eco-e tech

Torus & ECOFEEDER

The ingenious solution for an environmentally friendly, versatile and yet economically viable scrap preheating

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ecology economy

CLESID LORDER

Preface I

The climate crisis

If we continue to heat up the atmosphere, we will reap more droughts, storms, and floods.

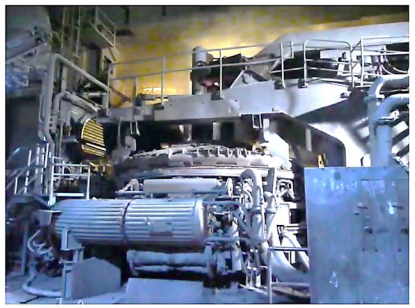
Politicians have set targets for 2030 and 2050 that require each of us to make restrictions, adjustments, and rethink. Commitment, new ideas and solutions are required.

We have analyzed the situation, have reconsidered the recycling of scrap and found a new ground-breaking concept on how untreated scrap can be preheated in an environmentally friendly, versatile and yet economical way.

Scrap Preheating

We offer three individual Steps to best use the energy contained in the off gas and to reduce the green house gas (GHG) emission to the minimum:

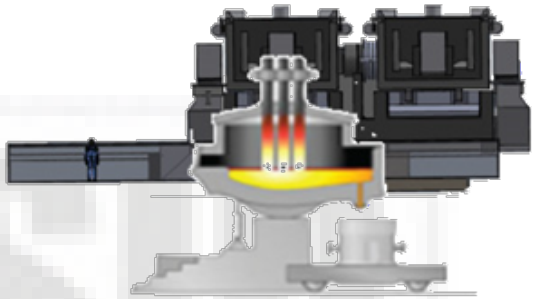
- Step 1:



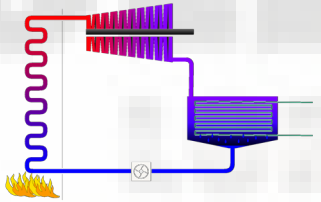
Preheating in the furnace

- Step 2:

Preheating after the furnace



- Step 3:



Use of remaining energy

Example ORC

Traditional EAF

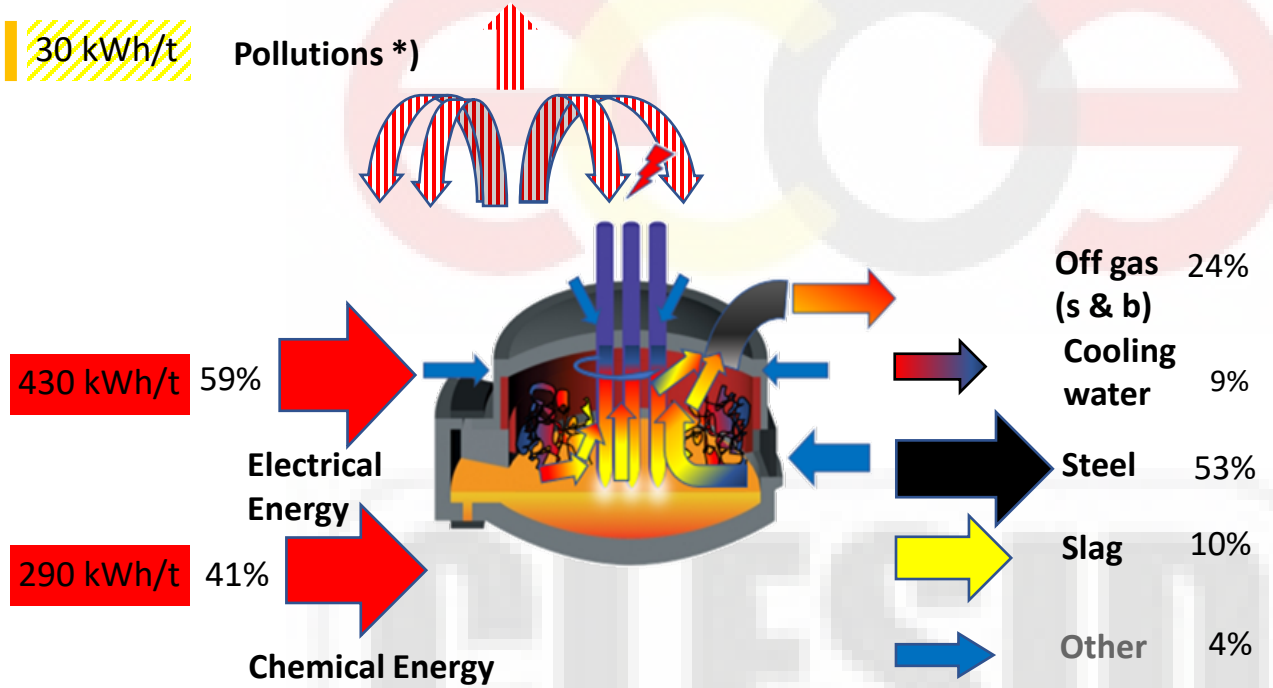
No Scrap Preheating in the Furnace

Energy balance 720 kWh/t

Total energy 720 kWh/t

Profit 385 kWh/t

Losses 335 kWh/t



*) Pollutions and reactions are inherent to the scrap

Heat to the environment 305 kWh/t

Untreated and unfiltered toxic output around the furnace

TORUS-EAF

Advantages: Less burners, less CO_2, lower electrode consumption, shorter melting time

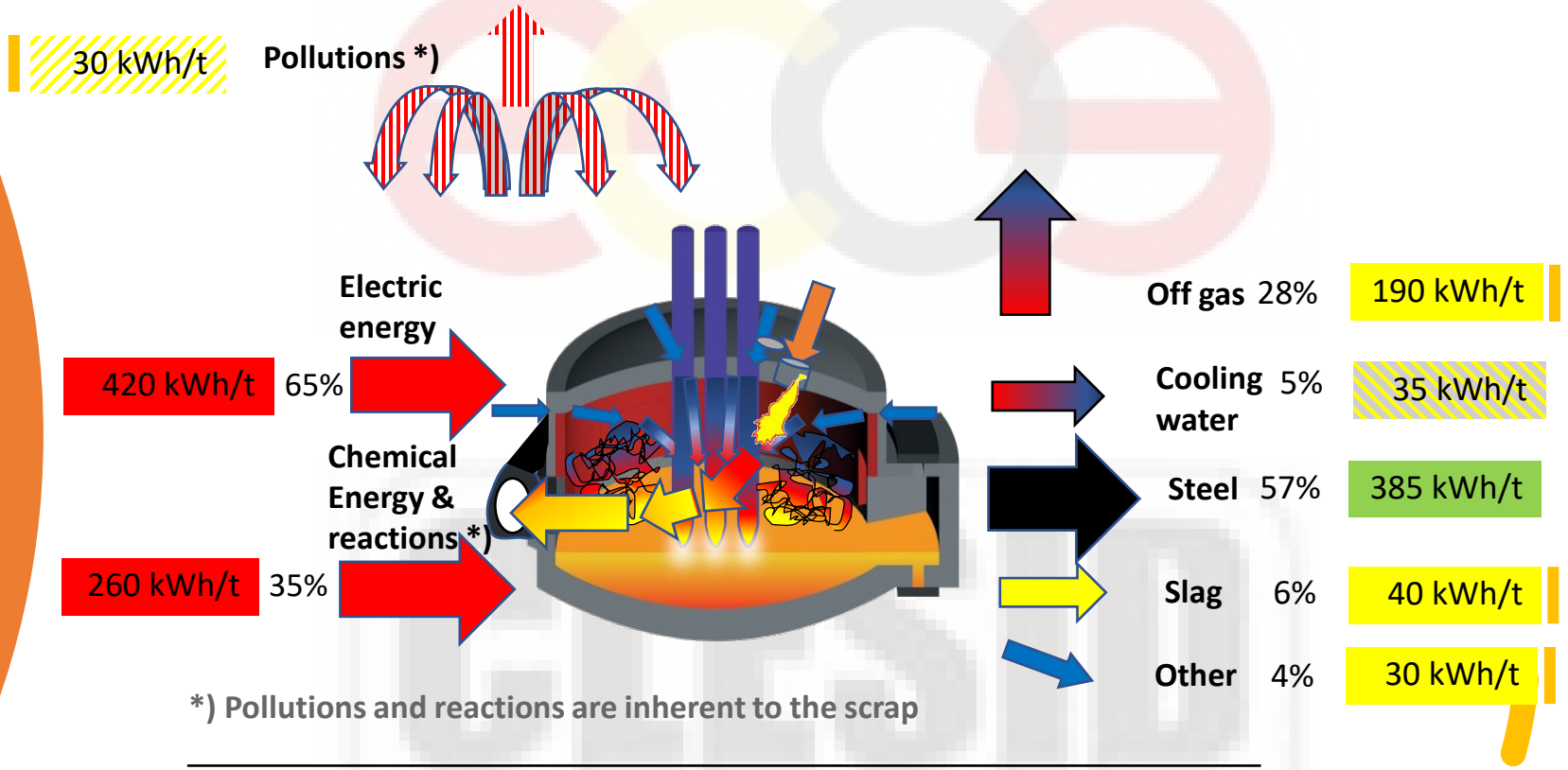
Scrap Preheating in the Furnace

Energy balance 680 kWh/t

Total energy 680 kWh/t

Profit 385 kWh/t

Losses 295 kWh/t



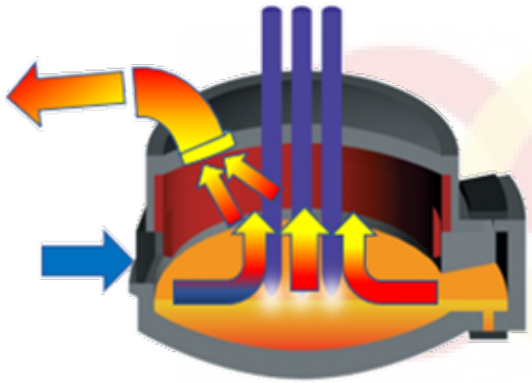
*) Pollutions and reactions are inherent to the scrap

