LARGE ELECTRIC FURNACES & SUPERBOOSTING. IS THIS THE FUTURE FOR CO_2 REDUCTION?

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17TH CONFERENCE ON ELECTRIC MELTING OF GLASS

PRAGUE, CZECHIA 10TH SEPTEMBER 2019

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OUTLINE/CONTENT

THE FUTURE OF THE GLASS INDUSTRY

BY 2030 THE EU REQUIRES A 40% REDUCTION IN CO_2 compared to 1990

Most of G7+1 group of nations agree!!

(there is one notable exception!)

THE FUTURE OF THE GLASS INDUSTRY

AND

BY 2050 – 80% REDUCTION c.f 1990

Most of G7+1 group of nations agree

British Glass has produced a Roadmap

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IPCC SPECIAL REPORT ON GLOBAL WARMING.

‘THE REPORT HIGHLIGHTS A NUMBER CLIMATE CHANGE IMPACTS THAT COULD BE AVOIDED BY LIMITING GLOBAL WARMING TO BELOW 1.5°C’ !!!

IPCC SPECIAL REPORT ON GLOBAL WARMING.

‘LIMITING GLOBAL WARMING TO 1.5°C WILL REQUIRE RAPID, FAR REACHING AND UNPRECEDENTED CHANGES’ !!!

IPCC SPECIAL REPORT ON GLOBAL WARMING.

‘LIMITING GLOBAL WARMING TO 1.5°C, COULD ENSURE A MORE SUSTAINABLE AND EQUITABLE SOCIETY’ !!!

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IPCC SPECIAL REPORT ON GLOBAL WARMING.

‘GLOBAL NET HUMAN-CAUSED

EMISSIONS OF CO_2 WOULD NEED TO

FALL BY ABOUT 45% FROM 2010 LEVELS

BY 2030’ !!!

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IPCC SPECIAL REPORT ON GLOBAL WARMING.

‘LIMITING WARMING TO 1.5 °C IS POSSIBLE WITHIN THE LAWS OF PHYSICS AND CHEMISTRY BUT DOING SO WOULD REQUIRE UNPRECEDENTED CHANGES’ !!!

IS THIS THE FUTURE FOR CO_2 REDUCTION?

DO WE REALLY REQUIRE DRAMATIC REDUCTIONS IN CARBON DIOXIDE EMISSIONS?

IS THIS THE FUTURE FOR CO_2 REDUCTION?

YOU MIGHT NOT THINK IT RELEVANT BUT YOUR CUSTOMERS ARE BEGINNING TO

AND YOUR COMPETITORS ARE

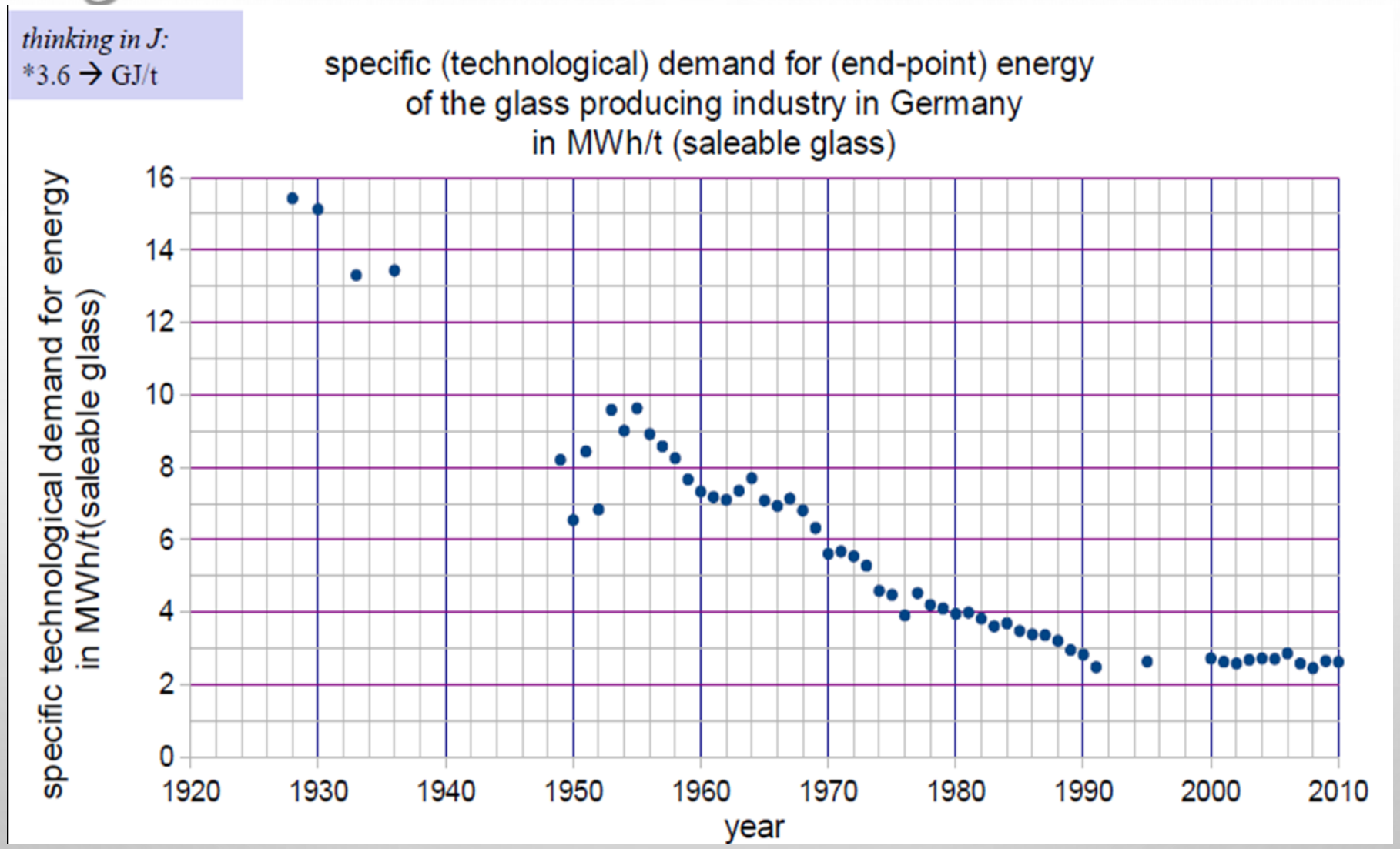
AND YOUR CHILDREN AND GRANDCHILDREN

WILL!!

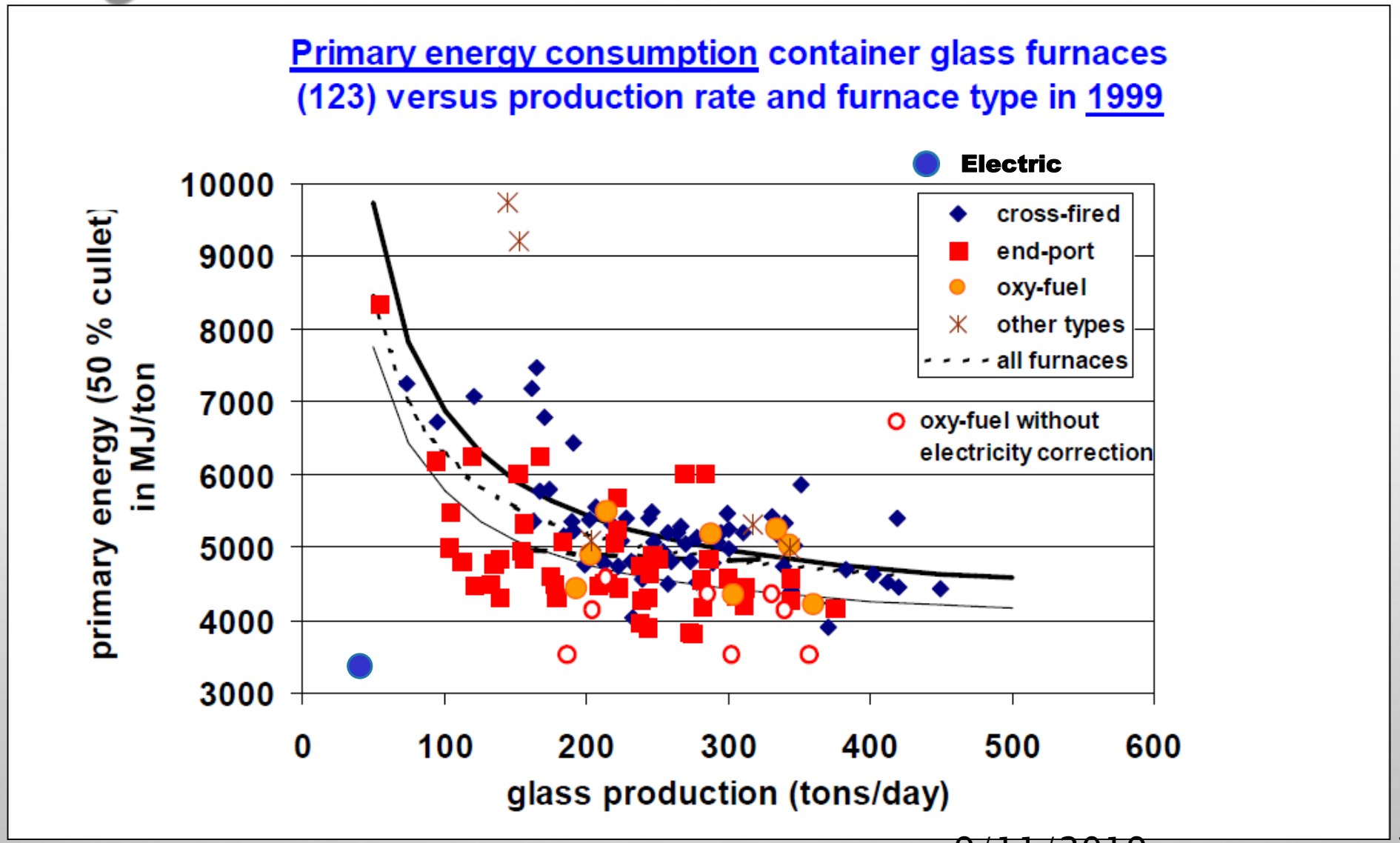
IS THIS THE FUTURE FOR CO_2 REDUCTION?

