz - 70 Hz	> Higher frequency during boring for higher ARC STABILITY > Lower frequency with flat bath for BETTER YIELD
POWER CONTROL	PHASE-BY-PHASE	> Possibility of ASYMMETRIC POWER levels to the phases > CONTROL OF COLD SPOTS (e.g. continuous charge)
MAX POWER	EXTENSIBLE	> MODULAR SOLUTION also IN PHASES > SCALABLE from 10 MW to 250MW

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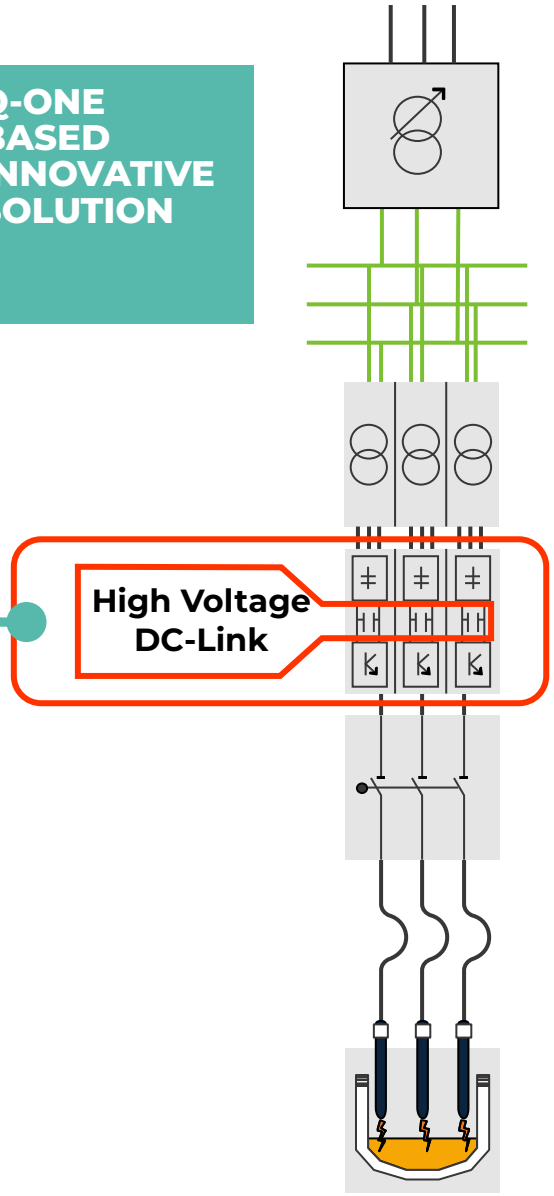
Q-ONE
HYBRID FEEDING

Q-ONE BASED INNOVATIVE SOLUTION



STEP DOWN TRANSFORMER

CLEAN BUSBAR

TRANSFORMERS FOR DRIVES (STANDARD EQUIPMENT)

Q-ONE

OFF-LOAD CURRENT DISCONNECTORS

HIGH CURRENT CIRCUIT

FURNACE

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Q-ONE SYSTEM

REFERENCES and FACTS

21 REFERENCES WORLDWIDE (USA, JAPAN, EUROPE, CANADA, BANGLADESH)

REFERENCE PLANTS POWER UP TO 150MW arc power (design up to 288 MVA)

6 references already in operation,
3 references to be commissioned in the next 3 months

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REFERENCES WORLDWIDE - ALGOMA

ALGOMA STEEL INC. DANIELI

TRANSITION FROM BF TO EAF

VERY WEAK NETWORK

Algoma Steel Selects Danieli as Technology Provider for New Electric Arc Steelmaking Facility

December 02, 2021 07:30 ET | Source: Algoma Steel Inc

SAULT STE. MARIE, Ontario, Dec. 02, 2021 (GLOBE NEWSWIRE) -- Algoma Steel Group Inc. (NASDAQ: ASTL; TSX: ASTL) ("Algoma" or "the Company"), a leading Canadian producer of hot and cold rolled steel sheet and plate products, today announced that it has selected Danieli & C. Officine Meccaniche S.p.A ("Danieli") as the sole technology provider for their new electric arc (EAF) steelmaking facility.

After a rigorous review of world class suppliers, Danieli's proven AC-Digimelter technology powered by Q-One digital power systems was determined to be the best choice for Algoma's needs as it transitions away from basic oxygen steelmaking. The transformation is expected to reduce Algoma's carbon emissions by approximately 70%, positioning Algoma as one of North America's leading providers of green steel.

The new green steel shop will have a design capacity of 3.7 million tons of liquid steel with two 250-ton electric arc furnaces at its core, powered by two Q-One digital power systems with a rated capacity in excess of 190 MVA each. Q-One is a patented technology capable of continuously varying the frequency during each of the melting phases, improving energy efficiency and electrode consumption.