Heat to the environment 290 kWh/t

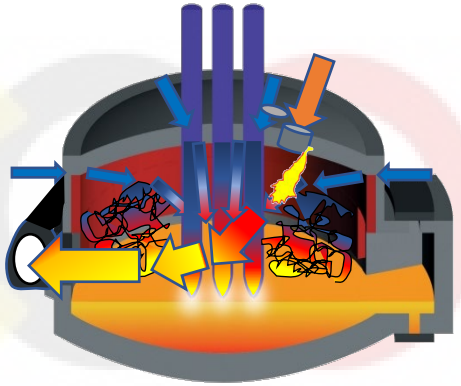
Untreated and unfiltered toxic output around the furnace

Scrap Preheating in the Furnace

Comparison



Convectional EAF



Preheating EAF (Torus)

Advantages:

Less burners,
Less CO_2,
Lower electrode consumption,
Shorter melting time,
Less weight on cover,
Reliable off-gas measurement,
Control of furnace atmosphere(ViU)
Off gas evacuation while opening roof

Total energy	**720 kWh/t**	**680 kWh/t**
Losses	**335 kWh/t**	**295 kWh/t**

Traditional Scrap Preheating after the Furnace

Internal energy balance 788 kWh/t

External energy balance 592 kWh/t

Energy balance furnace 668 kWh/t

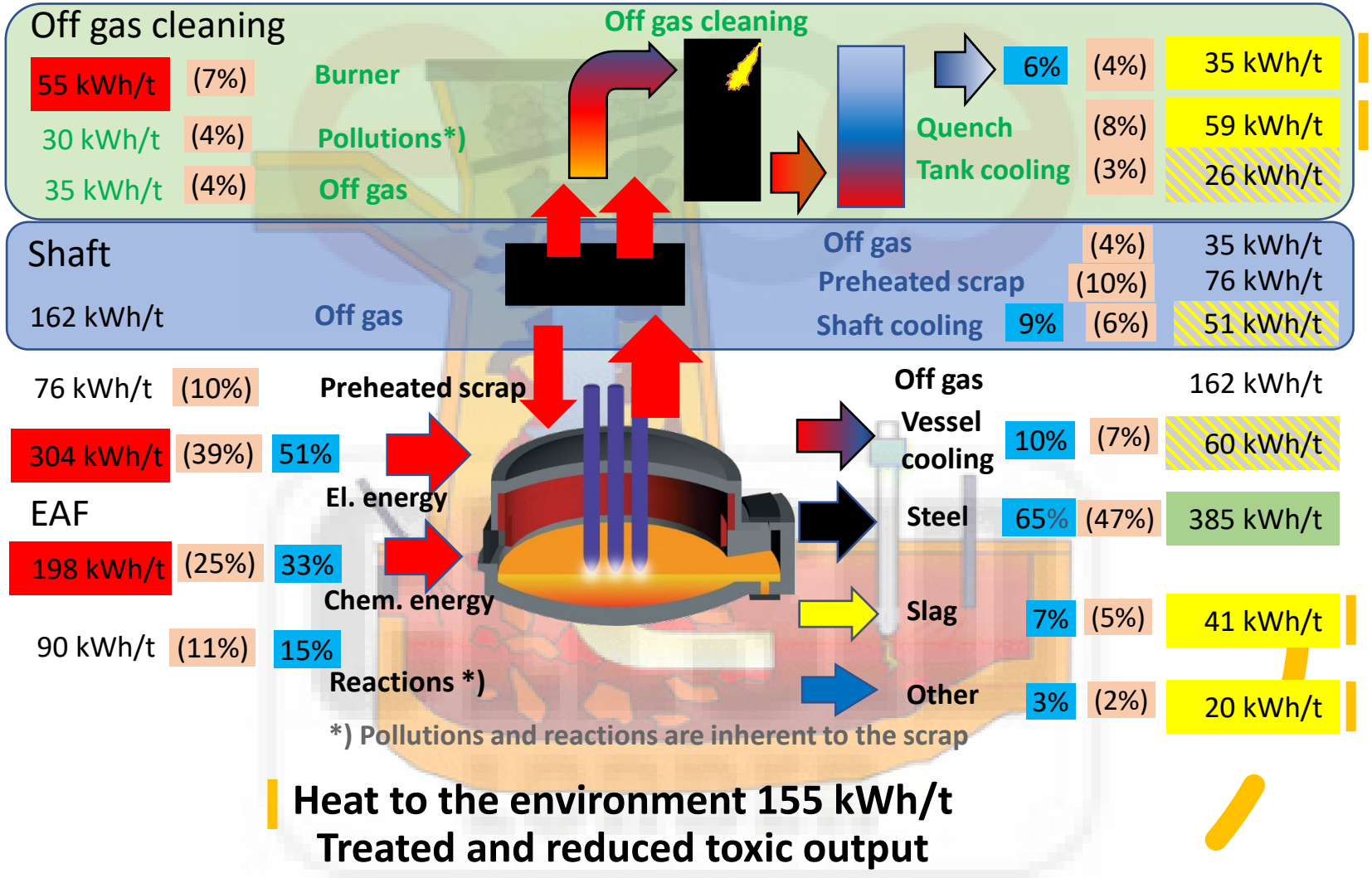
Real energy input 597 kWh/t

Profit 385 kWh/t

Losses 292 kWh/t

Energy recuperation 47%

Traditional single tank solution⁺)



Heat to the environment 155 kWh/t
Treated and reduced toxic output

These values are from an existing steel plant. (⁺) shaft EAF)

New Scrap Preheating after the Furnace

Internal energy balance 756 kWh/t

External energy balance 566 kWh/t

Energy balance furnace 680 kWh/t

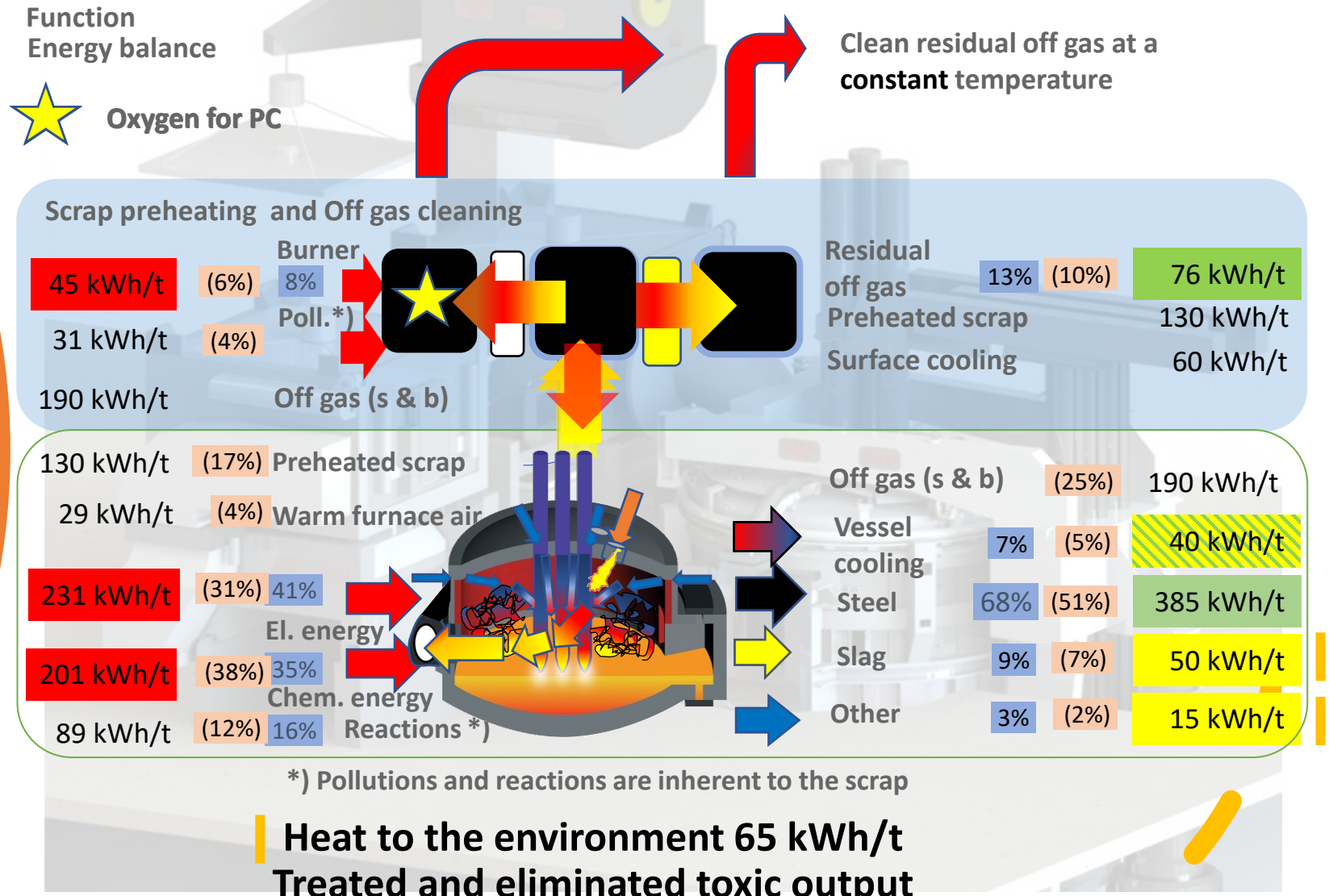
Real energy input 477 kWh/t

Profit 461 kWh/t

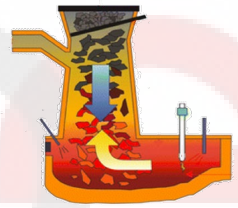
Losses 105 kWh/t

Energy recuperation 49%

eco-e tech (two tank solution)