IMPROVING ENERGY EFFICIENCY IS ONE OBVIOUS WAY TO REDUCE OUR CARBON FOOTPRINT.

thinking in J:
*3.6 → GJ/t

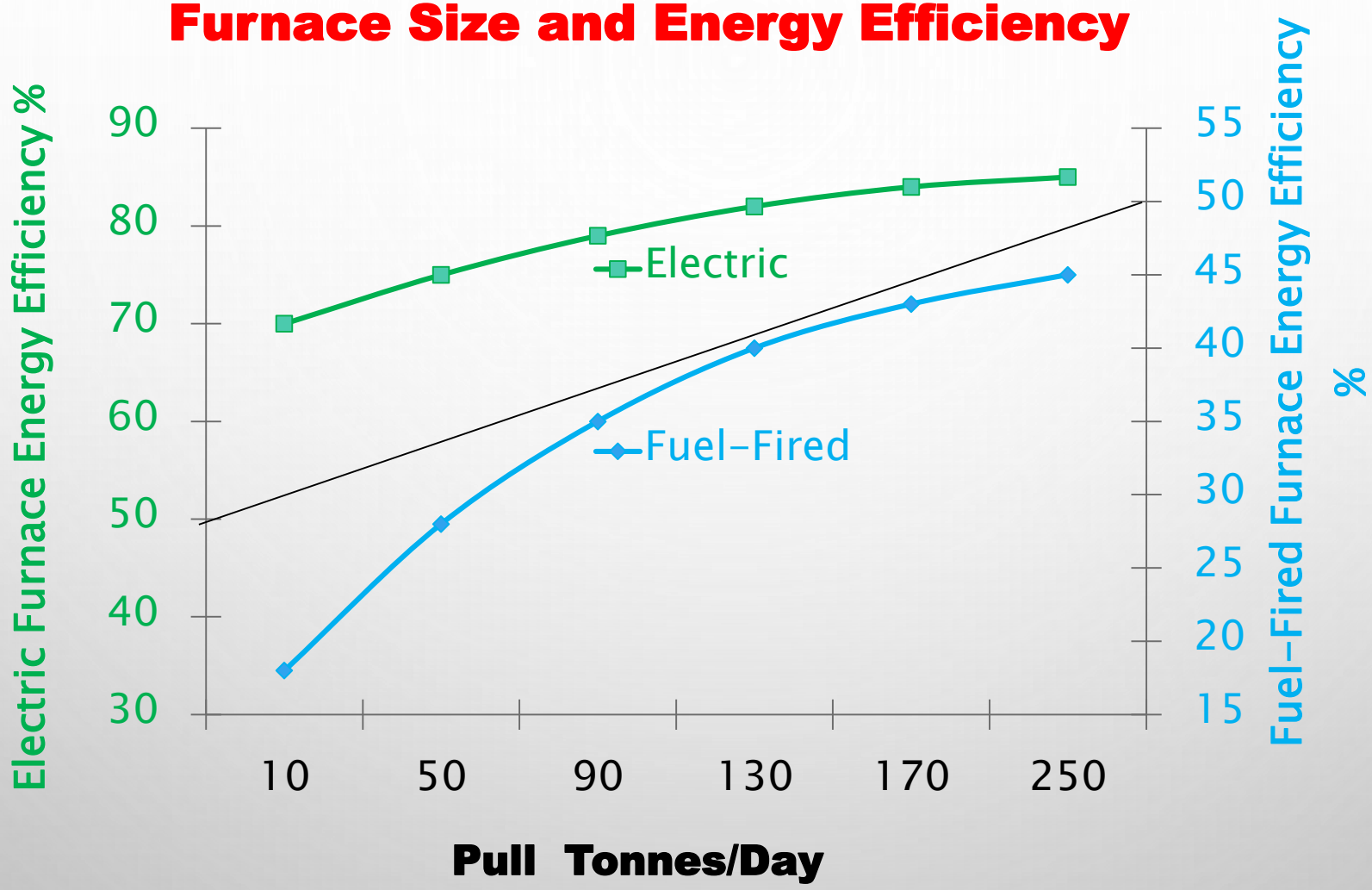


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Furnace Size and Energy Efficiency



ELECTRIC MELTING – IS THIS THE FUTURE FOR CO_2 REDUCTION?

ELECTRIC FURNACES OFFER ONE WAY OF GOING FORWARD IN THE FUTURE

OTHER ROADS TO HIGHER ENERGY EFFICIENCY

BRIQUETTING

PRE-HEAT BATCH AND/OR CULLET

DRY BATCH OPTIMISATION/ CALCINED RAW MATERIALS

BURNER TECHNOLOGY

ADVANCED FURNACE CONTROL (ESIII)

OXYGEN

SYN GAS

ENERGY SUBSTITUTION

IS THIS THE FUTURE FOR CO_2 REDUCTION?

THE CAUTIOUS APPROACH WILL NOT MAKE SIGNIFICANT REDUCTIONS IN FUEL EFFICIENCIES OR CARBON DIOXIDE

(OR NO_X AND SO_X)

PARADIGM SHIFT

G.M.I.C NEXTGEN MELTER PROJECT

SUBMERGED BURNERS ?

INFLIGHT PLASMA FURNACES?

‘VOLDEMOR’ !!!????

WE HAVE TO CONSIDER THE ENVIRONMENT! CO_2 (NO_X SO_X)

FOSSIL FUEL LONG TERM AVAILABILITY – BIO-FUELS

ELECTRIC MELTING – IS THIS THE FUTURE FOR CO_2 REDUCTION?

- The melting of glass by passage of **electric** current through the melt is becoming an ever more **favored** mode of its production; this method has a **high thermal efficiency**, is easy to control, yields homogeneous glass possessing the required properties and also economizes raw materials that **volatilize** readily and it therefore economically attractive.

- The construction of electric melting furnaces is **simpler** than that of the hitherto exclusively used flame-fired furnaces and as a consequence **less expensive** to build. A greater amount of glass is produced by unit volume.

- PROF. STANEK WROTE THAT IN HIS 1977 BOOK: "ELECTRIC MELTING OF GLASS"

- Only he expected growing NUCLEAR power to bring down electricity pricing….

WHY AREN'T THERE MORE ELECTRIC FURNACES?

CAPITAL COST IS CHEAPER

ENERGY EFFICIENT

NO EMISSIONS

COMPACT

WHY ARE ELECTRIC FURNACES SO ENERGY EFFICIENT

NO REGENERATORS

NO FLUE – NO EXHAUST GASES

NO SUPERSTRUCTURE

IS THIS THE FUTURE FOR CO_2 REDUCTION?

CLEARLY ELECTRIC MELTING IS A GOOD OPTION GOING FORWARD

IS THIS THE FUTURE FOR CO_2 REDUCTION?

ARE ELECTRIC FURNACES SUITABLE FOR MAINSTREAM USE?

ARE ELECTRIC FURNACES SUITABLE FOR MAINSTREAM USE?

"BECAUSE THEY ARE

- **EXPENSIVE?**
- **HAVE SHORT LIFE?**
- **LACK FLEXIBILITY ?"**

ARE ELECTRIC FURNACES SUITABLE FOR MAINSTREAM USE?

‘FAKE NEWS’

ARE ELECTRIC FURNACES SUITABLE FOR MAINSTREAM USE?

EXPENSIVE ??

CAPITAL COST IS LOW but operating cost can be high due to electricity pricing, BUT this is changing! Renewables.

THERMAL EFFICIENCY is considerably better. DOUBLE

ARE ELECTRIC FURNACES SUITABLE FOR MAINSTREAM USE?

SHORT LIFE ??

NOT NECESSARILY, could be an advantage

ARE ELECTRIC FURNACES SUITABLE FOR MAINSTREAM USE?

LACK FLEXIBILITY ??

NOT NECESSARILY. DEPENDS ON DESIGN!

eg. HOT TOP AND SEMI-HOT TOP DESIGNS.

ARE ELECTRIC FURNACES SUITABLE FOR MAINSTREAM USE?

WHERE ARE WE NOW? SIZES

MOST CURRENT FURNACES ARE IN THE RANGE 1 -25 TONS/DAY

THERE ARE MORE THAN 10 OPERATING BETWEEN 100 – 200 TONS/DAY

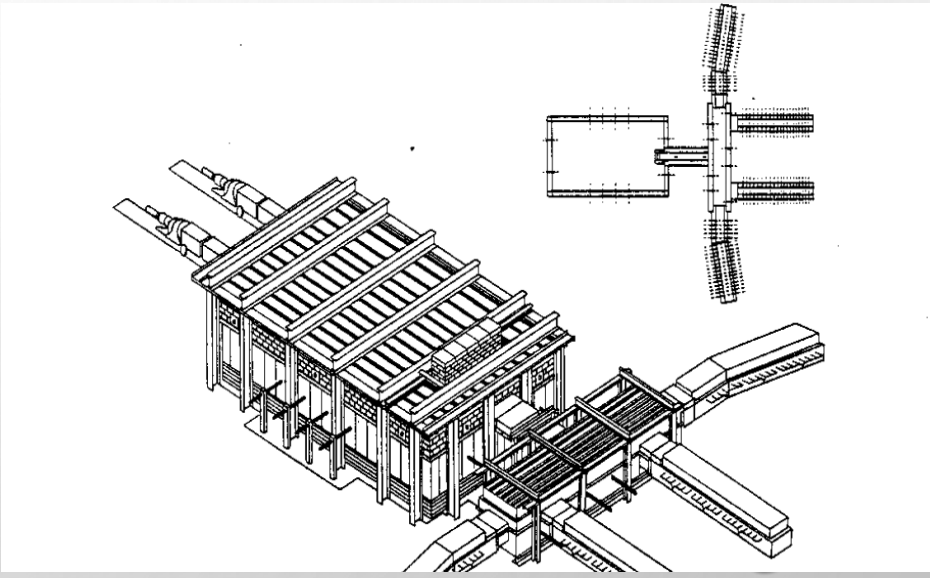
WE ARE CURRENTLY DESIGNING A FURNACE FOR A CUSTOMER REQUESTING **350** TONS/DAY

WE BELIEVE 600-800 TONS/DAY IS POSSIBLE

WHAT IS THE LARGEST SIZE ?

- UNTIL 1999 AN 180 TPD FULL ELECTRIC MELTER WAS IN OPERATION WITH A RESTART AROUND 2008 TO 220 TPD
- IN 2008 THE CAMERON FAMILY PRODUCED (BRIEFLY)

  270 - 300 TPD FULL ELECTRIC GREEN CONTAINER
- BORMIOLLI ROCCO OPERATES 3 HIGH QUALITY ELECTRIC MELTERS UP TO 80 TPD



THE FUTURE OF THE GLASS INDUSTRY

IT MEANS, IF YOU ARE PLANNING AND DESIGNING YOUR NEXT REBUILD NOW AND YOUR PLANNED FURNACE LIFE TIME WOULD BE >15 YEARS:

YOU SHOULD HAVE TO HAVE A PLAN HOW TO REDUCE CO_2 EMISSION

TYPES OF ALL-ELECTRIC FURNACES

COLD TOP, HOT TOP, SEMI-HOT TOP

GEOMETRY

SQUARE

RECTANGULAR

HEXAGONAL

DUODECAGONAL

ROUND

SHELF

TRANSFORMERS

THREE PHASE

DELTA:-OPEN/CLOSED/PARTIAL

STAR

TWO PHASE

SCOTT SQUARES (BALANCED)