The new EAF will be designed to produce high quality liquid steel from recycled steel scrap, with the option for the direct addition of a wide range of other iron inputs. The new technology is optimized for process quality, low operating costs, and enhanced safety through the extensive application of mechatronic technologies. The design also provides for best-in-class environmental performance with engineered enclosures encapsulating the two furnaces to minimize noise and emissions, and the Q-Melt automatic process control delivering superior energy efficiency. Two new off-gas treatment plants including baghouses, and a dedicated recirculating water treatment plant will combine to provide the leading technology for emission control and filtration, and water conservation.

Rounding out the package, the facility design includes an automated scrap yard featuring automatic cranes, scrap visual recognition, and automatic scrap sorting and charging. A new Danieli Twin-Tank Vacuum Degasser with an oxygen blowing facility will also be added to the process route to deliver advanced grades of steel and further enhance steel cleanliness and final product quality.

The new electric arc facility is expected to begin operations in early 2024.

About Algoma Steel Group Inc.

Based in Sault Ste. Marie, Ontario, Canada, Algoma is a fully integrated producer of hot and cold rolled steel products including sheet and plate. With a current raw steel production capacity of an estimated 2.8 million tons per year, Algoma's size and diverse capabilities enable it to deliver responsive, customer-driven product solutions straight from the ladle to direct applications in the automotive, construction, energy, defense, and manufacturing sectors. Algoma is a key supplier of steel products to customers in Canada and Midwest USA and is the only producer of plate steel products in Canada. The Company's mill is one of the lowest cost producers of hot rolled sheet steel (HRC) in

After a rigorous review of world class suppliers, Danieli's proven AC Digimelter technology powered by Q-ONE digital power systems was determined to be the best choice for Algoma's needs as it transitions away from basic oxygen steelmaking.

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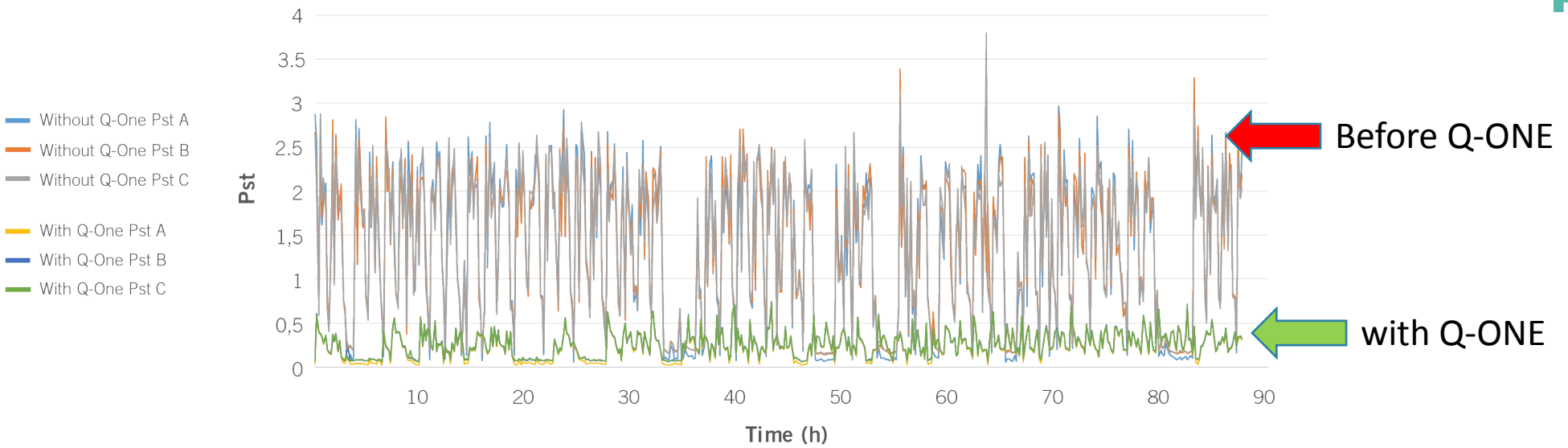
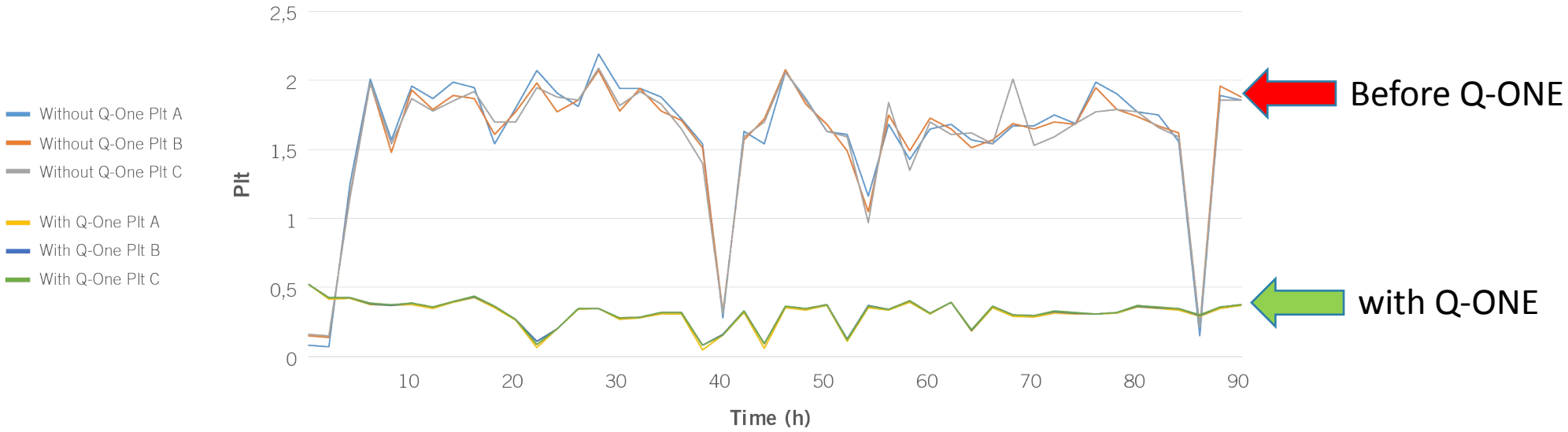
ABS SISAK Q-ONE FLICKER