Comparison

	 Shaft type	 eco-e tech
Transfer of the sensible heat of the off-gas to the scrap	✓	✓
Integrated combustion of pollutions and reactions	×	~30 kWh/t_{Scrap}
Post-combustion in the scrap	×	~ 70 kWh/t_{LS}
Integrated burners to burn the combustion products (PCDD/F, VOC)	×	~ 45 kWh/t_{LS}
Off-gas analysis for burner control and container change	×	✓
Application for special electrode tip cooling (CCU)	×	✓
Better heat transmission due to low off-gas speed and large cross section change	×	✓
Addition of heavy internal scrap to the furnace	×	✓
Addition and preheating of slag builder	×	✓
Real energy input [kWh/t]	597	477

Scrap preheating

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TORUS EAF

The scrap preheating inside the furnace

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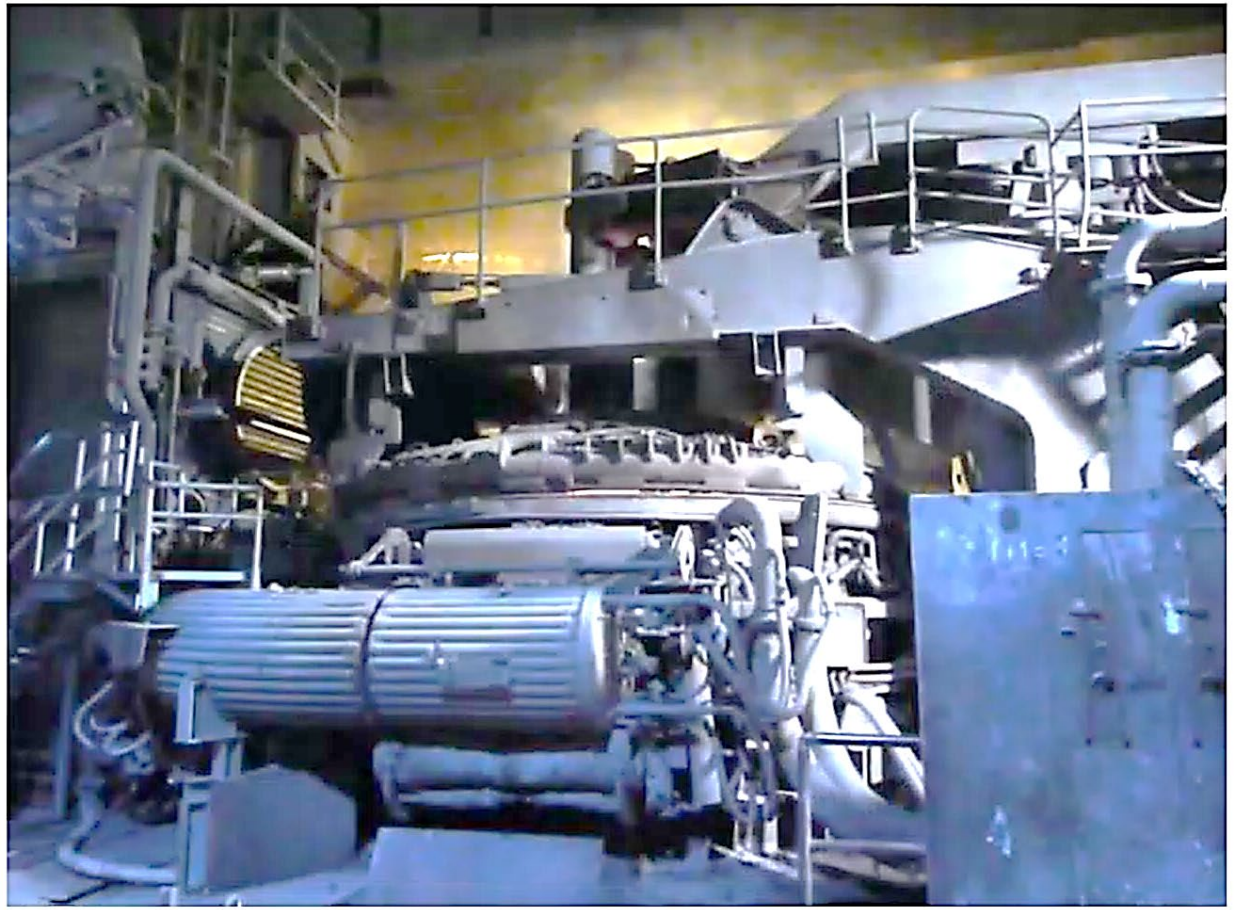
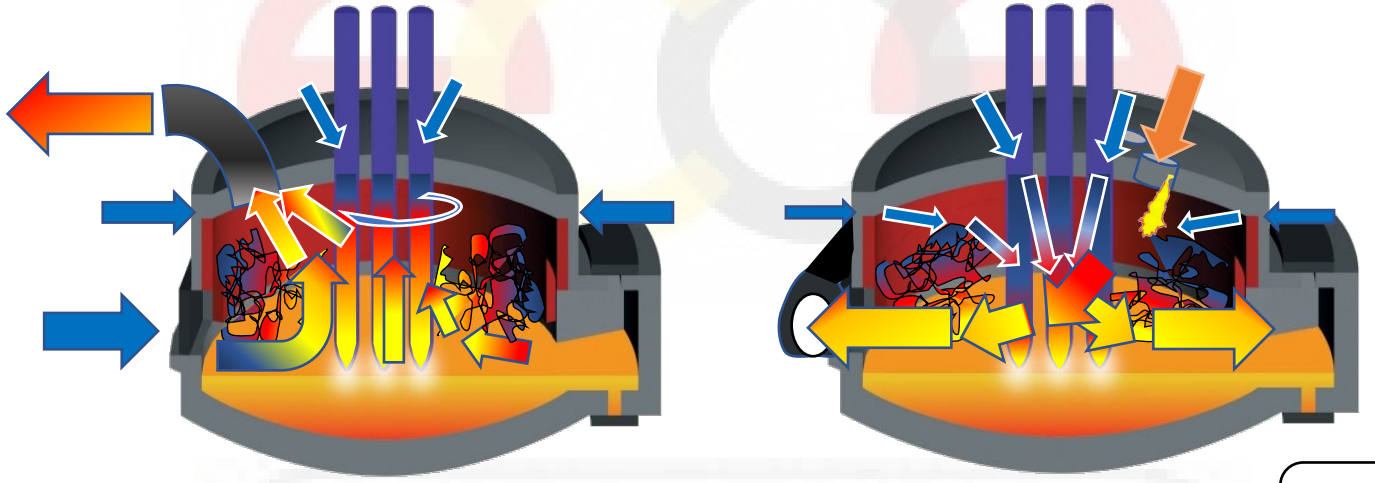
The scrap preheating after the furnace

Torus EAF

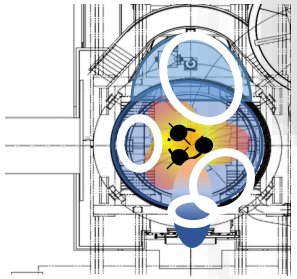


Traditional EAF vs Torus EAF



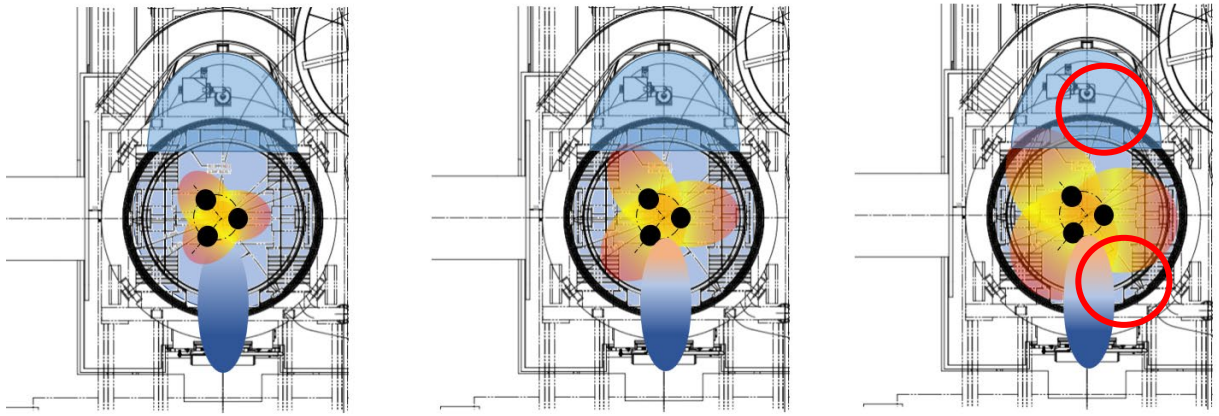
Scrap preheating in the furnace

Electrode consumption
Scrap preheating in the furnace
Cold spots
Off-gas measurement
Slag door