SINGLE PHASE

ELECTRODE POSITIONS

TOP ELECTRODES

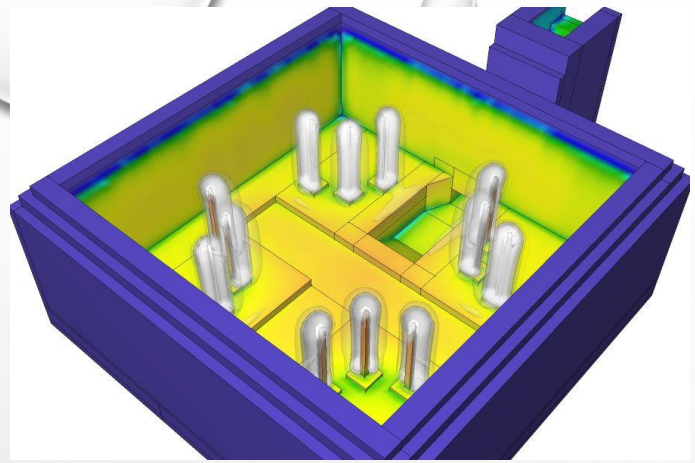
SIDEWALL ELECTRODES

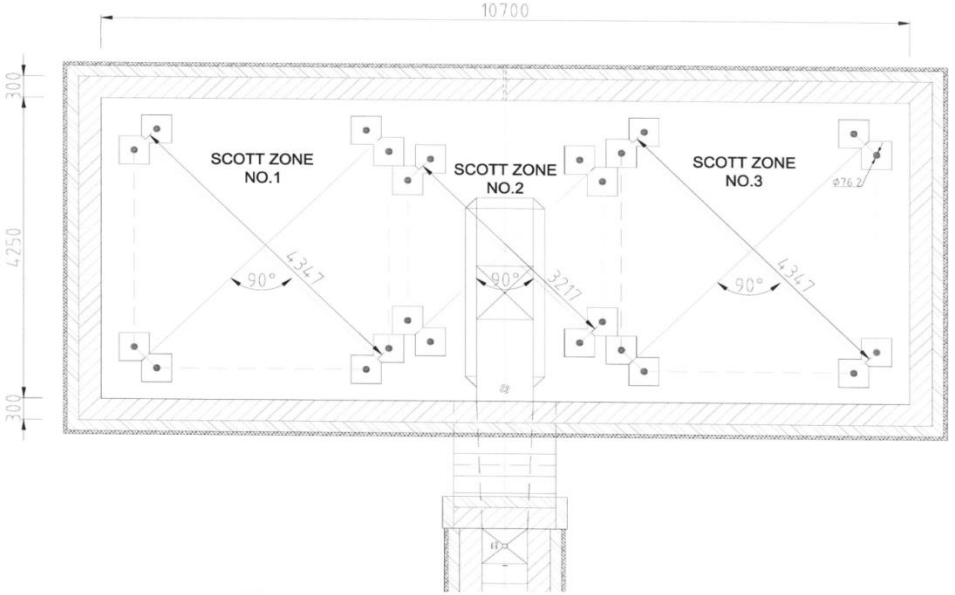
SHELF ELECTRODES

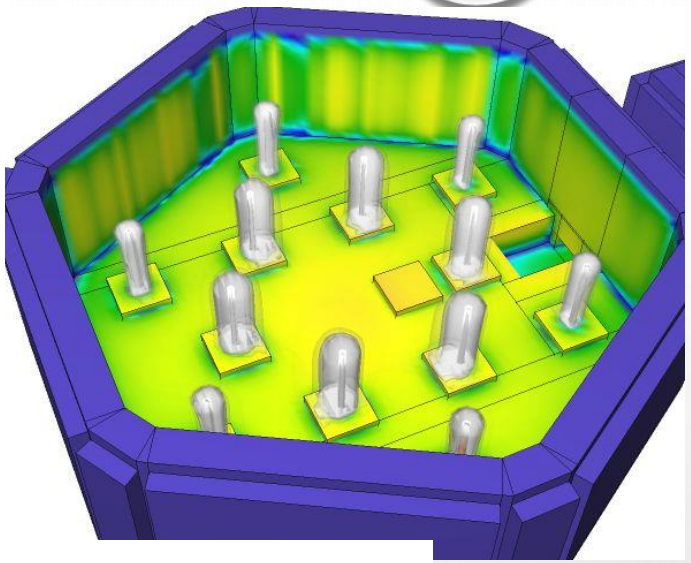
BOTTOM ELECTRODES

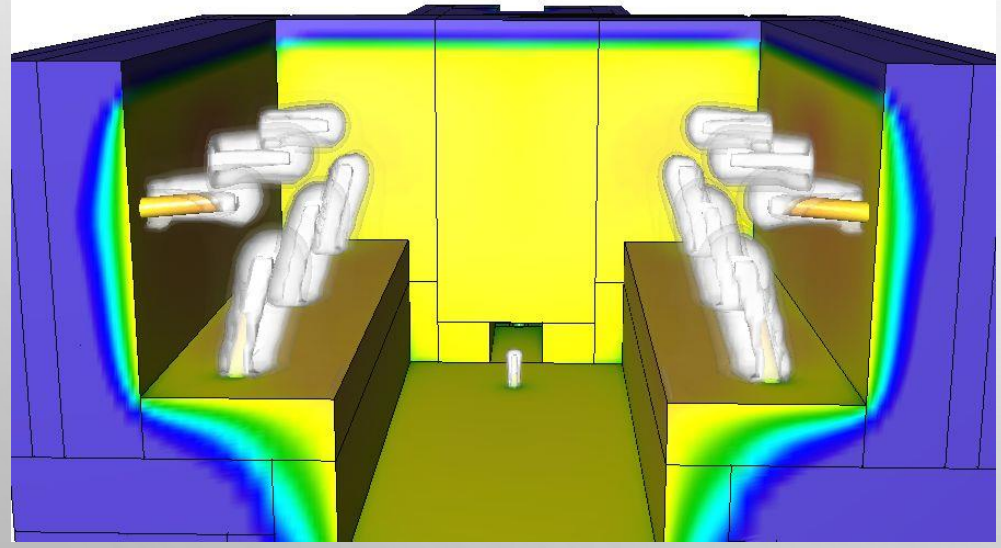
PLATE ELECTRODES

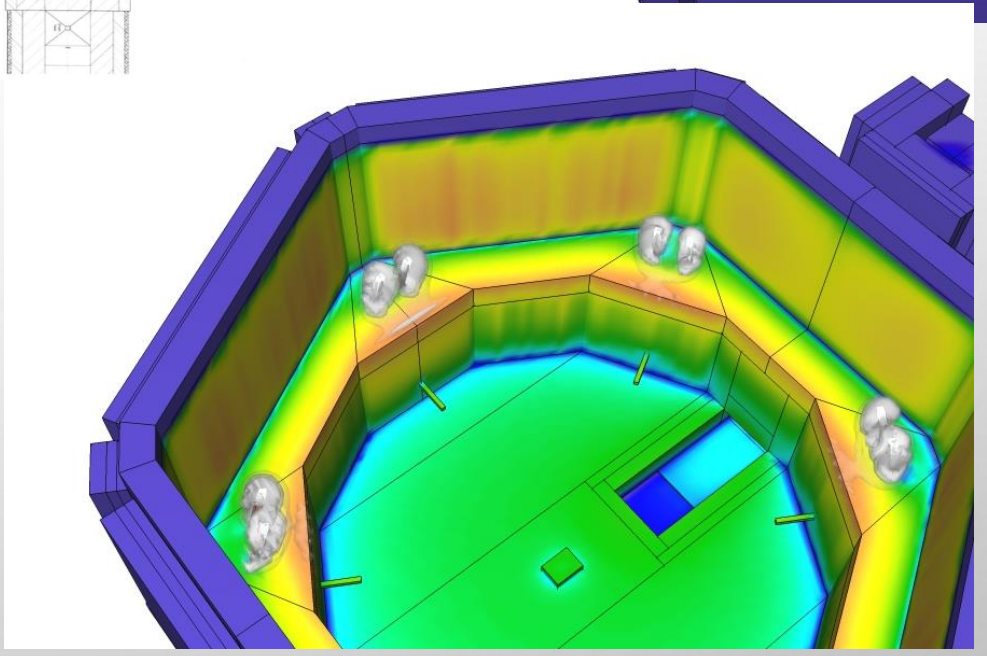
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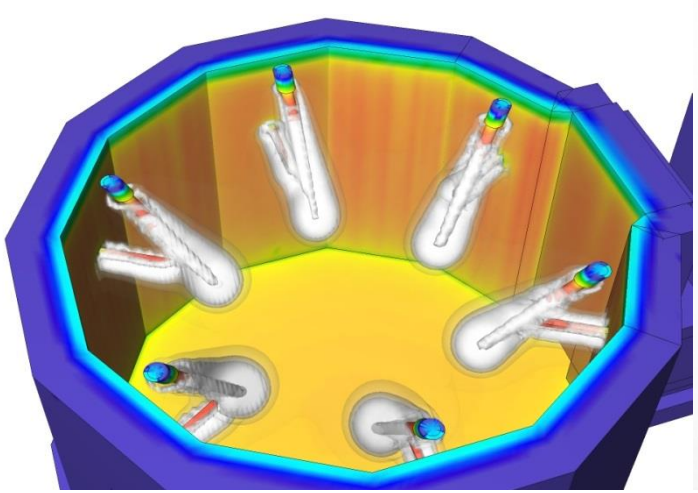


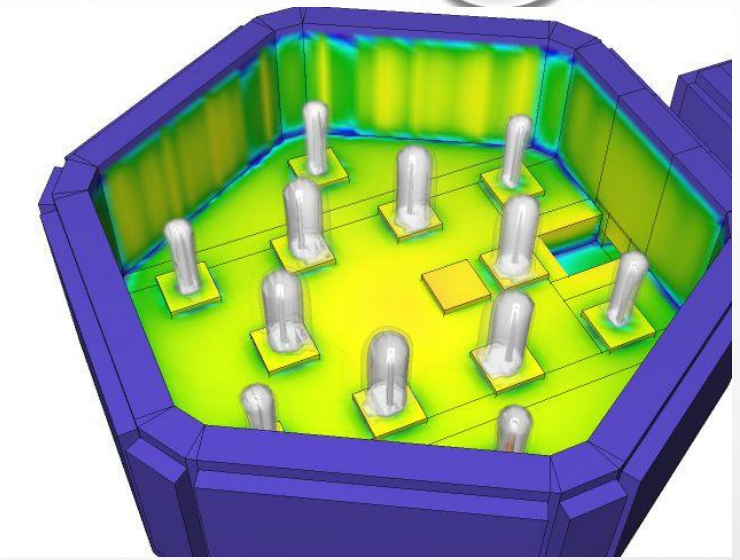


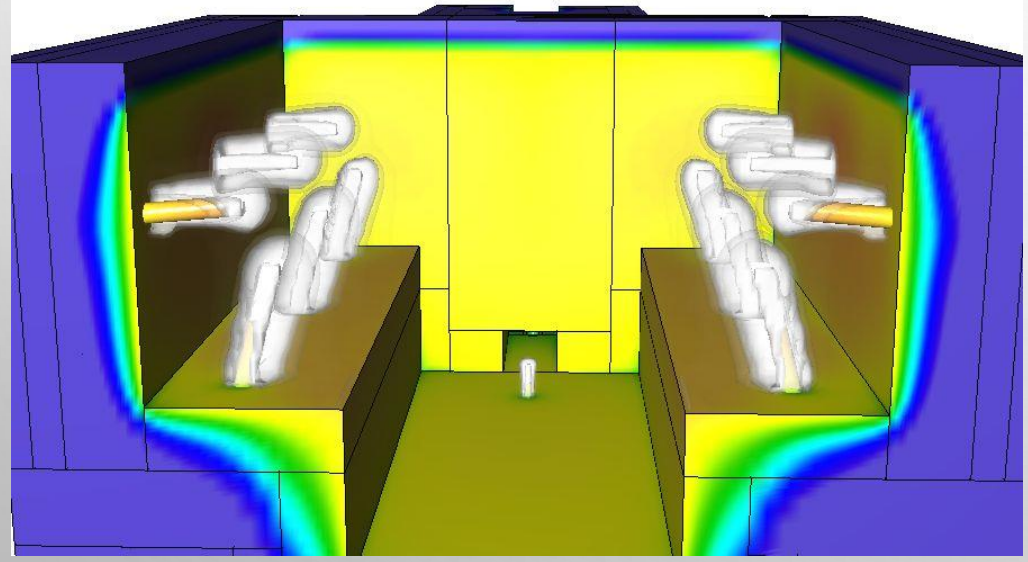




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ALL PRESENTED SOLUTIONS AREN'T RELEVANT FOR MAINSTREAM FLOAT AND CONTAINER FURNACES