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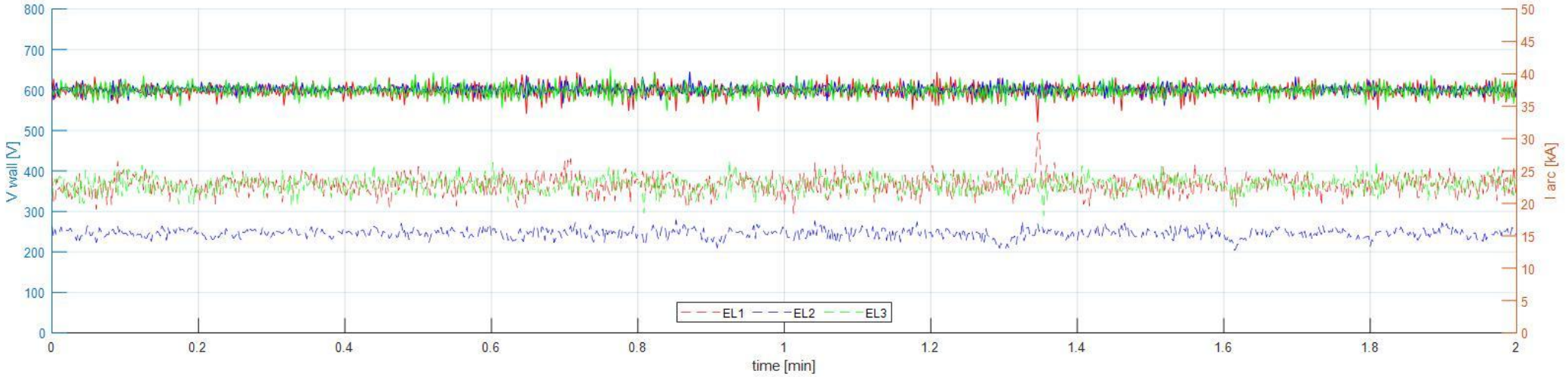
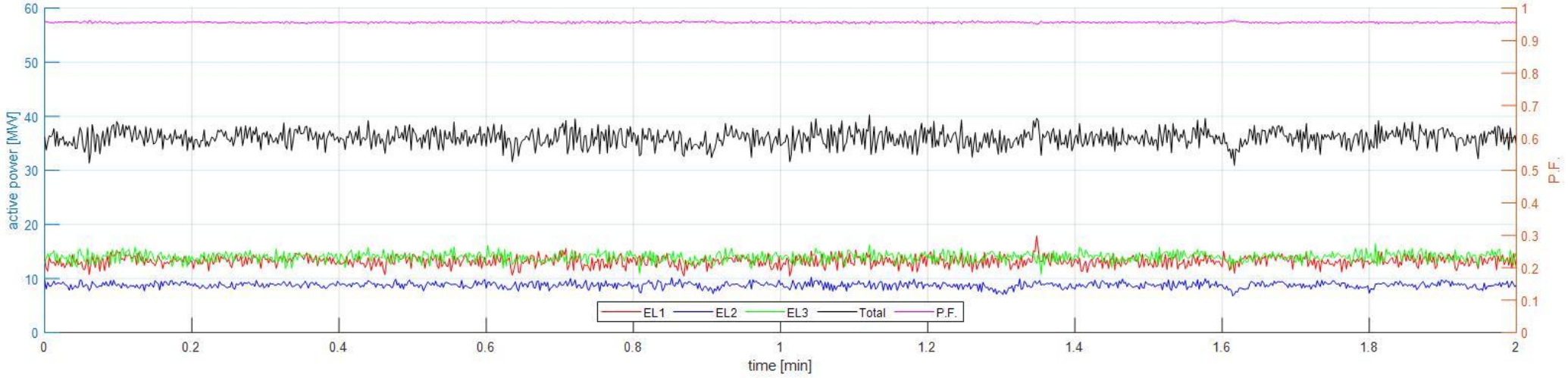
ABS SISAK Q-ONE
UNBALANCED SYSTEM