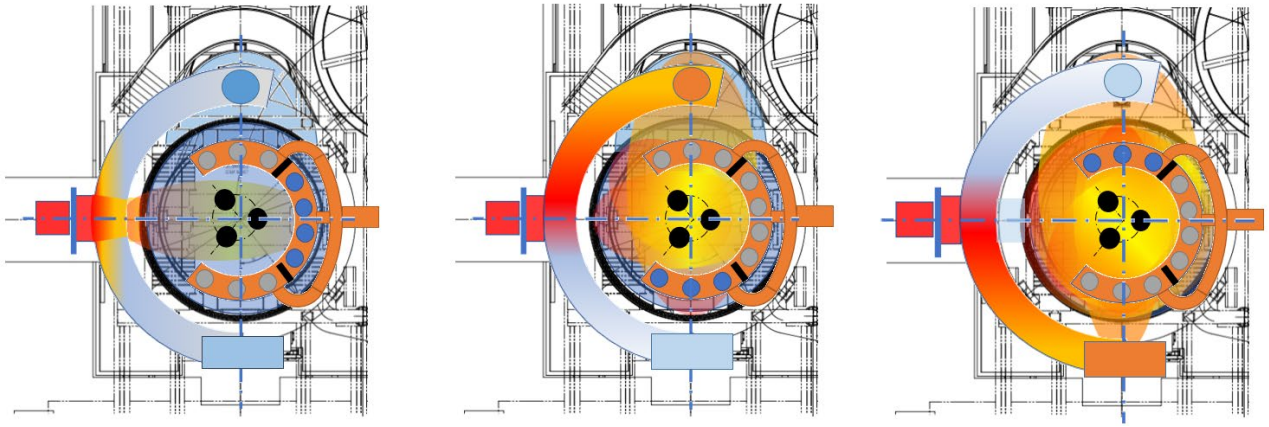


			Benefit
Electrode consumption	1.4 kg/t_{LS}	~0.8 kg/t_{LS}	~0.6 kg/t_{LS}
Scrap preheating in the furnace	0 kWh/t_{LS}	~40 kWh/t_{LS}	~40 kWh/t_{LS}
Cold spots	Yes	No	
Off-gas measurement	Not reliable	Reliable	
Slag door	Needed	Included	

Torus EAF
(no cold spots)

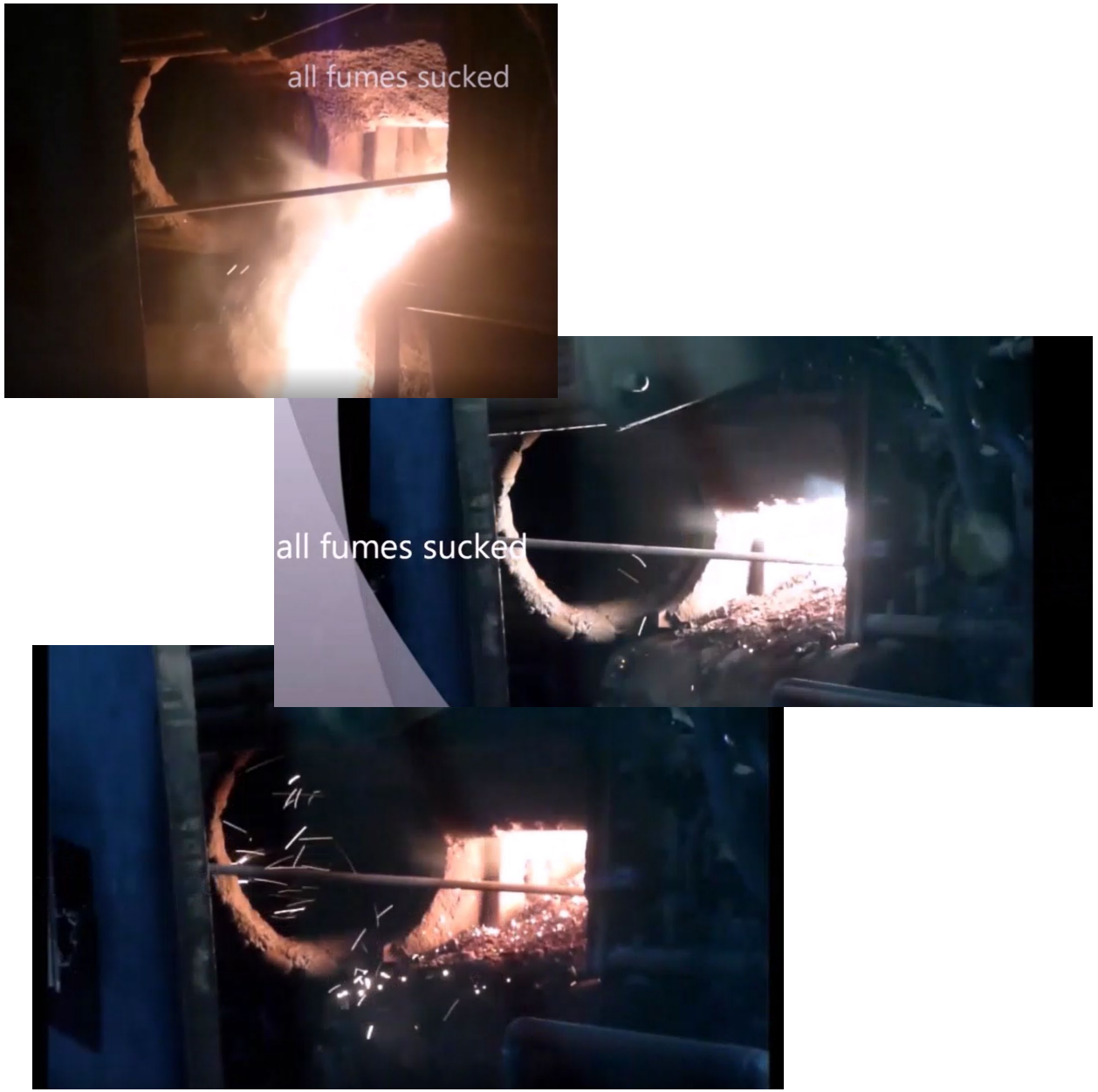


The traditional melting and its cold areas



The horizontal melting without cold spots

Torus EAF
(fumes **always** sucked)