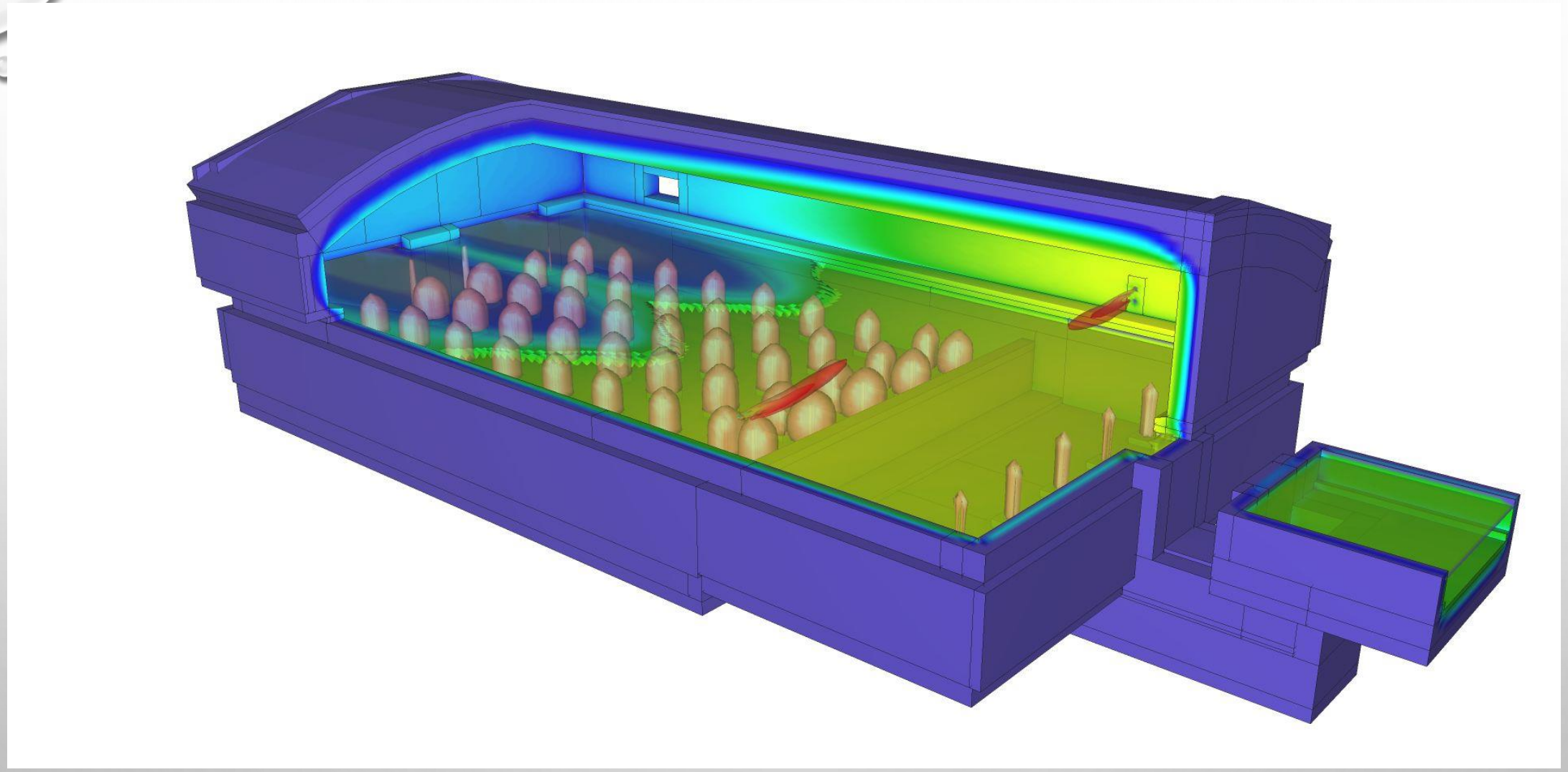
CAPACITY BETWEEN 5 AND 50 TIMES MORE

INSTALLED ELECTRICAL POWER BETWEEN 2 AND 6 TIMES MORE FOR A HYBRID MELTER

THERE IS A NEED FOR DIFFERENT THINKING

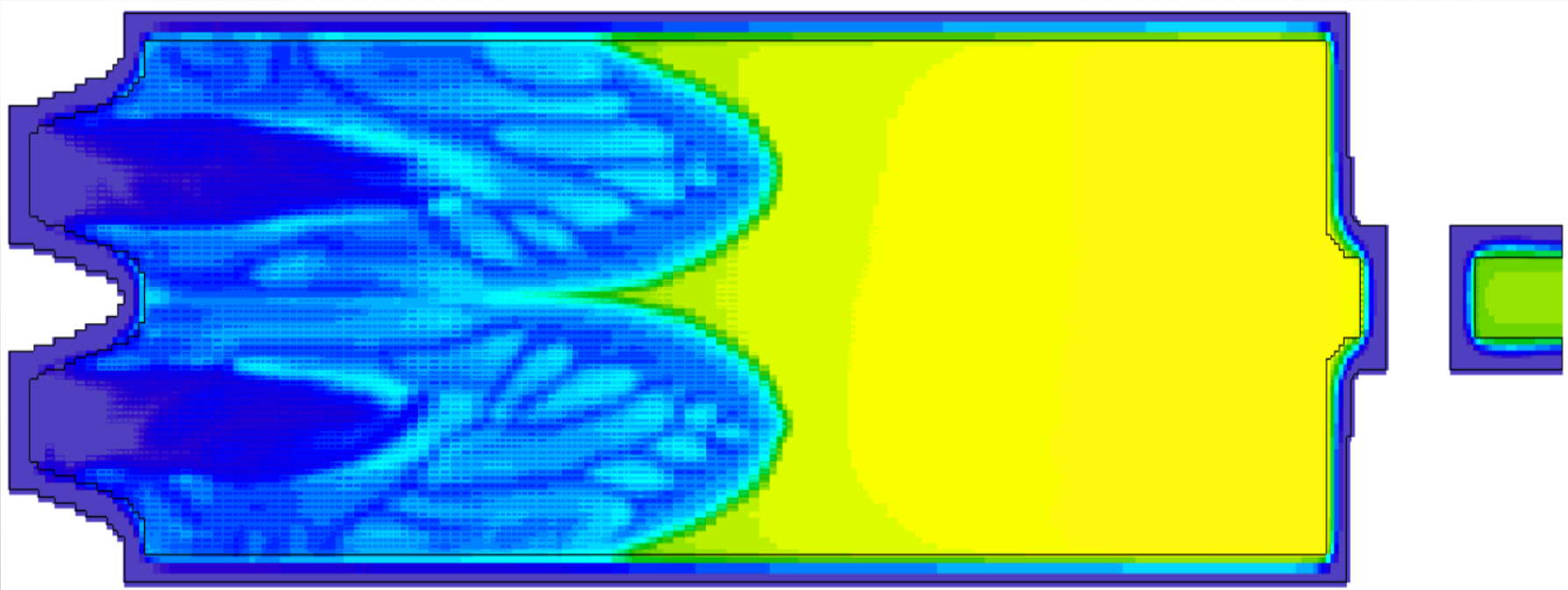
SO WHAT DO WE DO AND WHERE DO WE GO?

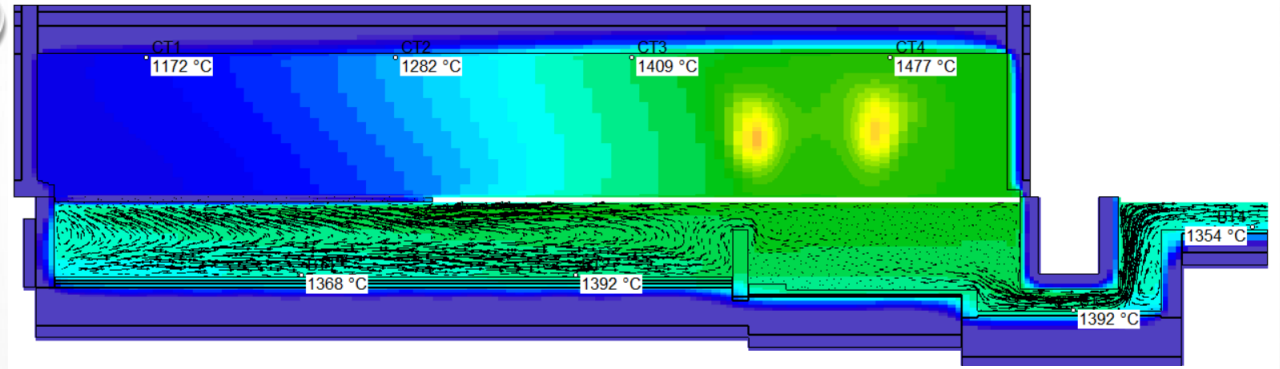
GS/FIC Horizontal Hybrid (Hot top) Electric Melter (H^2EM) Container 300-350 TPD at 2.6 GJ/Ton



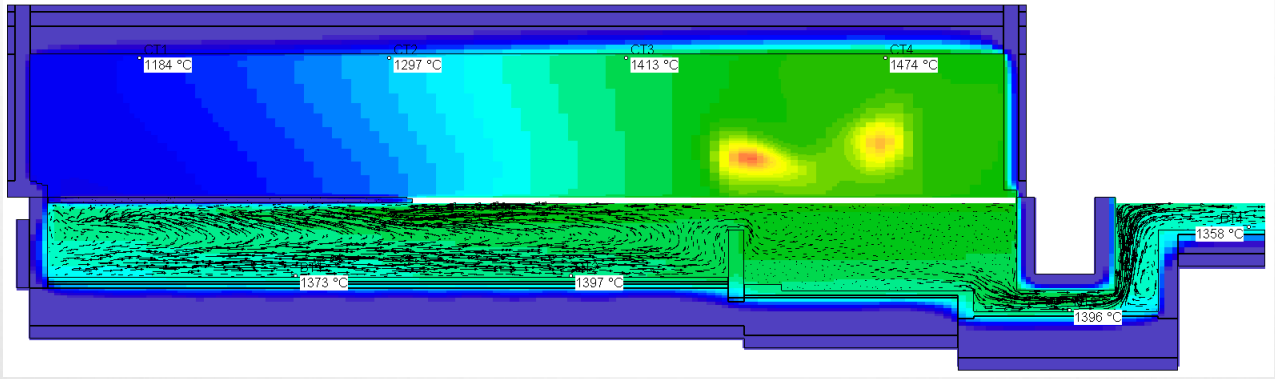
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Glass Model – Top view – glass surface – **converged** 330 t/Day