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ABS SISAK Q-ONE
SUMMARY OF PERFORMANCES

Performance period: 01.MAR.2021 – 07.MAR.2021 – Nr. Heats: 78 (3BCK - 40 Hz)

	BEFORE	Q-ONE	DELTA	DELTA%	NOTE
Electrode consumption (kg/tls)	2.63	2,18	0,45	-18%	Data collected on May 2021 (on March Miss El. Wgt)
Power on time (min)	70	50.54	-19.46	-27%	Actual trials in December showed that with 60 Hz the P-on can be decrease by a further 5%
TtT (min)	106	88.01	-17.99	-17%	
Flicker Pst 95%	2.52	0,45 -0,68	-2.07 -1.84	-560% -377%	Measured on 04/2021 @ 110kV, Short Circuit Current from 12,3kA (contractual) to 5,552kA (real value, due to fault in 220/110kV Network)
Energy consumption (kWh/tls)	444	421	-23	-5,1%	**TARGET: 400 kWh/tls (with 3-buckets)** *(with a tapping temperature of 1666°C as per their usual practice)*
P_{MV} (MW)	24.4	34.79	+10.39	+42%	Average Active Power at Medium Voltage
Productivity (t/h)	37.2	46.12	+8.92	+24%	

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Q-ONE IN ACTION – BORING STAGE FROM CONTROL ROOM

Q-ONE IN ACTION – BORING STAGE FROM SHOP FLOOR

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Q-ONE IN ACTION – REFINING STAGE WITH FREQUENCY CHANGE

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Q-ONE LRF TOKYO STEEL - ELECTRICAL ENERGY SAVINGS

TOKYO STEEL MANUFACTURING CO.,LTD.

Summary table before, after Q-One comparison from Tokyo steel analysis

PERIOD []	Delta T (Last temp. measured – First temp. measured) [°C]	Electrical Energy consuption [kWh/ton]	Electrical energy saving [%]
Before Q-One	40	30.37	
After Q-One 60 Hz	40	28.91	-4.8 %
After Q-One 40 Hz	40	26.84	-11.6 %
After Q-One 30 Hz	40	26.05	-14.0 %

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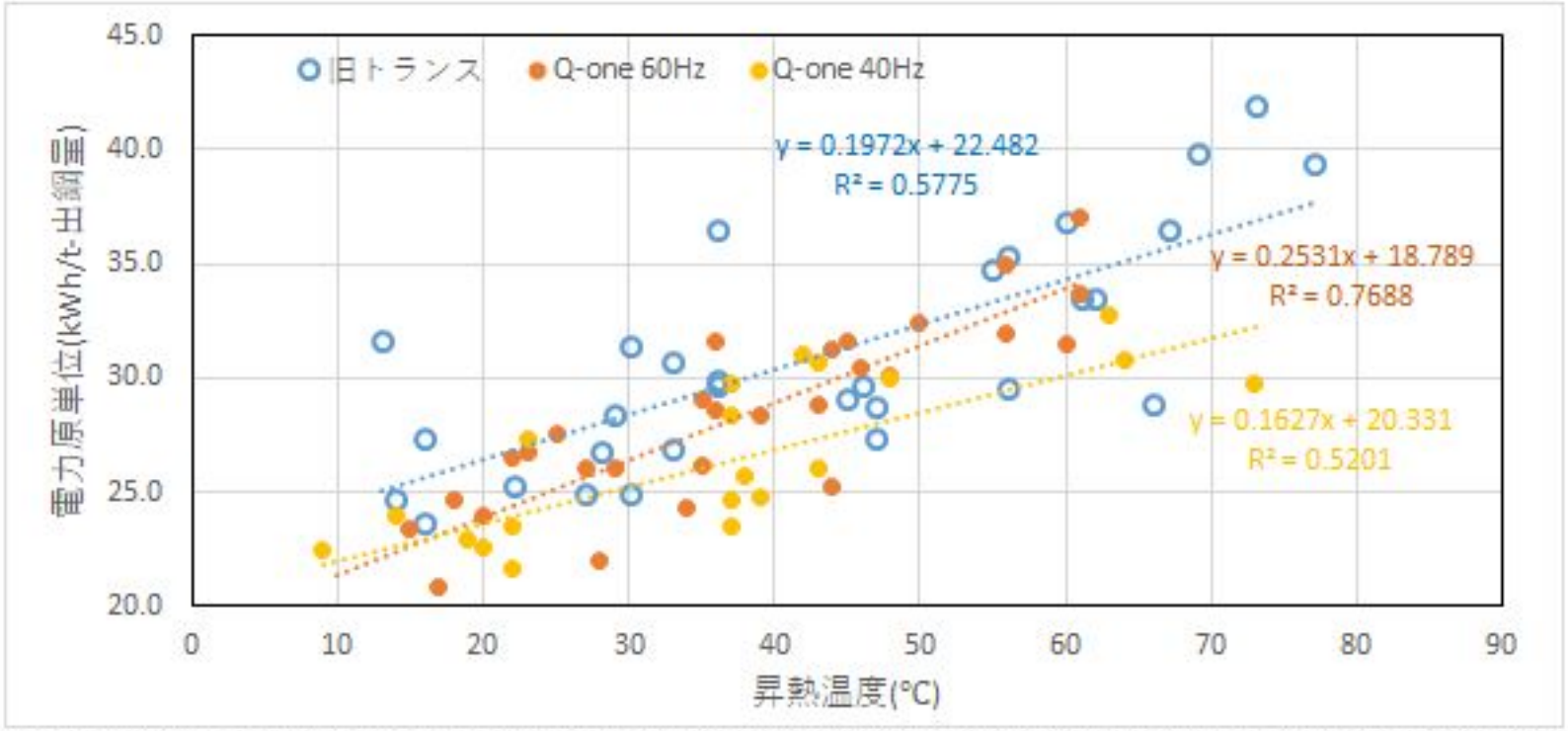
ELECTRICAL ENERGY CONSUMPTION – TRENDS FROM TOKYO STEEL ANALYSIS