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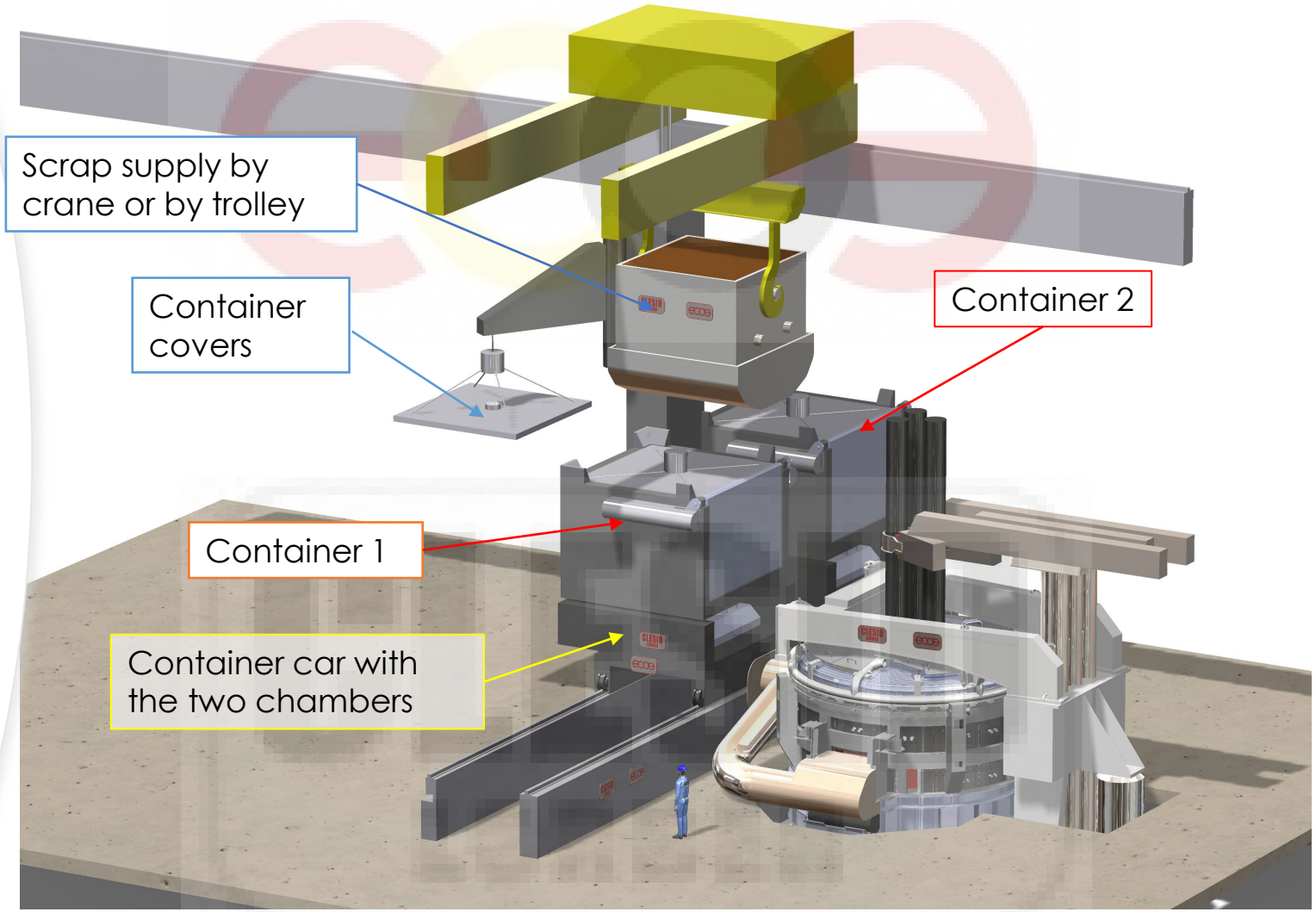
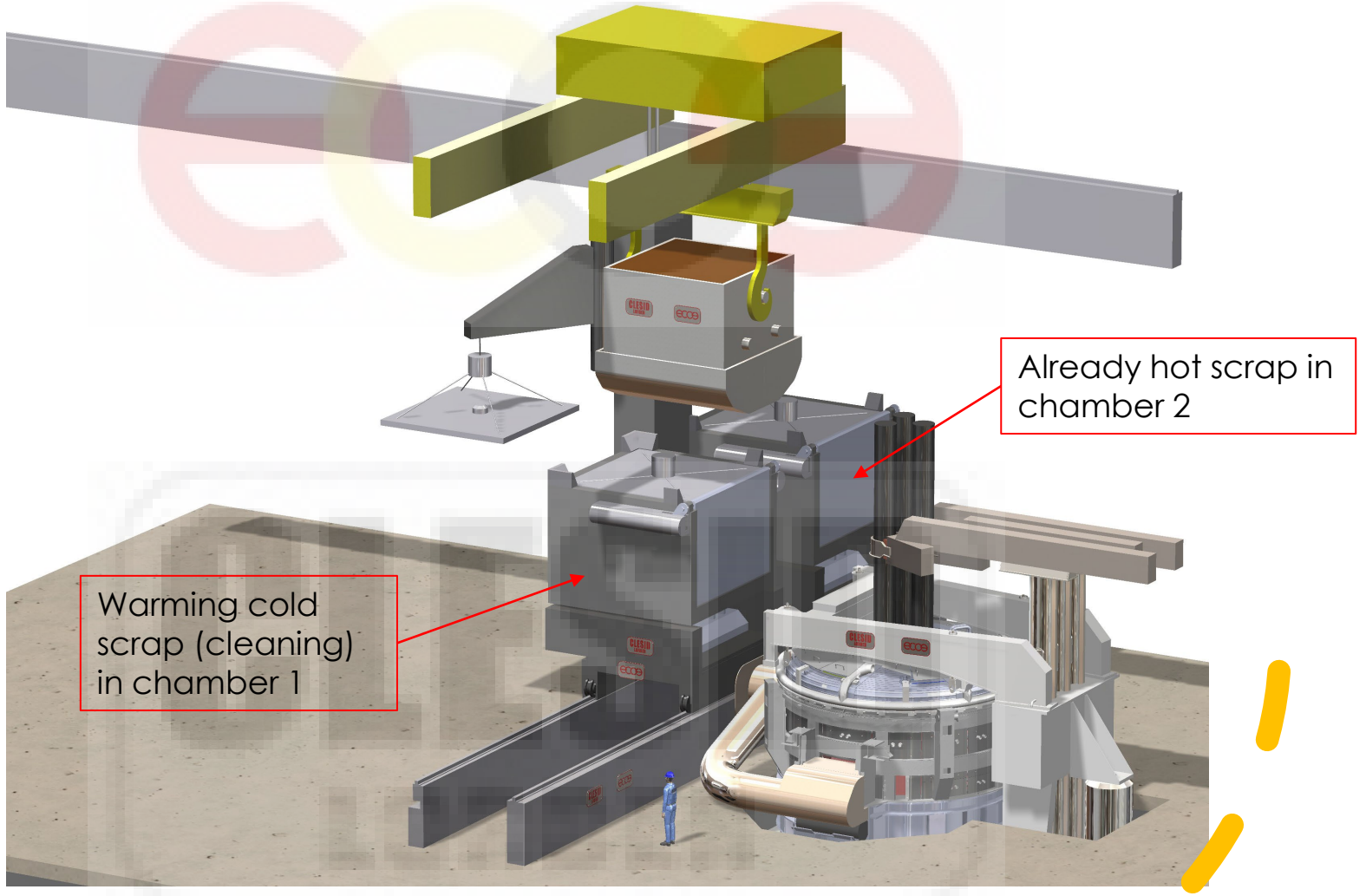
The Torus EAF doesn't need a 4th hole and a slag door