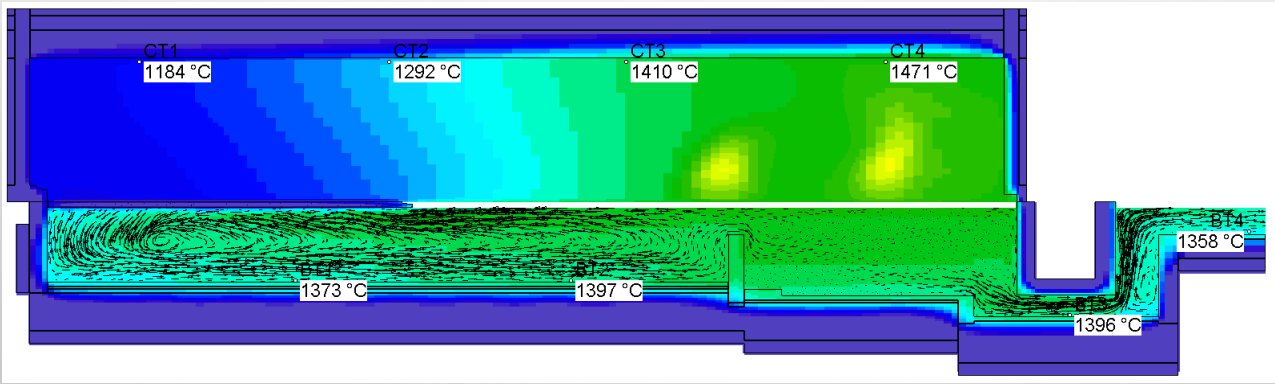




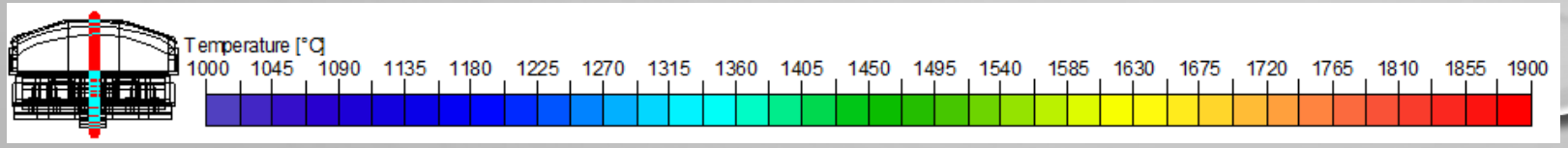
Case_CH_4



Case2_H_2

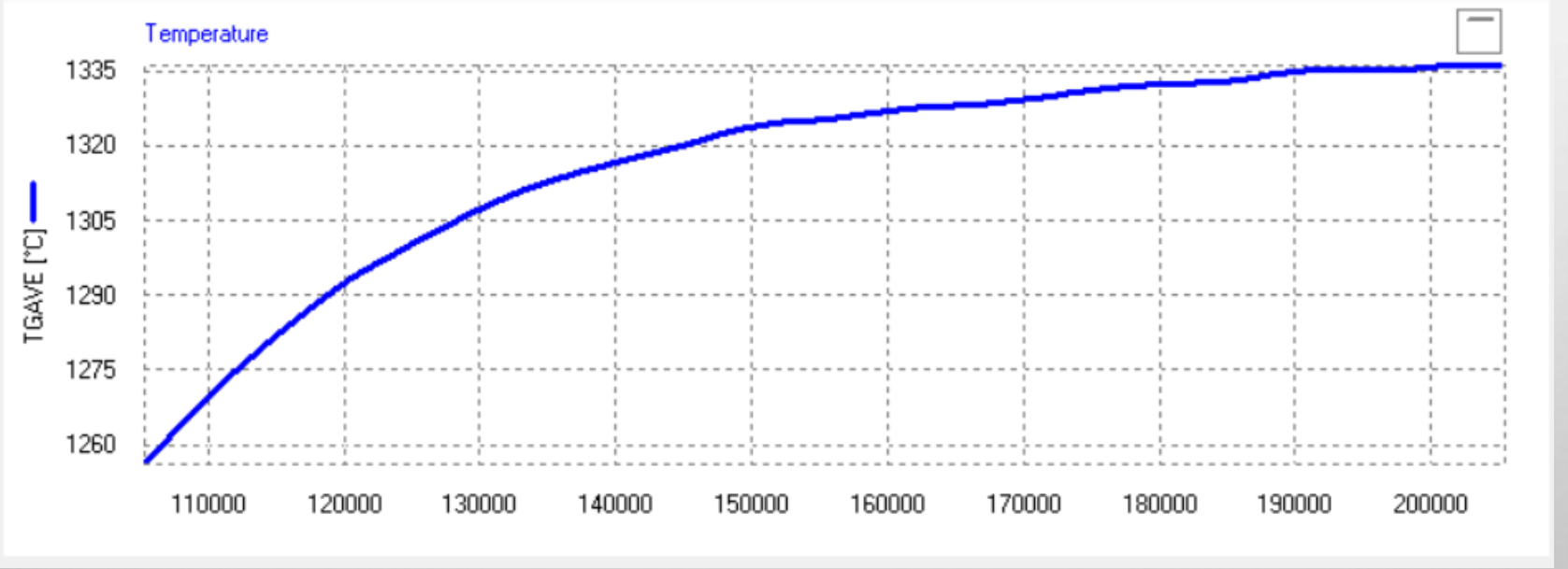


Case2_H_2
Adapter burner



20128 particles calculated (947.8 per second) on 2018-10-16 14:18
20127 particles (100.00%) at selected targets
1 particles (0.00%) at unknown targets (not included in results)

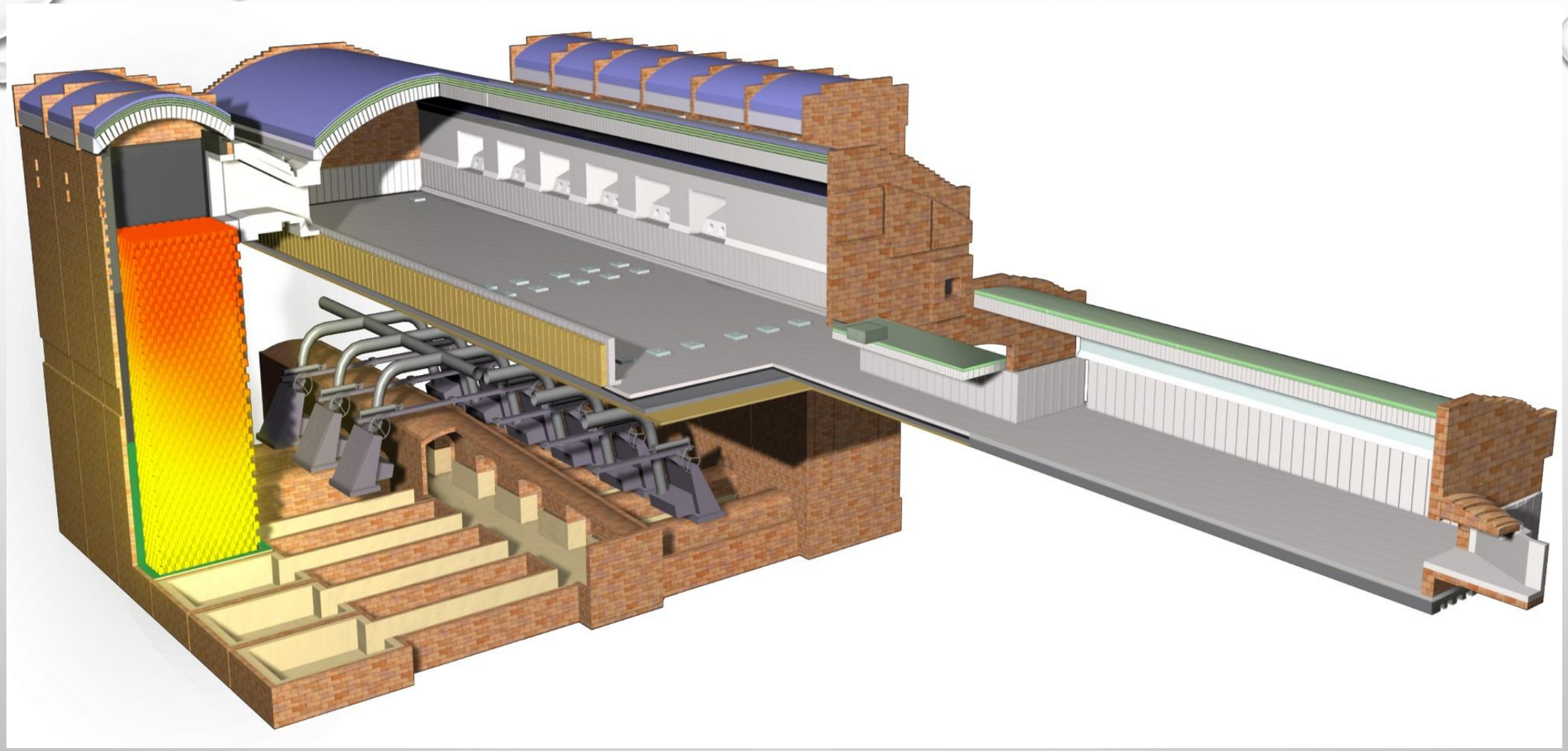
	Minimum	Least 0.1%	Least 1%	Median	Average	Std. deviation	
Residence time [hr]:	3.70313	4.06857	4.85633	21.2099	27.1601	21.0772	
Sand dissolution index:	1.11959	1.17917	1.27812	6.84176	8.47116	6.37176	
Bubble growth index:	0.866341	0.890208	0.948496	5.36759	6.58054	4.91503	
Mixing index:	1.40288	1.58358	2.01314	12.2897	17.1181	15.8989	
Melting index:	779667	834349	931294	4.79006e+006	5.99482e+006	4.55645e+006	
Fining index:	0	0	0	19143	80785.3	144635	(1400



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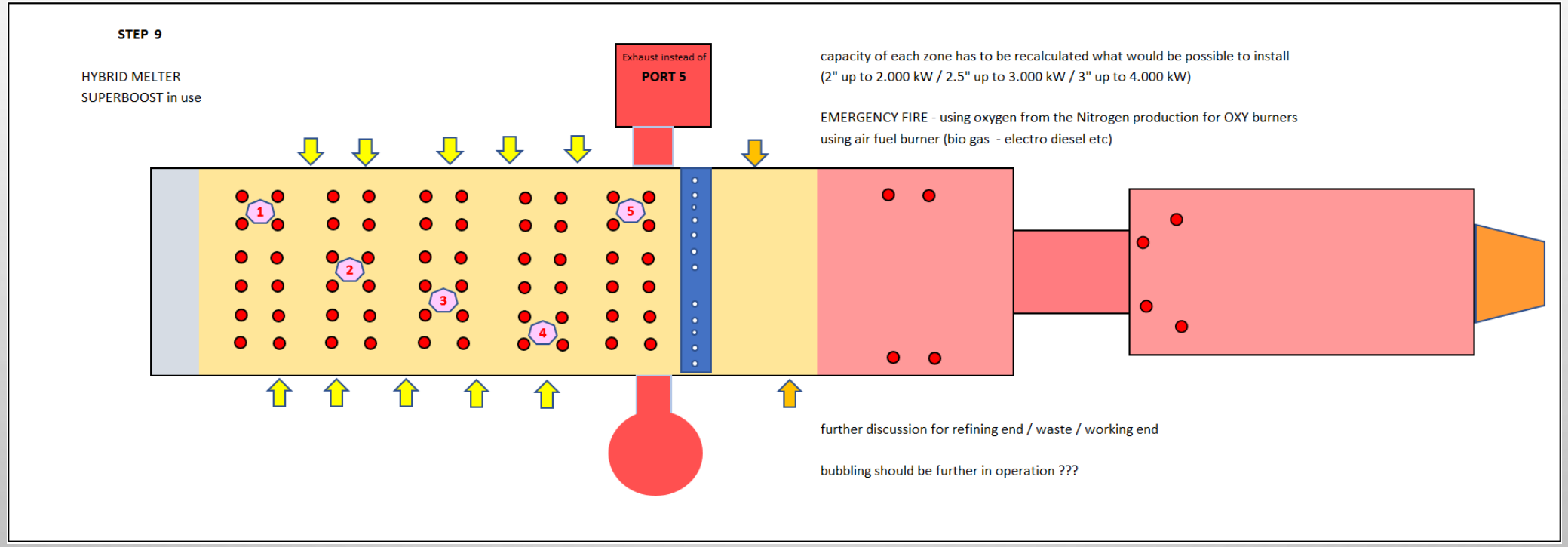
SO WHAT DO WE DO AND WHERE DO WE GO?

GS/FIC Horizontal Hybrid (Hot top) Electric Melter (H^2EM)
Float 600-800 TPD at 3.0 GJ/Ton
Furnace life 8-10 years?



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HOW DO WE GET TO A HORIZONTAL HYBRID ELECTRIC MELTER (H^2EM)?