9/3夜勤からLFの周波数を40Hzにすることで良好な電力原単位が期待される結果となりました
40Hzでの操業を継続します。

昇熱温度40℃の時、既	30.37			
Q-one 60Hz	28.91	差異	-1.457	-4.8%
Q-one 50Hz		差異		
Q-one 40Hz	26.84	差異	-3.531	-11.6%

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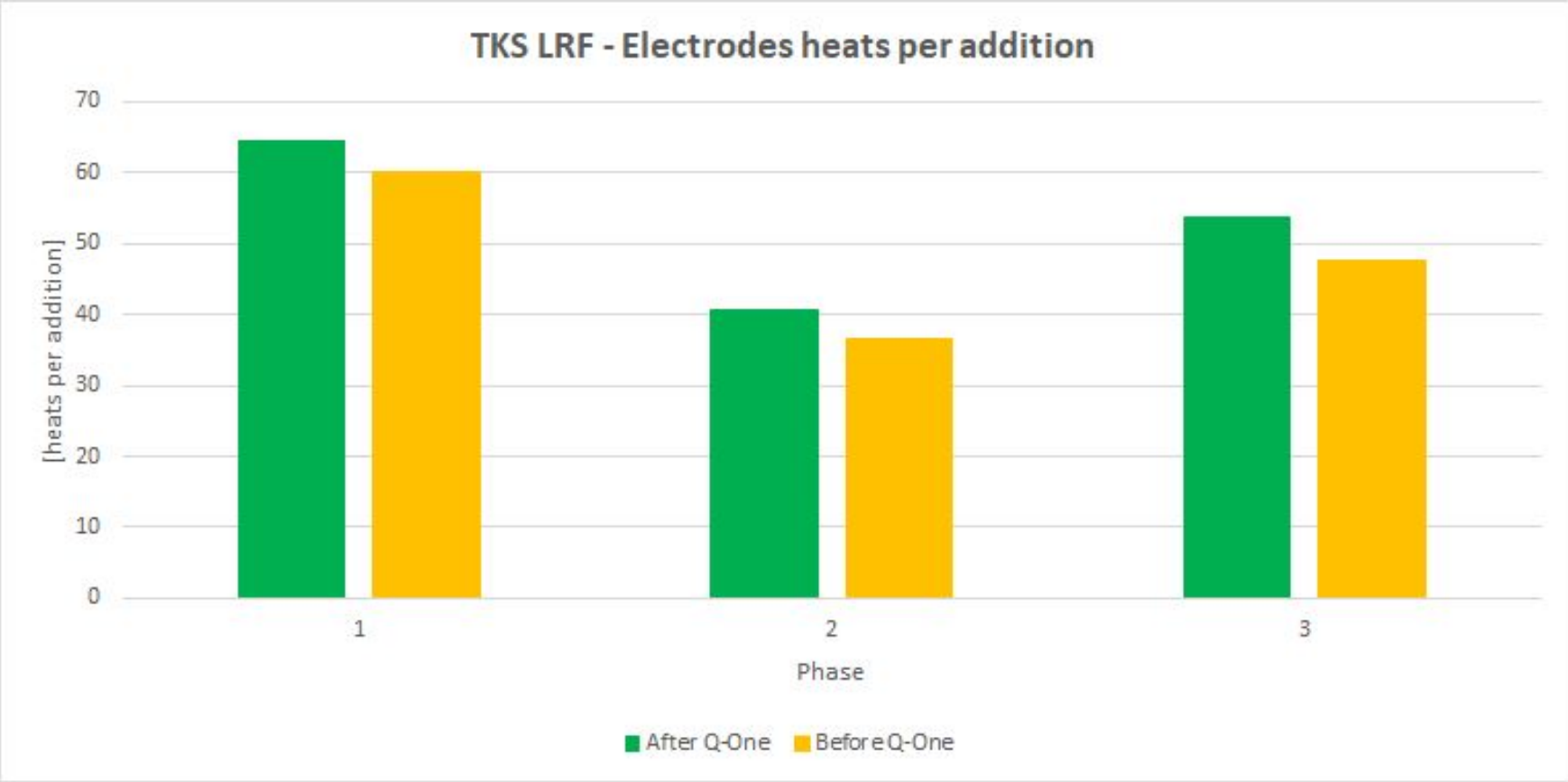
Q-ONE LRF TOKYO STEEL - ELECTRODES CONSUMPTION