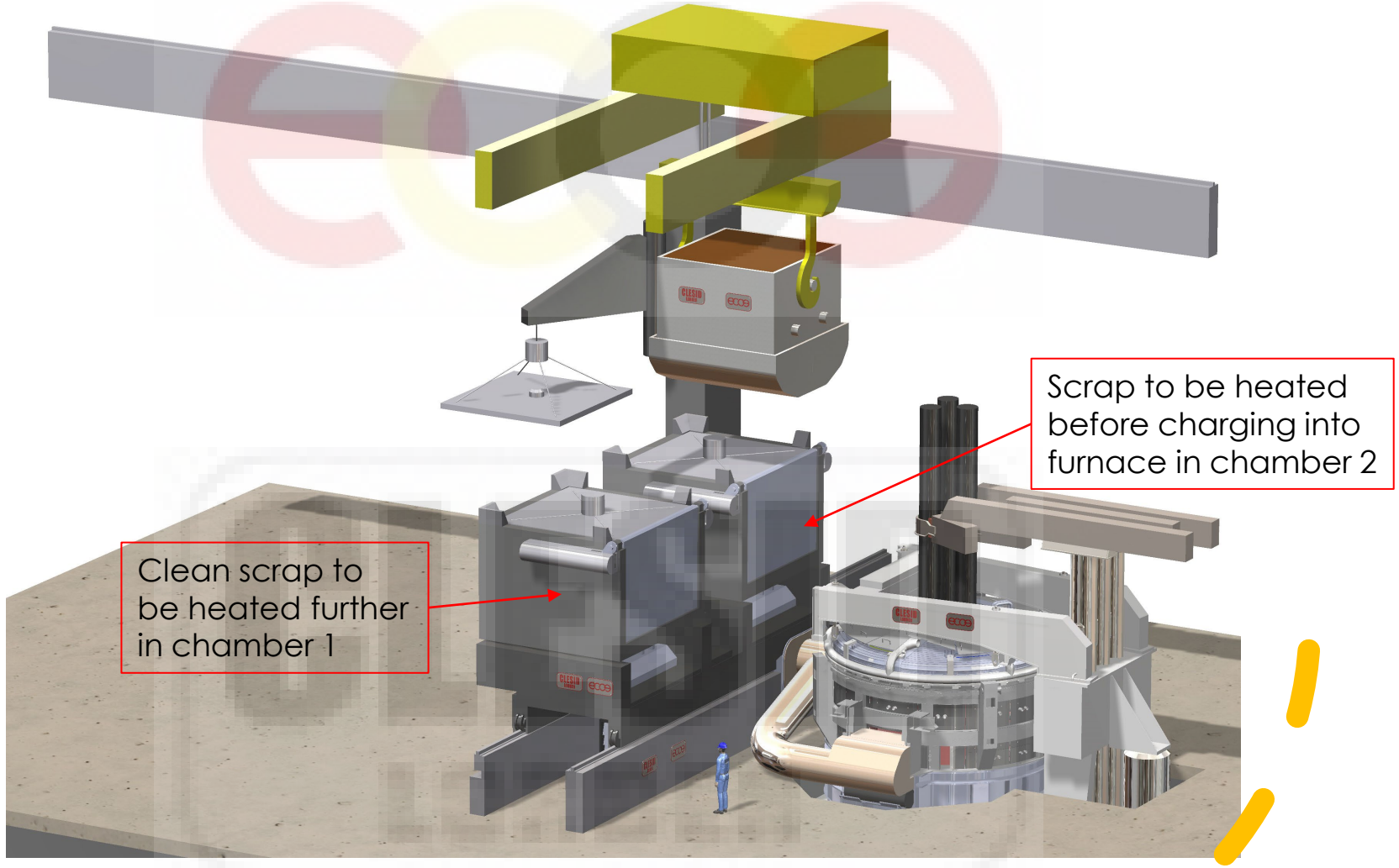
Scrap preheating after the furnace

The container movement



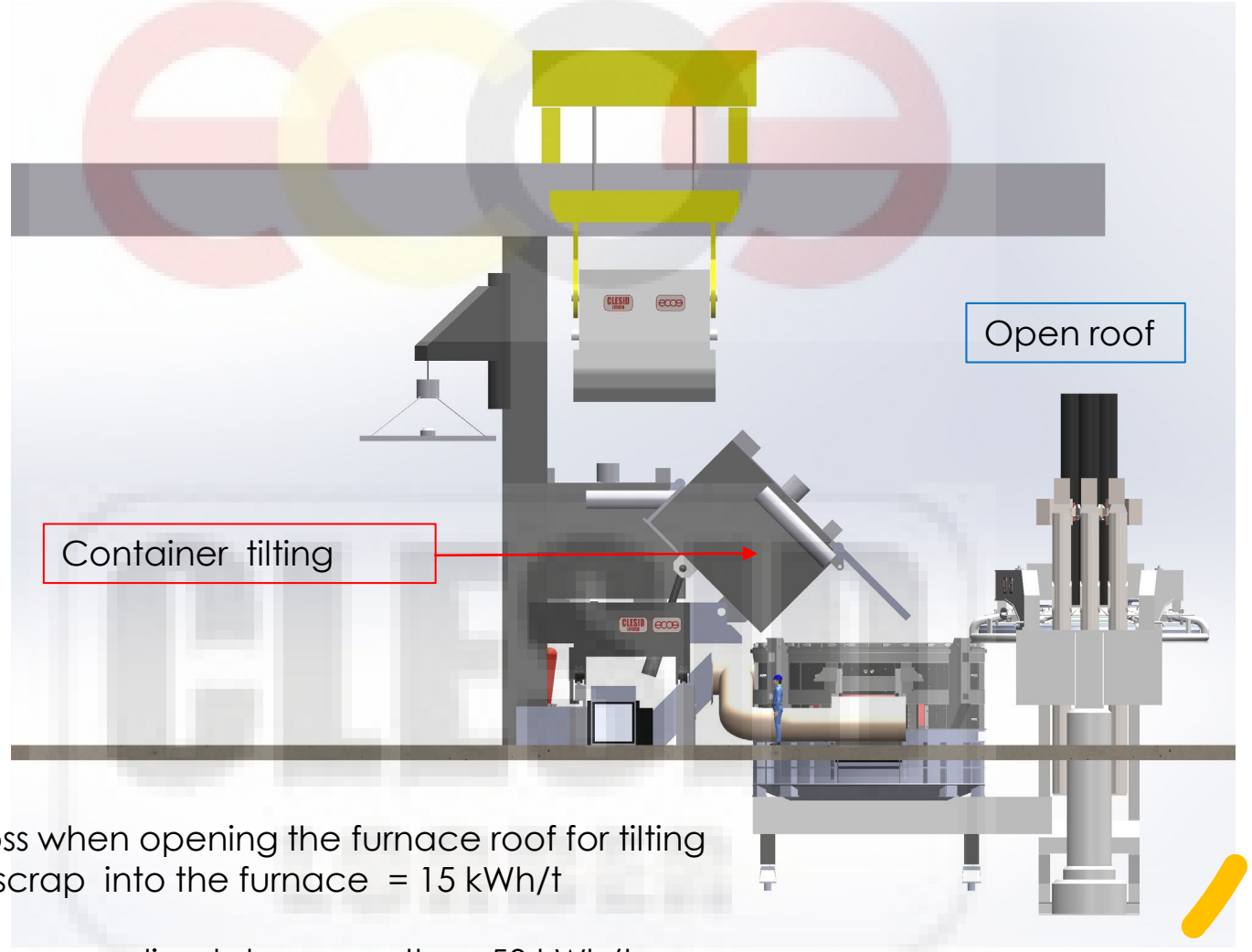
Scrap preheating after the furnace

The container movement



Charging the scrap into the furnace

Scrap preheating after the furnace



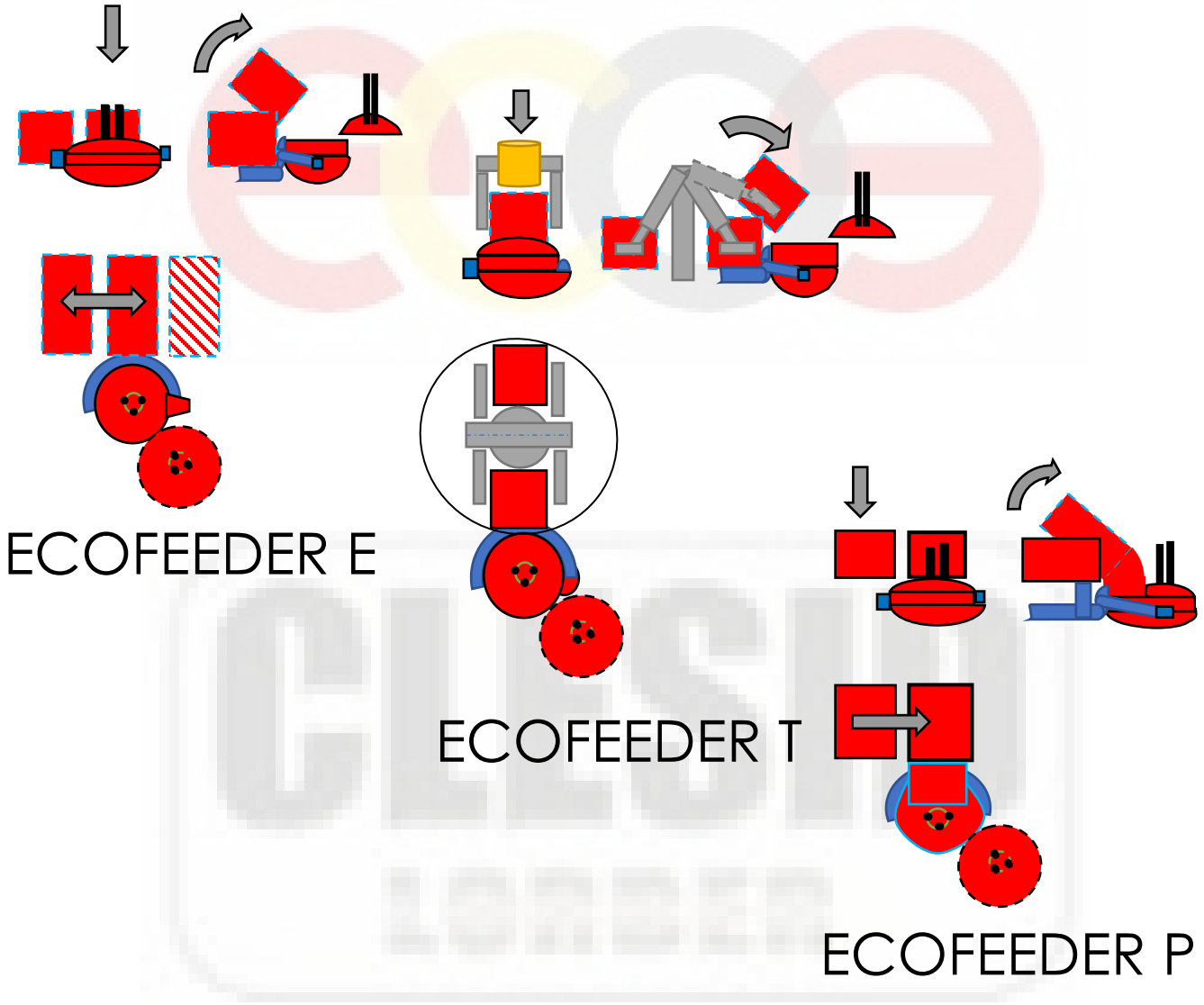
Radiation loss when opening the furnace roof for tilting preheated scrap into the furnace = 15 kWh/t
While
Shaft and finger cooling takes more than 50 kWh/t