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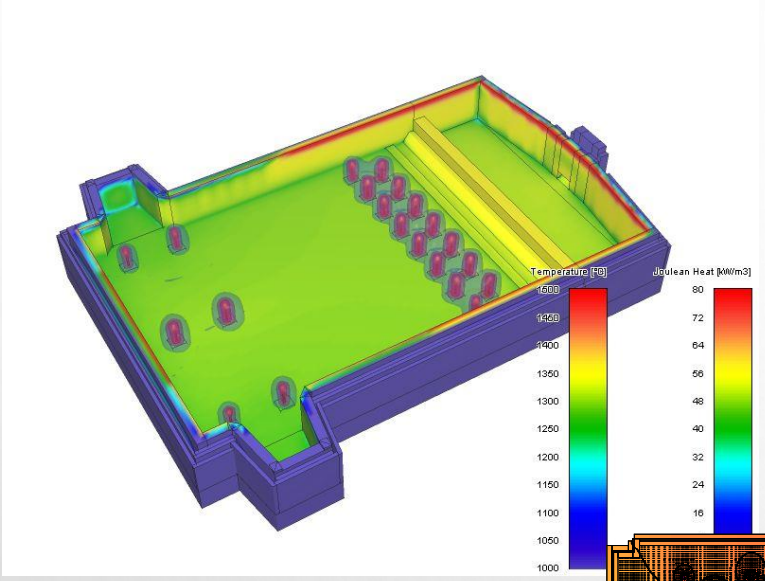
HORIZONTAL HYBRID ELECTRIC MELTER (H^2EM)

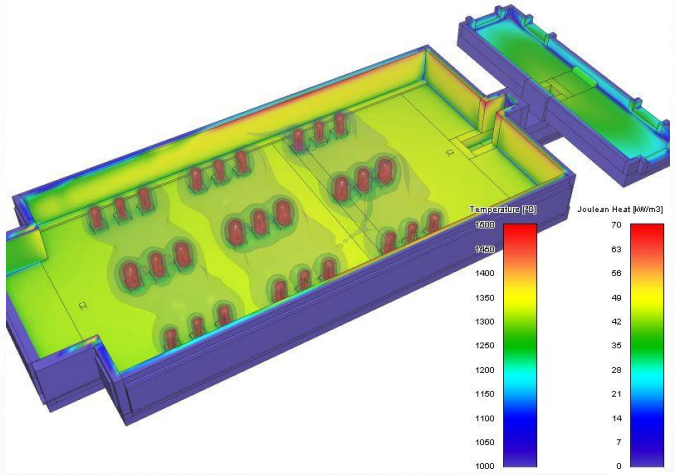
- **HAS TO BE HOT-TOP OR SEMI HOT-TOP**
- **IS HORIZONTAL MELTING NOT VERTICAL**
- **SIMILAR FOOTPRINT TO EXISTING FURNACES**

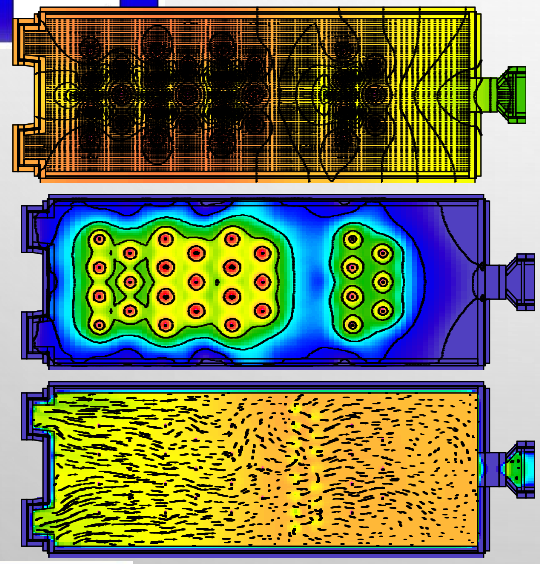
HOW DO WE GET TO A HORIZONTAL HYBRID ELECTRIC MELTER (H^2EM)?

SUPERBOOSTING

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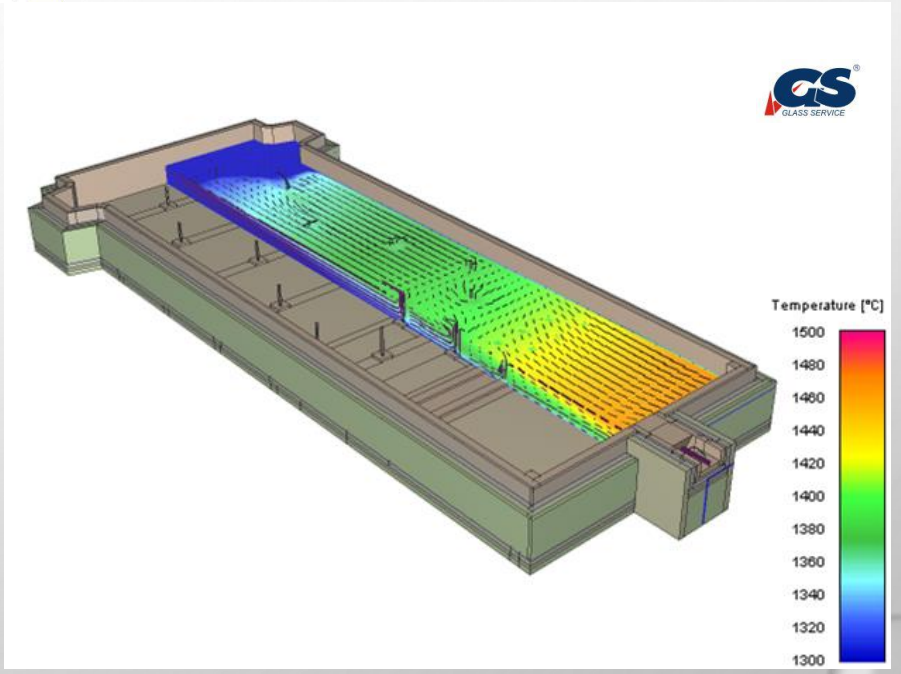




Electric potential (total) and electric current (total)

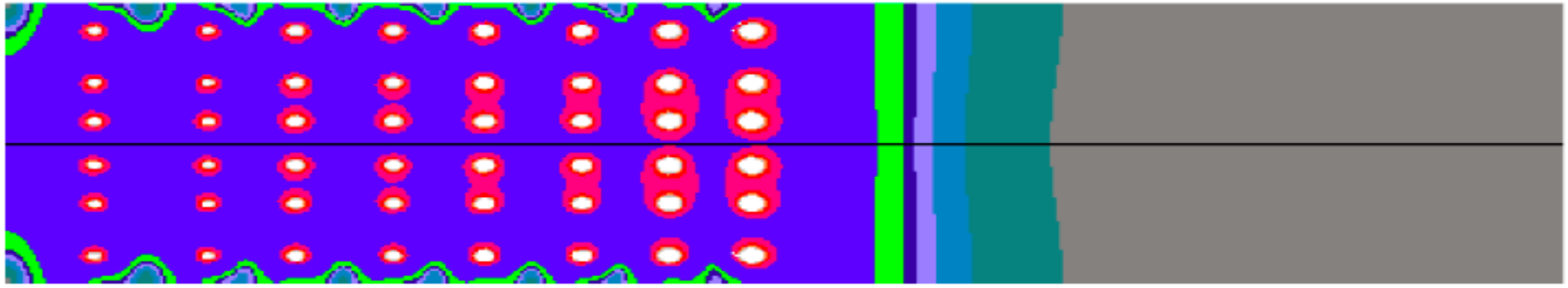
Joulean heat distribution [kW/m3]

Temperature and flow distribution



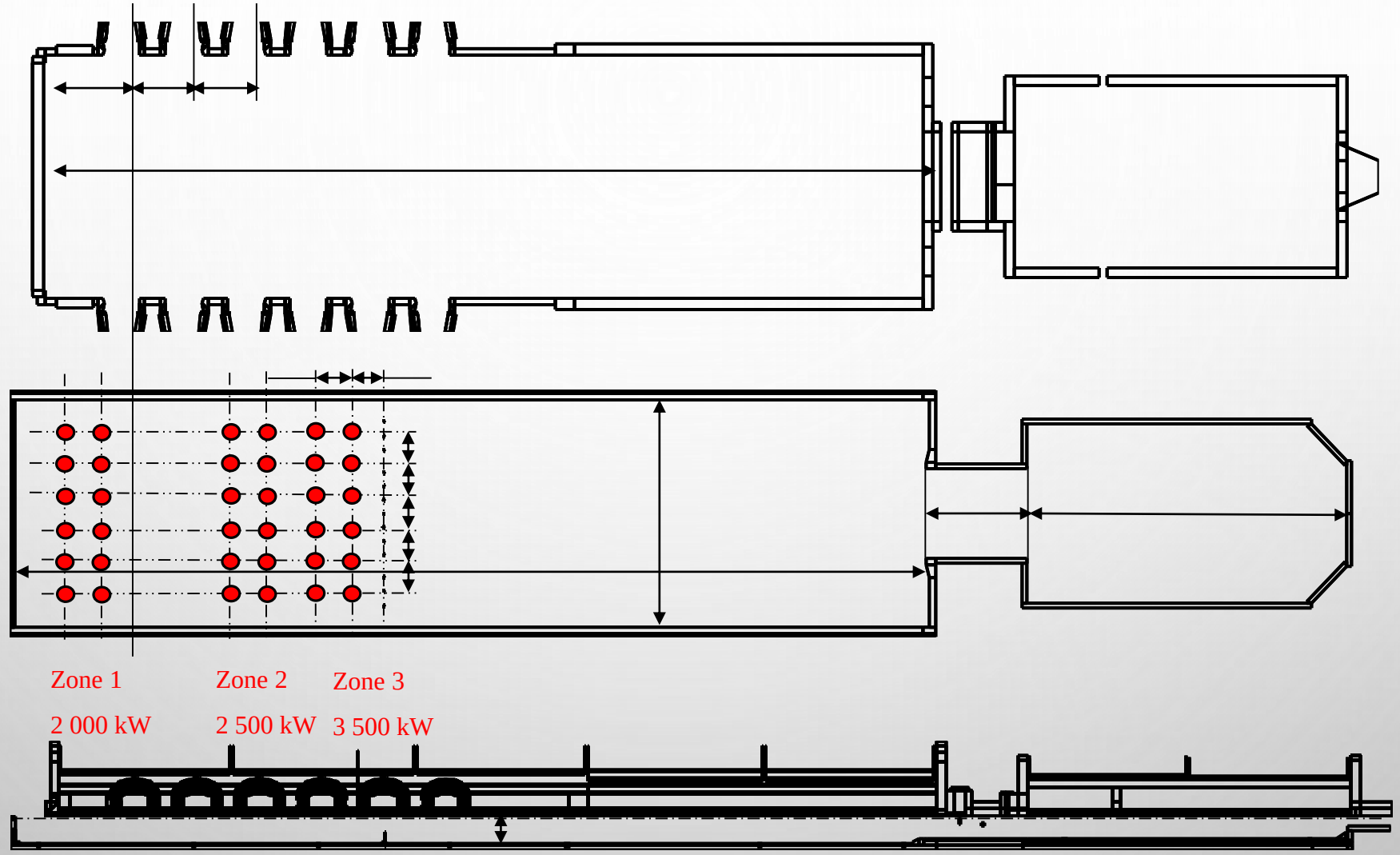
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Typical Float Furnace
4-Zone Distributed Boost System