Electrodes consumption comparing Q-One at 40 Hz results with Before Q-One (July 2021).



After Q-One at 40 Hz, saving in kWh/ton is equal to 7.1%; espressed in g/kWh saving is 5.1%. Consumption is 0.20 kg/ton and 5.66 g/kWh.

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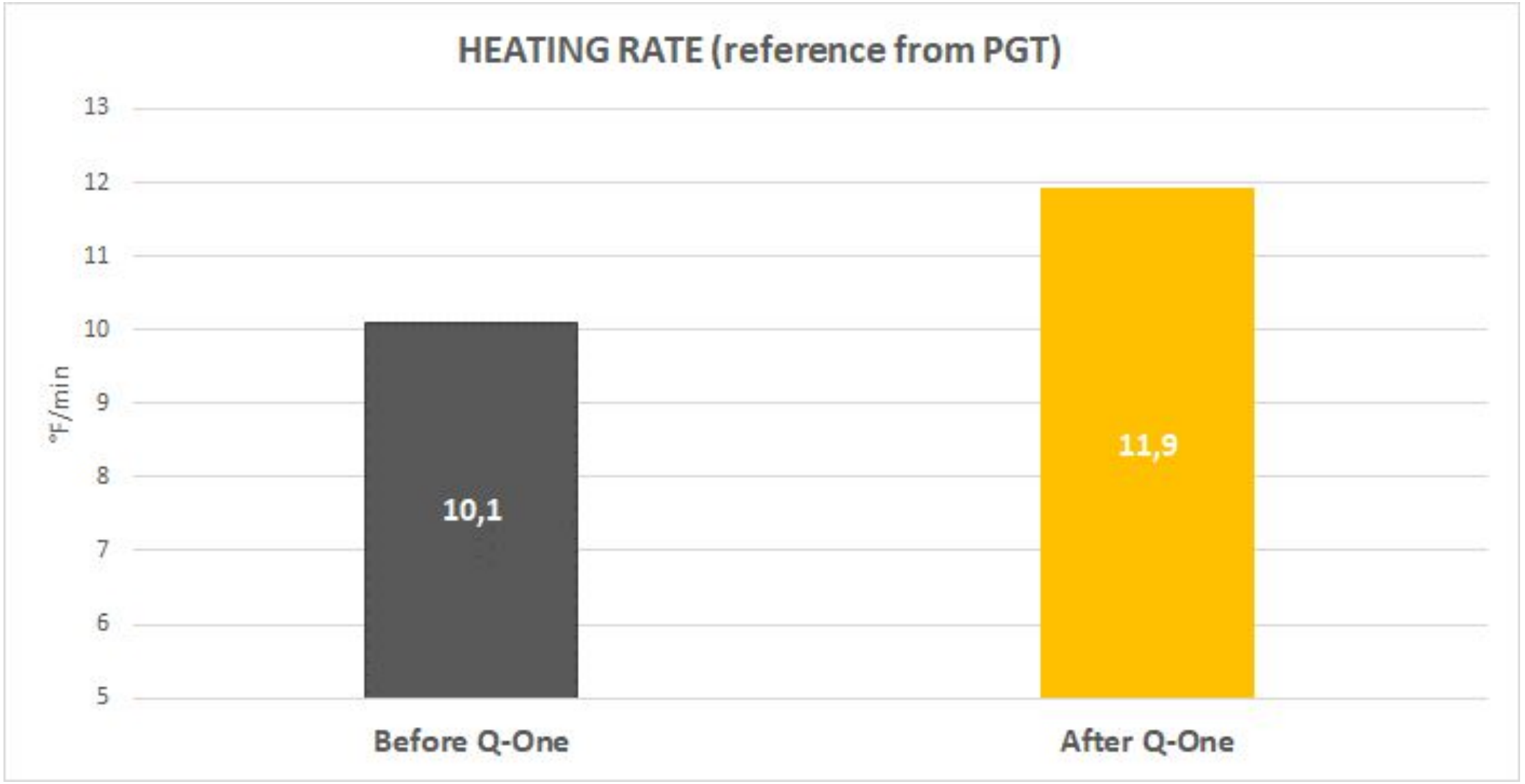
REFERENCE LRF– HEATING RATE