Advantages and outstanding differences

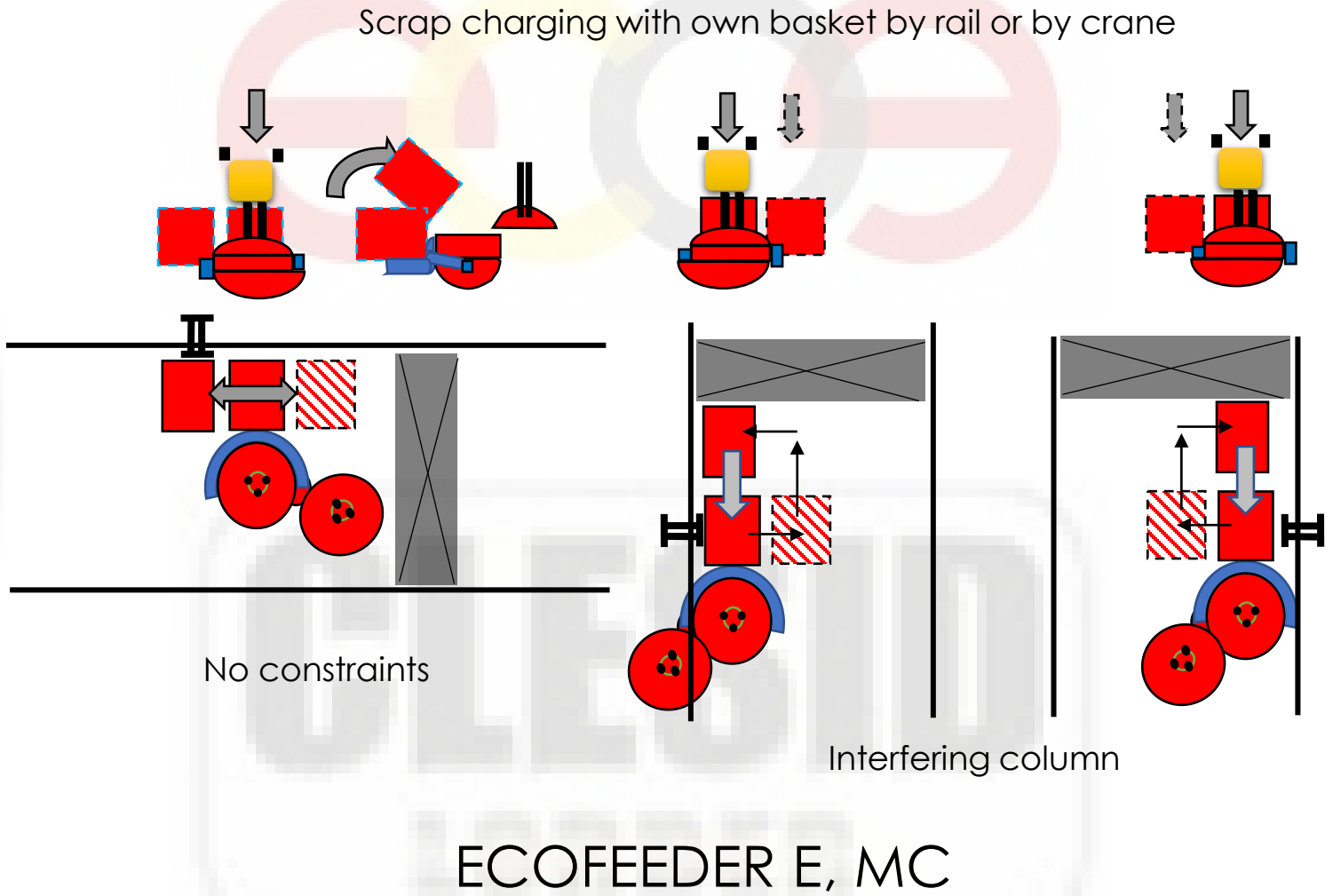
Some important advantages and outstanding differences of the **eco-e tech** solution are:

- Possibility to open the roof for loading heavy scrap (return and internal), for maintenance, and for repair.
- Use of the furnace in both, scrap preheating and traditional mode (bypass mode)
- No mechanical elements near the furnace (no fingers, no pusher, no belt, and no vibration table).
- Unlimited use of residual energy and almost no dust waste.
- Storage of preheated scrap during interrupts, down-times, traditional mode, and stops.
- Reinforced refractory-concrete lined container assures more equal energy transfer. No on-board maintenance – relining!

The ECOFEEDER Family

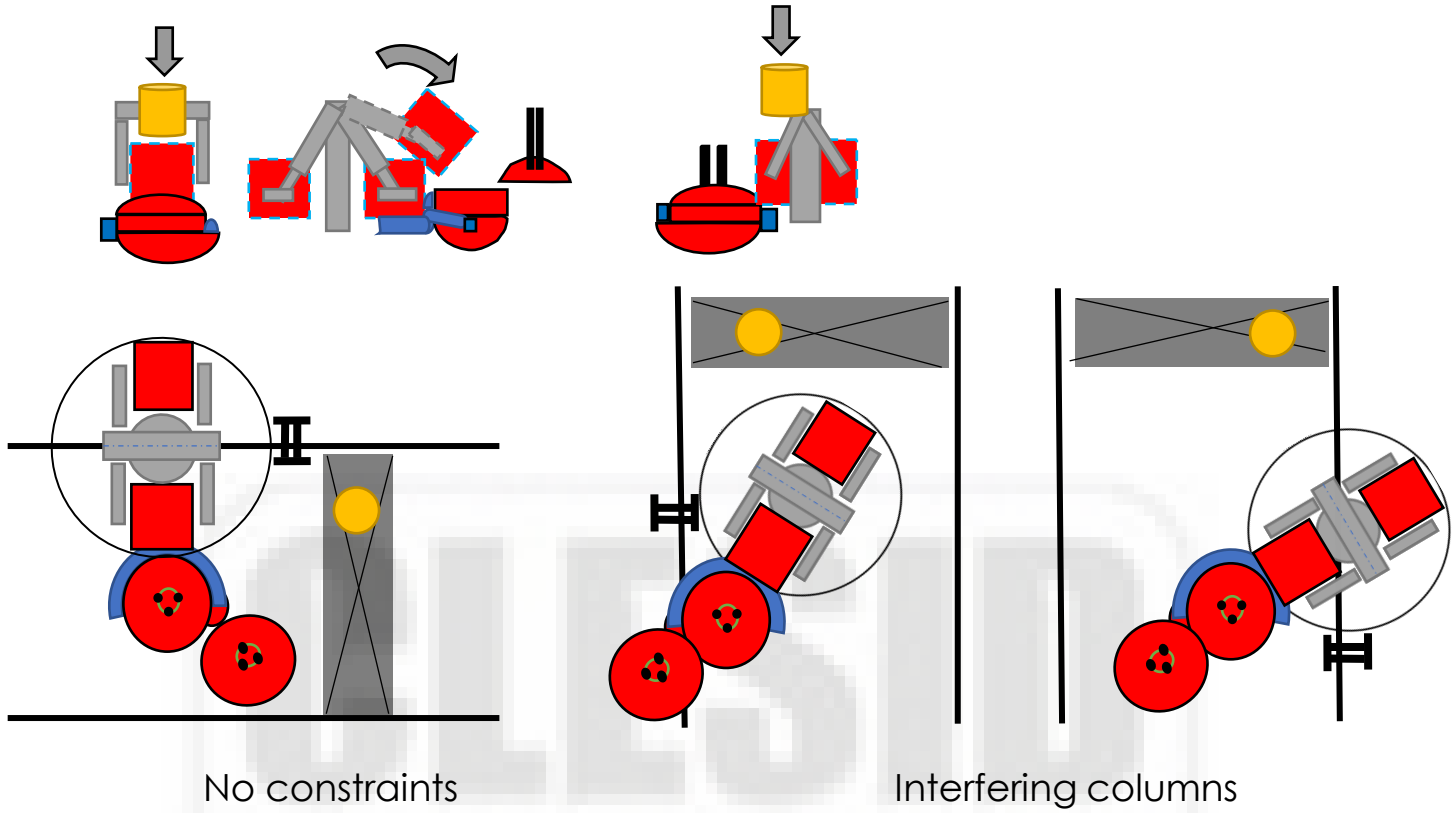


The ECOFEEDER Adaptability



The ECOFEEDER Adaptability

Scrap charging by **existing** basket



No constraints

Interfering columns

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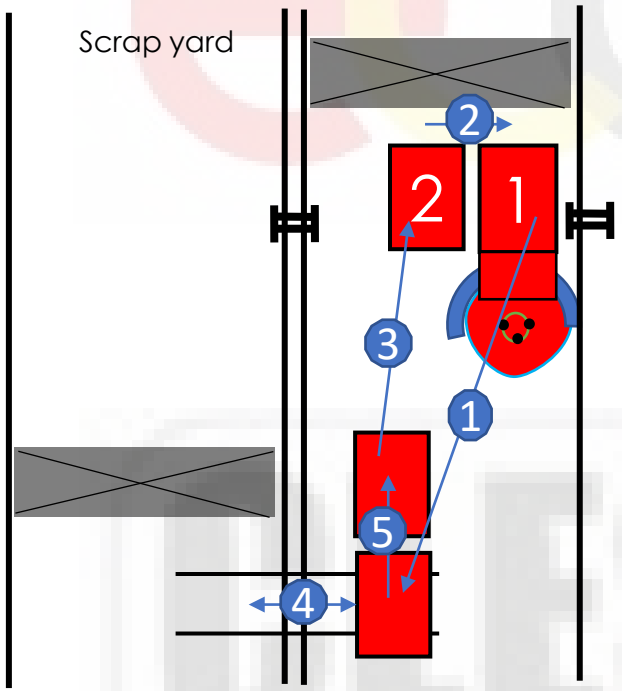
The ECOFEEDER Adaptability

Container movement
(no need for a scrap basket)

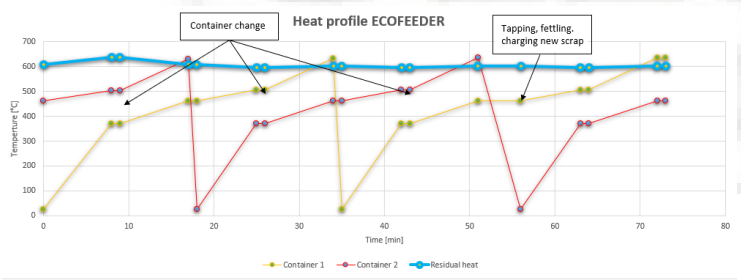


1. After charging into the furnace lift off the container at pos. 1 and move it to the transfer car
2. Push full container in front of the furnace
3. Bring full container from stand to pos. 2 and start melting.
4. Move empty container to the scrap yard and fill it again.
5. Move full container from transfer car to stand.