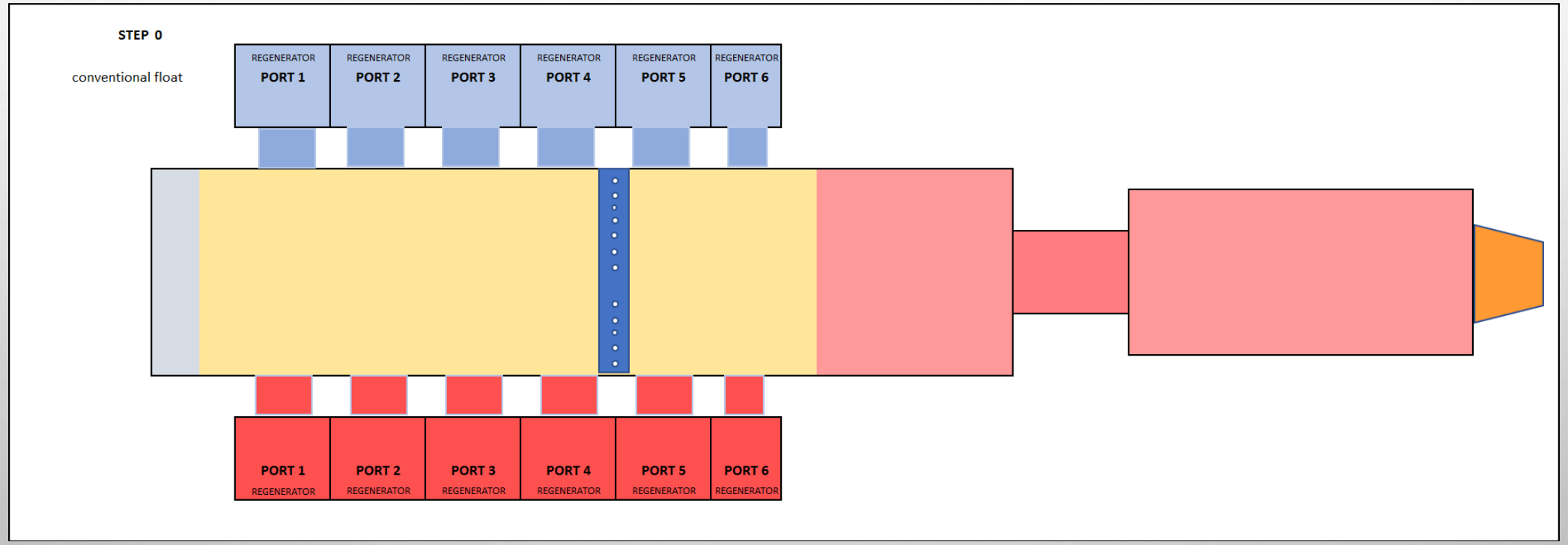
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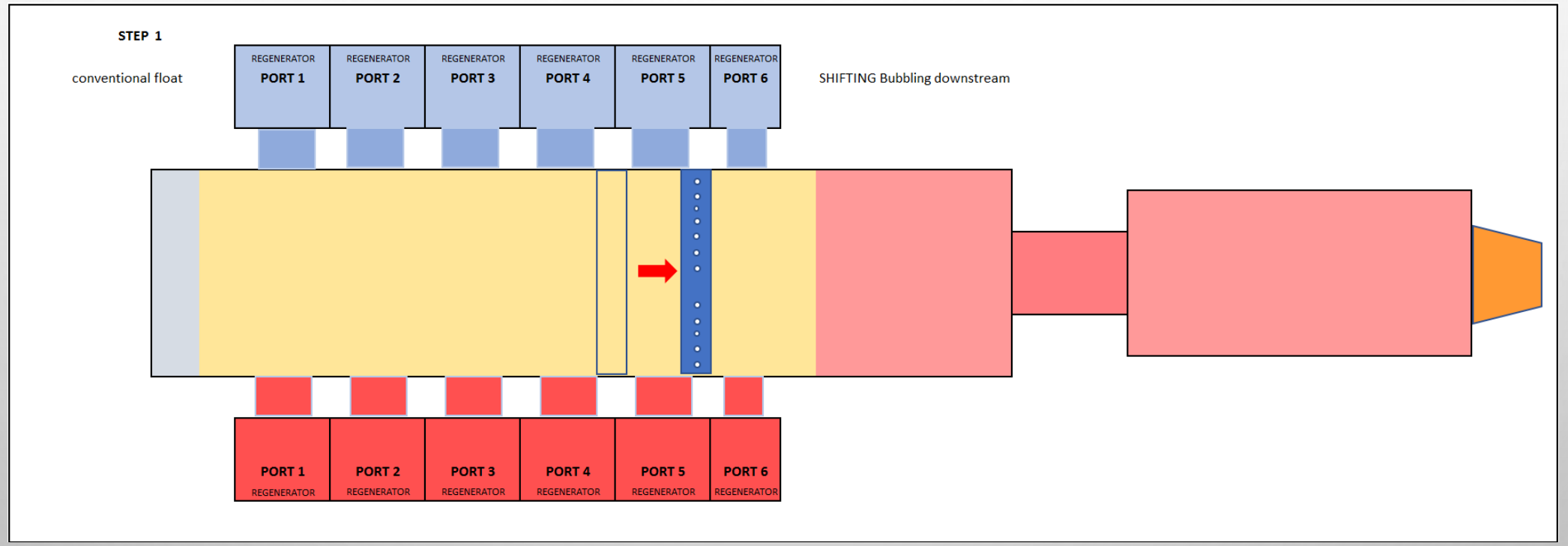
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SUPERBOOSTING TOWARDS HORIZONTAL HYBRID ELECTRIC MELTER (H²EM)



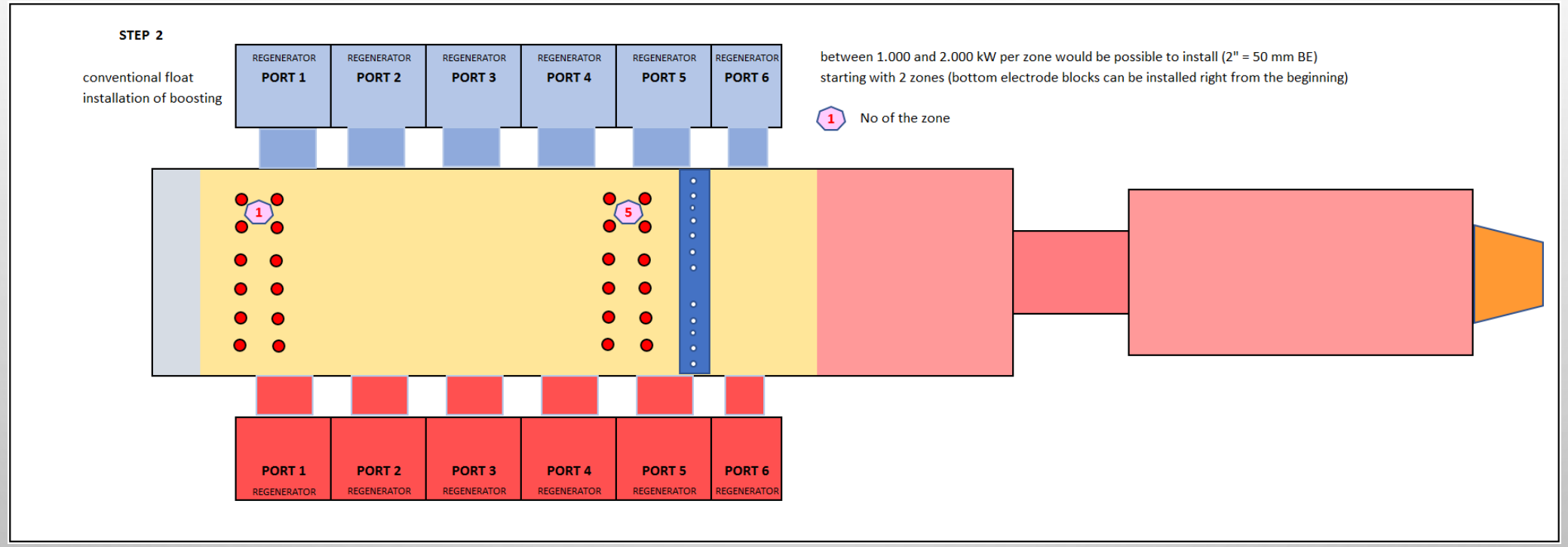
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SUPERBOOSTING TOWARDS HORIZONTAL HYBRID ELECTRIC MELTER (H²EM)



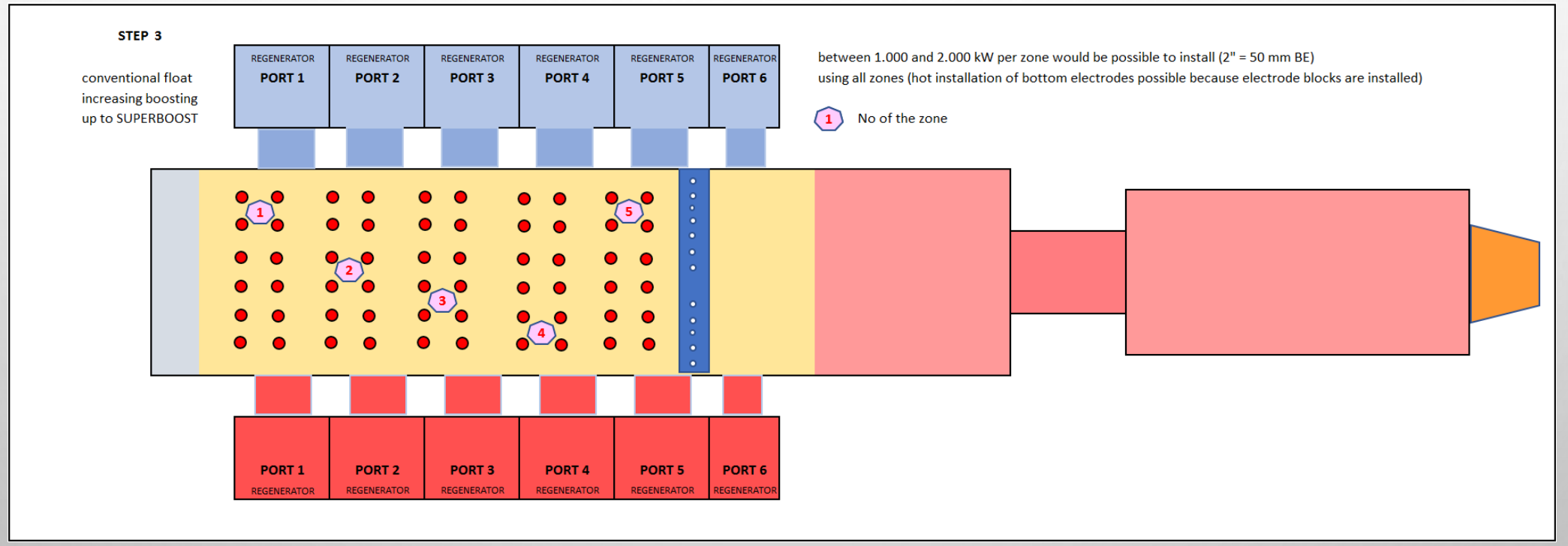
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SUPERBOOSTING TOWARDS HORIZONTAL HYBRID ELECTRIC MELTER (H²EM)



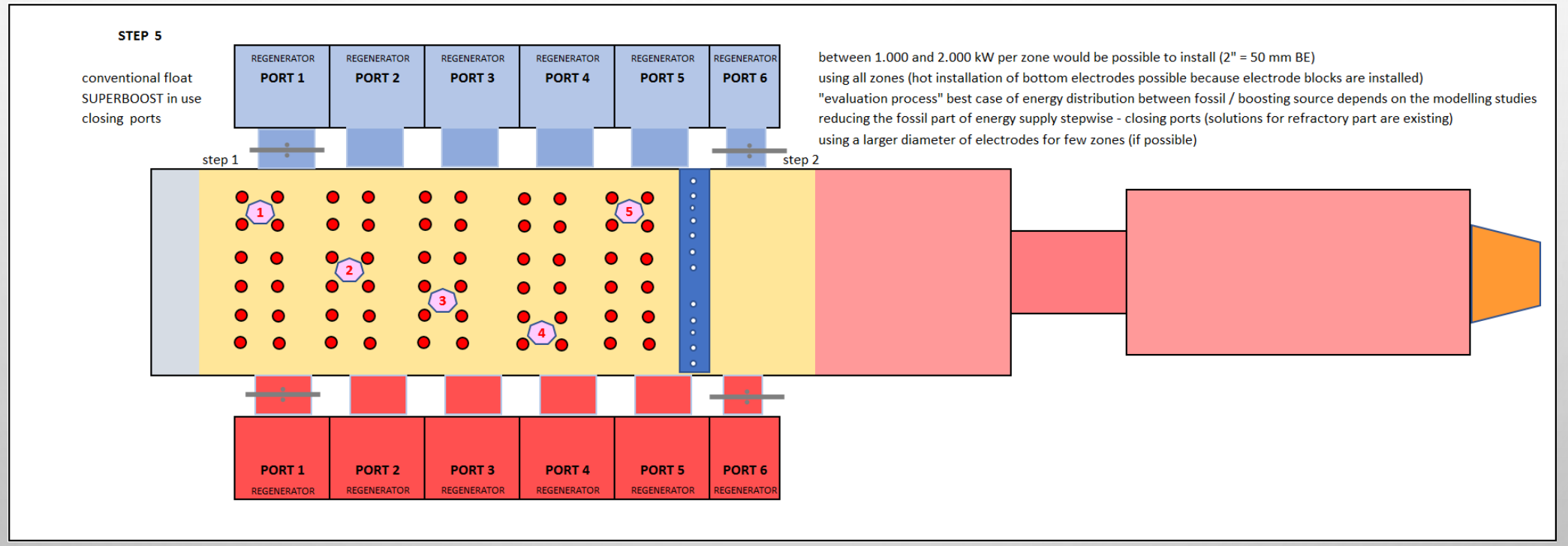
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SUPERBOOSTING TOWARDS HORIZONTAL HYBRID ELECTRIC MELTER (H²EM)