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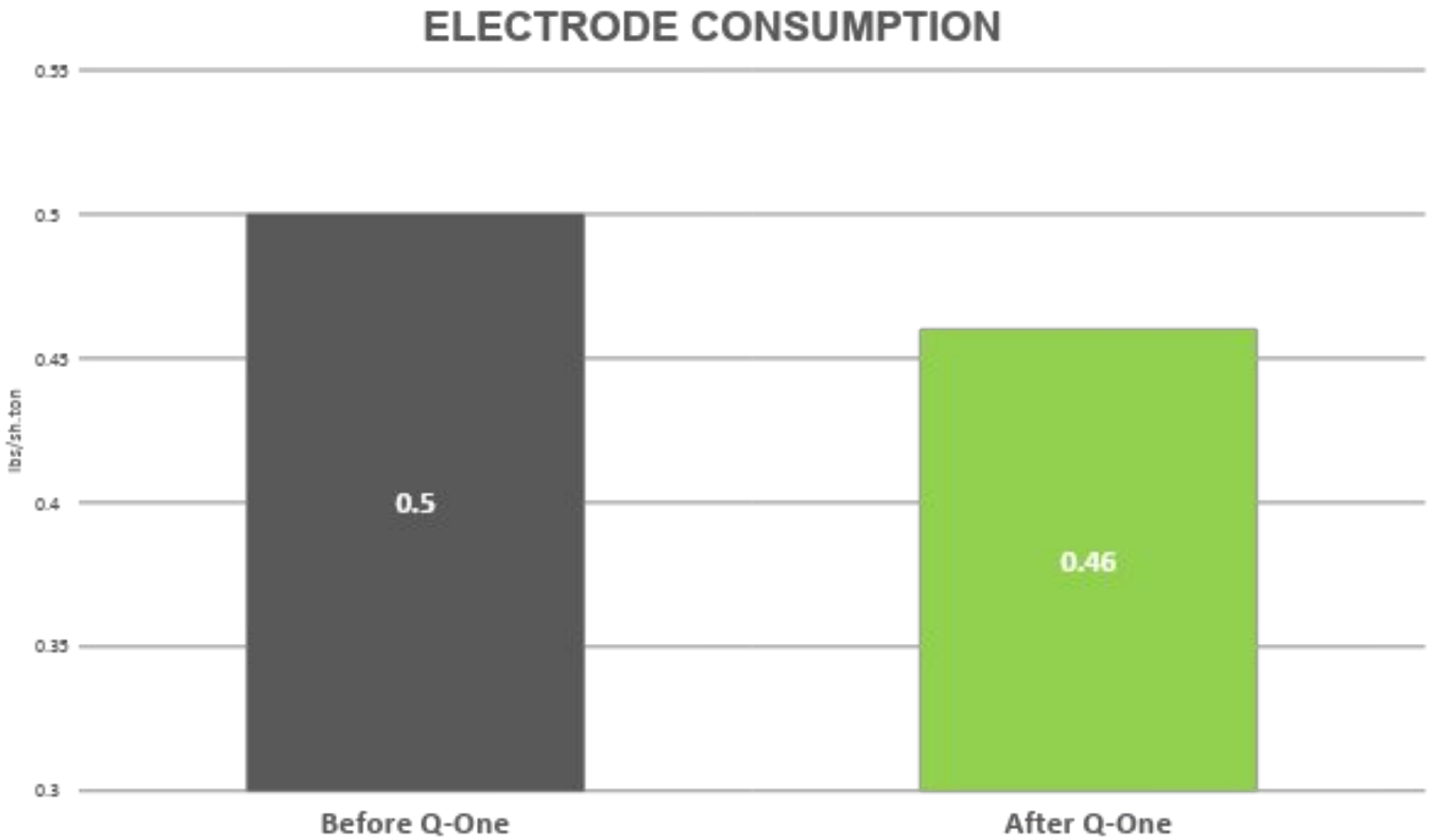
REFERENCE LRF – ELECTRODE CONSUMPTION