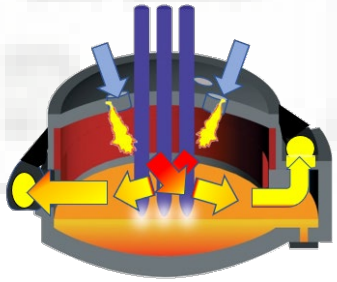
ECOFEEDER P

Conclusion Comparison and Benefits

- We have seen the advantages of the Torus furnace.
- The two-tank solution has convincing advantages such as **less energy input** (-120 kWh/t) and a far **smaller environmental footprint** (CO_2, heat to the environment, NOx).
- The combination of the benefits: a reliable furnace atmosphere control, the versatility in use, and finally a clean and almost dust-free off gas which allows to benefit of its energy in various applications is unprecedented.
- The flexibility of the eco-e tech solution allows to use almost all scrap qualities **from light to heavy scrap**, thanks to the container shape and the possibility to open the furnace roof at any time.
- The adaptability of the eco-e tech solution allows to integrate into an existing steel plant without major modifications and building extensions, it usually fits with the actual combustion chamber



Typical heat profile of the off gas after scrap preheating



Internal scrap preheating

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Economic aspects

Torus EAF (Step 1)

Example: Short business plan

- Revamping of an AC-EAF
- Business objective: minimal exhaust emissions, minimal heat dissipation, minimal energy input

• Interim goal:	Energy input	- 40	kWh/t
	Electrode consumption (3.75gr/kWh)	~- 0.6	kg/t

➢ Timeline:	Basic engineering	4	6 weeks
	Detail engineering	8	14 weeks
	Fabrication	10	24 weeks
	Pre-assembly & -comm. & transp.	4	28 weeks
	Erection (prod. interruption)	2	30 weeks
	Commissioning	2	32 weeks
	Start of production	2	34 weeks

➢ Cost **)	Engineering	500,000 Euro
	EPC (Eng., Prod., Comm.)	1,200,000 Euro
	Turnkey	2,200,000 Euro

✓ ROI		after start-up / contract
	(savings 11.30€/t*)	19 / 53 weeks

*) El. Energy@100€/MWh, NG@40€/MWh, Coal@120€/t, Electrodes@15€/kg, H_2@10€/MWh, O_2@0.1€/Sm^3; prod. 10'000 t/week

**) Costs: The indicated figures are representing a mean value. We usually elaborate on offer with the real costs together with a feasibility study.

ECOFEEDER (Step 2)

Example: Short business plan

- Business objective: minimal exhaust emissions, minimal heat dissipation, minimal energy input

  - Interim goal: Energy input - 120 kWh/t
    Electrode consumption (3.75gr/kWh) ~- 0.3 kg/t

  - ➢ Timeline:

Basic engineering	6	8 weeks
Detail engineering	10	18 weeks
Fabrication	16	34 weeks
Pre-assembly & -comm. & transp.	6	40 weeks
Erection (prod. interruption)	2	42 weeks
Commissioning	2	44 weeks
Start of production	4	48 weeks

  - ➢ Cost**)

Engineering	1,600,000 Euro
EPC (Eng., Prod., Comm.)	5,000,000 Euro
Turnkey	8,400,000 Euro

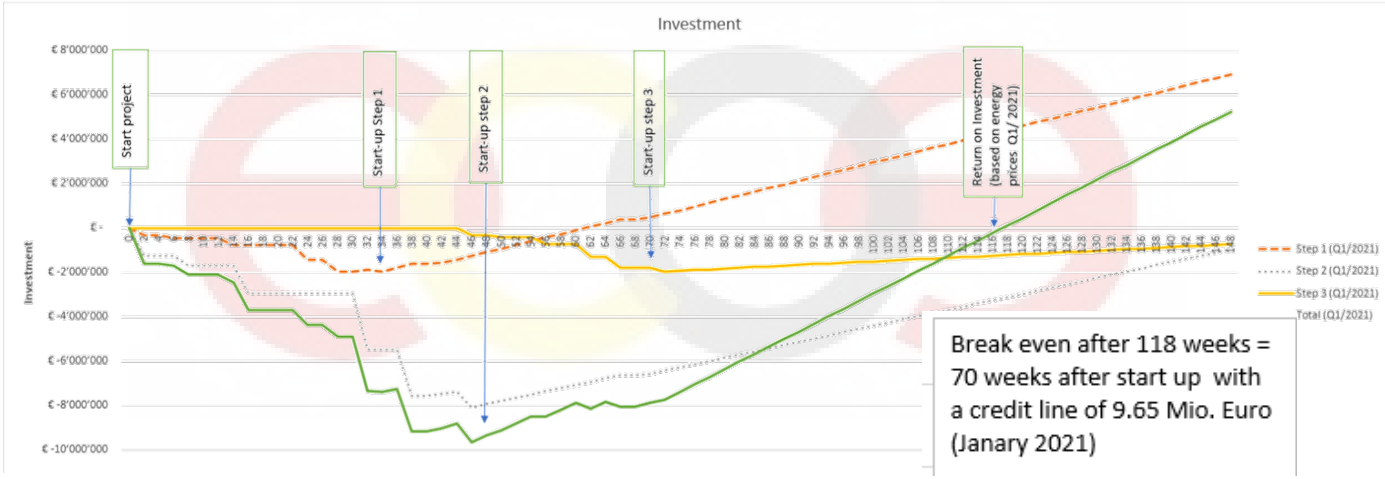
  - ✓ ROI after start-up / contract
    (savings 17.10€/t*) 49 / 97 weeks

*) El. Energy@100€/MWh, NG@40€/MWh, Coal@120€/t, Electrodes@15€/kg, H_2@10€/MWh, O_2@0.1€/Sm^3; prod. 10'000 t/week

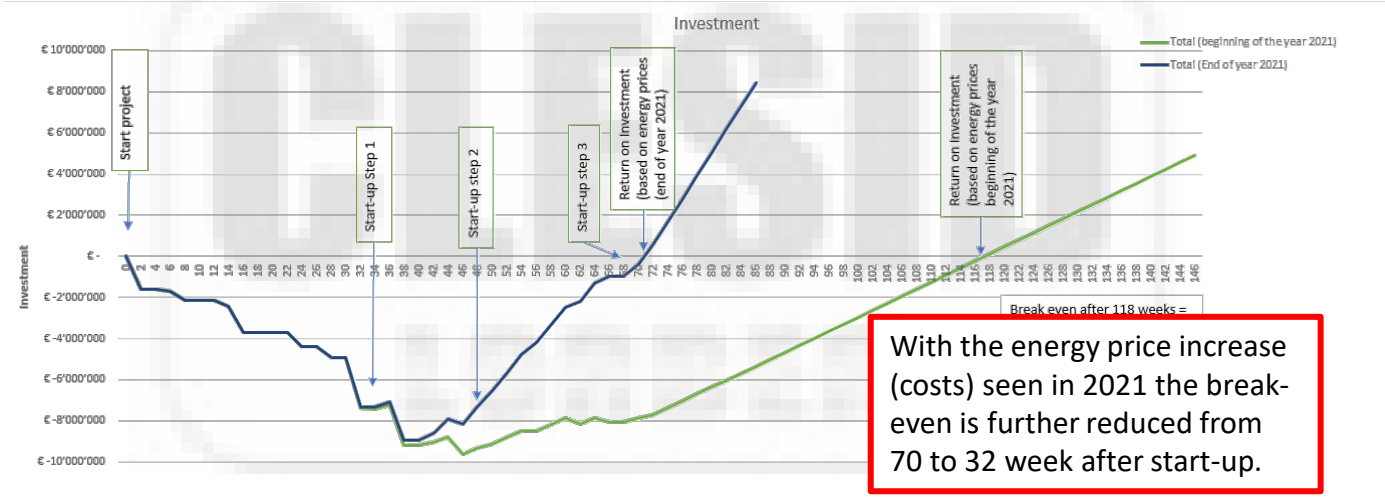
**) Costs: The indicated figures are representing a mean value. We usually elaborate on offer with the real costs together with a feasibility study.

Break-even point and cost developments

Project investment and break-even point (Jan. 2021 basis)



Cost developments and break-even point (Jan. 2021 vs. Dec. 2021)



Conclusion ECO-E TECH and the benefit

Higher benefit due to:

- High energy recuperation:
  - High energy backflow
  - High energy efficiency
  - Less electrode consumption
- No uncontrolled energy loss:
  - Burn-off of pollutants and reactors
  - Less radiation and el. resistance losses
- Reliable off-gas control
  - Better utilisation of the off-gas energy
  - Lower GHG footprint
- Less operational costs
  - Less dust waste
  - Less maintenance
  - 'Use and refit' practice
- High versatility
  - Use of different raw material
  - wide range of scrap densities, light and heavy scrap

For the sake of the company …

Conclusion ECO-E TECH and the Environment

Lower environmental impact due to:

- Less toxic and harmful emissions
  - No uncontrolled burn-off of pollutants and reactions
  - No post-combustion losses
- Less heat emissions
  - Better heat transmission
  - Lower off-gas speed
  - Two container system
- Less environmental waste
  - Less dust waste
  - Active CO_2 process use (CCU)
- Less GHG emissions
  - Lower need of fossil energy

For the sake of the environment …

We are ready for 2030! And you?

- Interested?
- Order a feasibility study based on your plant and you will get the real data!
- Thank you for your attention!