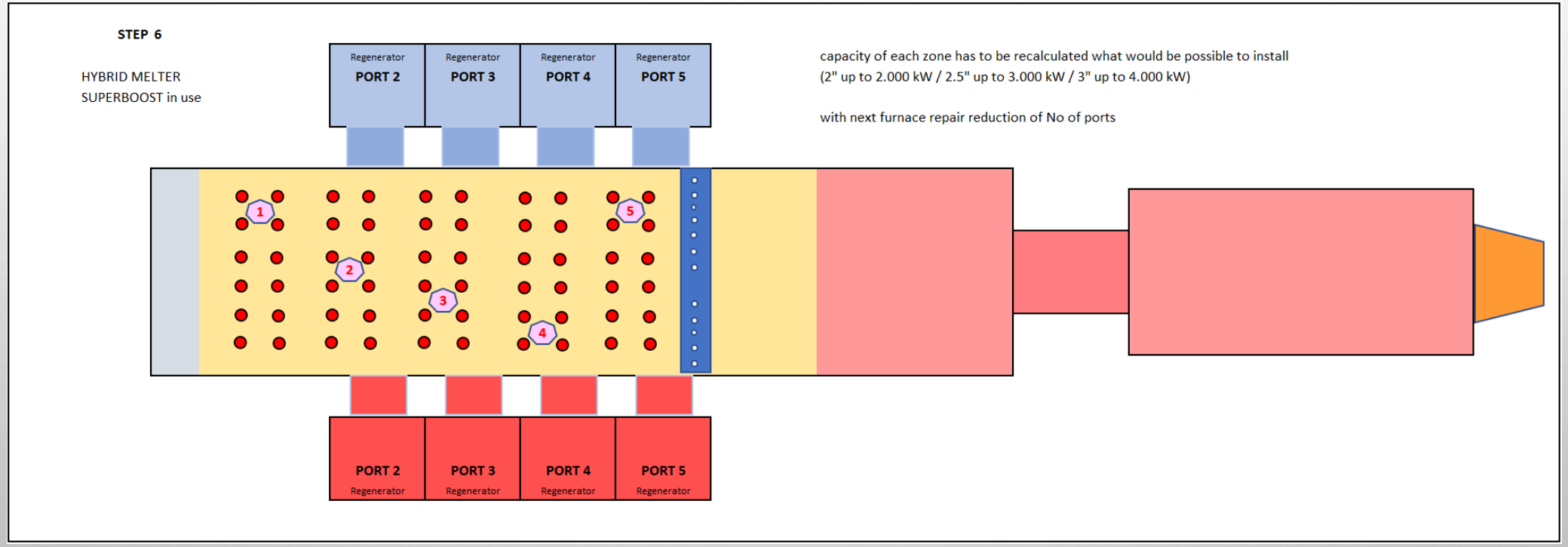
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SUPERBOOSTING TOWARDS HORIZONTAL HYBRID ELECTRIC MELTER (H²EM)



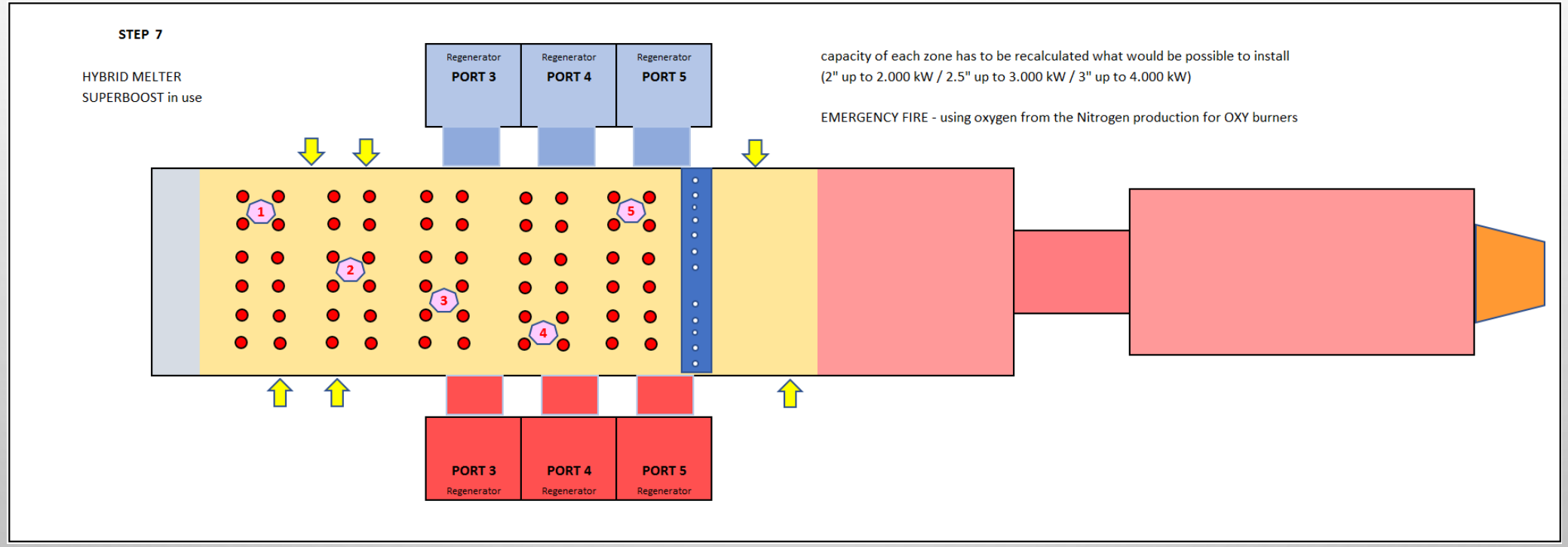
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SUPERBOOSTING TOWARDS HORIZONTAL HYBRID ELECTRIC MELTER (H²EM)



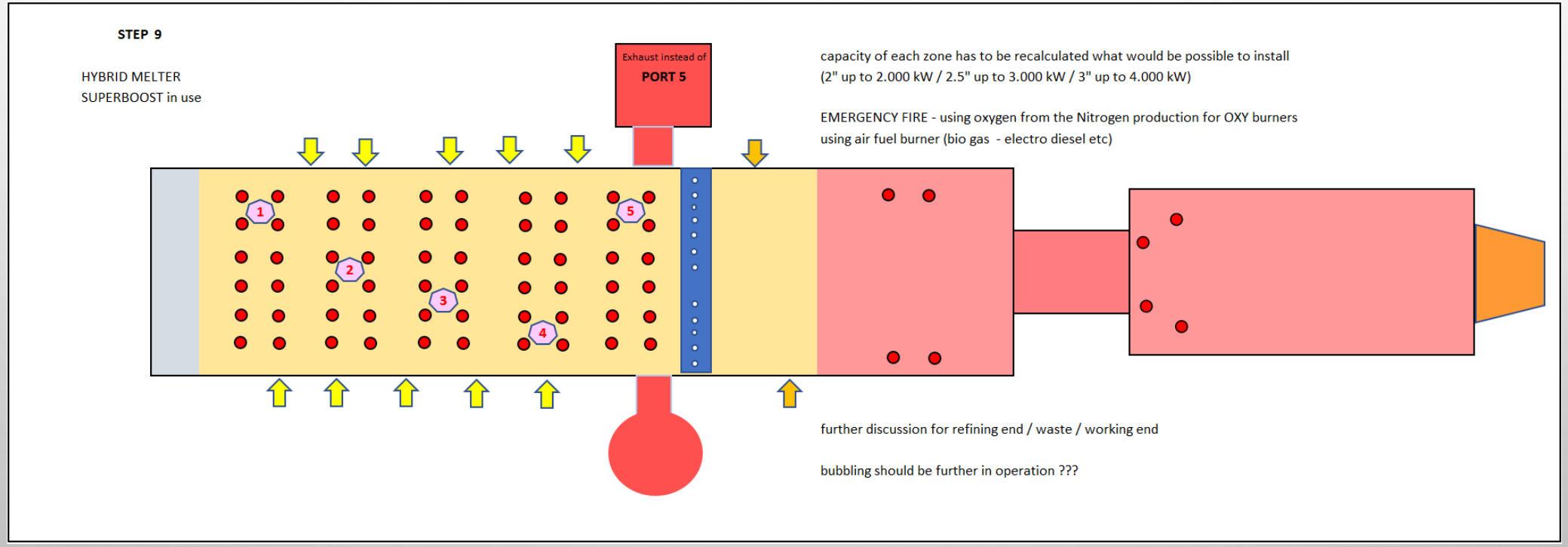
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SUPERBOOSTING TOWARDS HORIZONTAL HYBRID ELECTRIC MELTER (H²EM)



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HORIZONTAL HYBRID ELECTRIC MELTER (H^2EM)



WHAT OTHER OPTIONS AVAILABLE?

STEP CHANGE REQUIRED

U.S.A - G.M.I.C NEXTGEN MELTER PROJECT

SUBMERGED BURNERS ?

INFLIGHT PLASMA FURNACES ??

WE HAVE TO CONSIDER THE ENVIRONMENT! CO_2 NO_X SO_X

FOSSIL FUEL LONG TERM AVAILABILITY

'VOLDEMOR' !!!????

THE FUTURE OF THE GLASS INDUSTRY
WHAT IS THE FUTURE?

NEW THINKING REQUIRED

- **SHORTER FURNACE CAMPAIGNS**
- **LOW THERMAL MASS SUPERSTRUCTURES**
- **SURFACE COATINGS TO IMPROVE EMISSIVITY**

SOMETHING TO THINK ABOUT

WHAT IF WE COULD BUILD A FURNACE THAT WE COULD WORK WITH THE POWER SUPPLY COMPANY TO MANAGE PEAK LOADS WITHOUT DISRUPTION TO PRODUCTION?

WE CAN AND WE DID! - IN 1981

WHAT WAS IT LIKE?

SEMI-HOT TOP ALL-ELECTRIC FURNACE.

SUPERSTRUCTURE HEATED BY ELECTRICITY.

LOW THERMAL MASS SUPERSTRUCTURES

SCREW CHARGERS

WHAT WAS IT LIKE?

SODA LIME GLASS FOR EXPORT

- TABLEWARE;- MDP PRESS AND HARTFORD 28
- CONTAINERS;- FLACONAGE

FLINT, HONEY GOLD, AMBER, SMOKEY QUARTZ

WHAT WAS IT LIKE?

SODA LIME GLASS FOR EXPORT

- FURNACE NO.1 FIVE LINES, **60 TPD**

MDP PRESS, 5DG, 6SG, 5DG, H28

- FURNACE NO.2 TWO LINES, **30 TPD**

MDP PRESS, H28

WHAT WAS IT LIKE?

SODA LIME GLASS FOR EXPORT

- FURNACE NO.1 CAPACITY **3.00 MW**
- FURNACE NO.2 CAPACITY **1.75 MW**
- MANAGEABLE LOAD **1.75 MW**

WHAT WAS IT LIKE?

SODA LIME GLASS FOR EXPORT

- MANAGEABLE LOAD 1.75 MW OR **37%**
- MONITOR CITY MAX DEMAND WITH SUPPLIER
- MANAGE TOP HEAT

WHAT IS THE FUTURE?

WHAT ARE OUR REAL OPTIONS?

ELECTRICAL ENERGY

THE ONLY WAY IN THE LONG TERM!!

WE NEED TO PREPARE NOW

LARGE ELECTRIC FURNACES AND SUPERBOOSTING IS THIS THE FUTURE FOR CO_2 REDUCTION?

THE FUTURE IS BRIGHT, THE FUTURE IS ELECTRIC.

THANK YOU FOR YOUR ATTENTION

WITH THANKS TO MY CO-AUTHORS

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