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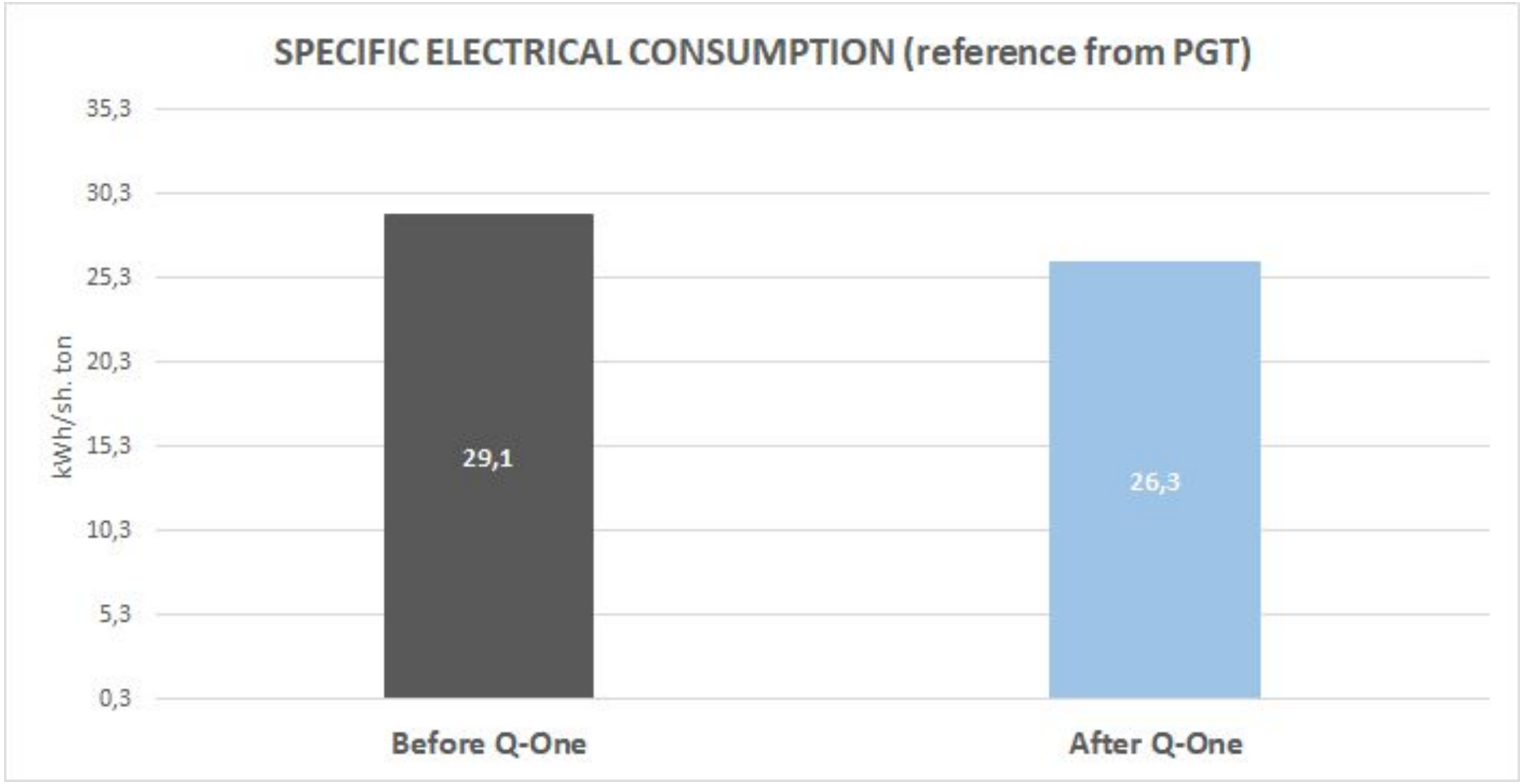
REFERENCE LRF –ELECTRICAL CONSUMPTION



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Q-ONE SYSTEM

CONCLUSIONS

CHALLENGES FOR A GREEN STEELMAKING – Q-ONE RESULTS

FLEXIBILITY IN OPERATION

PHASE BY PHASE POWER CONTROL, TO **UNBALANCE ARC** DISTRIBUTION (FOR HOT/COLD SPOTS)
POSSIBILITY TO **CHANGE FREQUENCY**, WITH IMPROVED PROCESS CONTROL
MODULAR DESIGN FOR **EASY MAINTENANCE** AND FURNACE OPERATIVITY

LOW DEPENDANCE FROM ELECTRIC NETWORK

NO NEED OF ADDITIONAL SVC
HYBRID FEEDING, WITH CONTROLLED USE OF RENEWABLE ENERGY SOURCES (SOLAR, WIND)
STABLE ARC IN ALL CONDITIONS

REDUCE CONSUMPTION

REDUCED **ELECTRICAL ENERGY** CONSUMPTION (5-14%)
REDUCED **ELECTRODE CONSUMPTION** (5-15%)
LESS **REFRACTORY** CONSUMPTION (15-20%)
SHORTER **POWER ON** TIME (10-20%)

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Q-ONE
IS A PATENTED AND UNIQUE TECHNOLOGY,
A GAME CHANGER IN ARC FURNACES
THANKS TO REDUCED IMPACT ON NETWORK AND OPTIMIZATION ON OPEX

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