



**«LUELU»  
LLC  
LOGICALU**

Presentation  
of the industrial implementation of a  
new digital technology for logic  
control of an electrolyzer at  
Emirates Global Aluminium (EGA)

**sk**  
СКОЛКОВО

# Project summary



**LUEL LLC**, a participant of the **Skolkovo innovation center**, he has created in **Russia at the Bratsk Aluminum Plant** a new in the world practice **digital technology** of logical control of an aluminum electrolyzer.

**At EGA, the artificial intelligence of the LUEL control program will automatically select** the optimal parameters of the technological process to achieve the maximum TEP of the electrolyzer operation and the resulting profit.

### **Industrial tests at the Bratsk aluminum plant showed:**

- Decrease: voltage on the electrolyzer by 50-70 mV;
- electricity consumption by 250-300 kWh per ton of aluminum;
- consumption of aluminum fluoride by 1-3 kg. per ton of aluminum;
- Labor intensity of performing technological operations by 5-10%.
- Increase in metal current output by 0.3–0.5%.

### **At EGA the technology will be implemented**

on the basis of industrial tests for 3-4 months and a visual demonstration of the achieved TEP values with minimal costs, by reprogramming and improving the existing control system. There is no need to increase operating costs and stop the operation of electrolyzers, which ensures minimal risks, long-term profit for the entire period of operation and high profitability of the introduction of new technology.



# Revolutionary advantages of LUEL logic control

- All electrolyzer control systems existing in world practice: **Potion EGA**, **ALPSYS-Rio Tinto Alcan**, as well as Dassie-China, Alcoa QLC-USA, SAAT-2-Russia and other control systems **control the deviation of one parameter** based of current and voltage measurements at electrolyzer, which does not allow to promptly select the optimal parameters of the technological process to achieve the maximum TEP.

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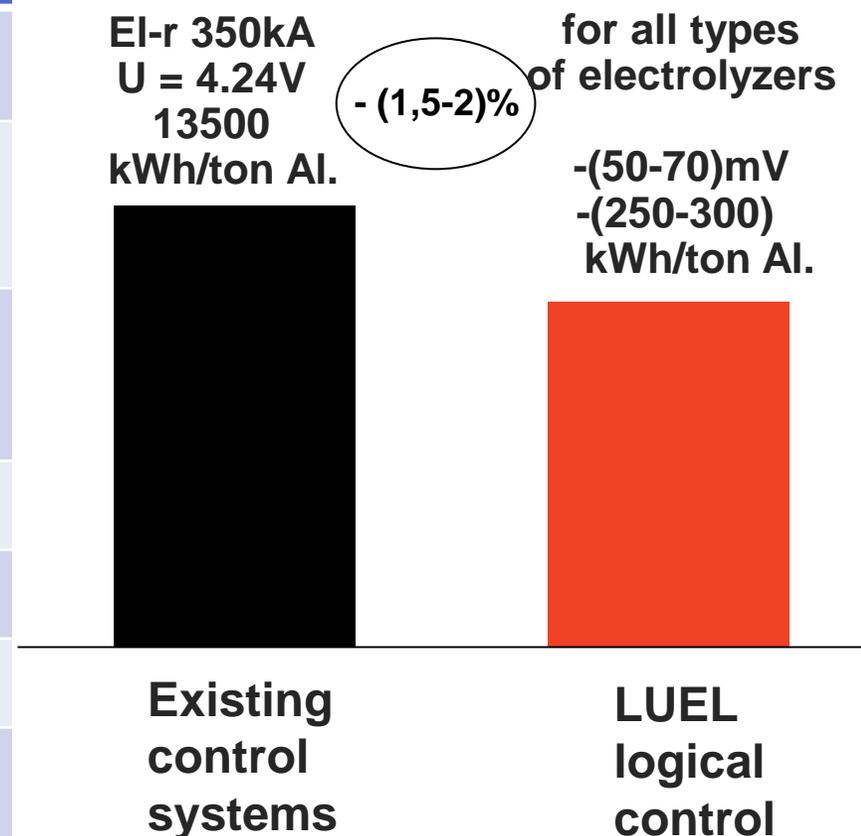
- **Logic control LUEL monitors 15 parameters of the electrolyzer at minimum power.** This makes it possible to evaluate the operation of the electrolyzer from all sides and automatically determine the optimal parameters of the thermal balance of the electrolyzers in order to achieve the maximums TEP in each period of time. |

# The efficiency of logical control of LUEL in comparison with the world control systems for electrolyzers

Achieved performance of leading companies using existing electrolyzer control systems.

Aluminum company	Hydro Aluminium	Alcoa USA	Rio Tinto Alcan	Chalco China	RUSAL Russia
Electrolyzer type	HAL-250	A-817	AP-35	Q-350	PA-300Б
Current strength kA.	275	320	350	350	320
Daily productivity kg.	2104	2448	2664	2664	2408
Current density A / cm <sup>2</sup>	0,82	0,80	0,83	0,84	0,86
Current output %	95,0	95,0	94,5	94,5	93,5
Voltage on the electrolyzer	4,25	4,38	4,30	4,24	4,36
Electrolyzer control system	HAL 3000	Alcoa QLC	ALPSYS	Dassie	SAAT-2

Increase of TEP for all types of electrolyzers and control systems using the logical control of the electrolyzer.



The tasks of LLC "LUEL" are to achieve maximum TEP with minimum costs in all aluminum smelters.

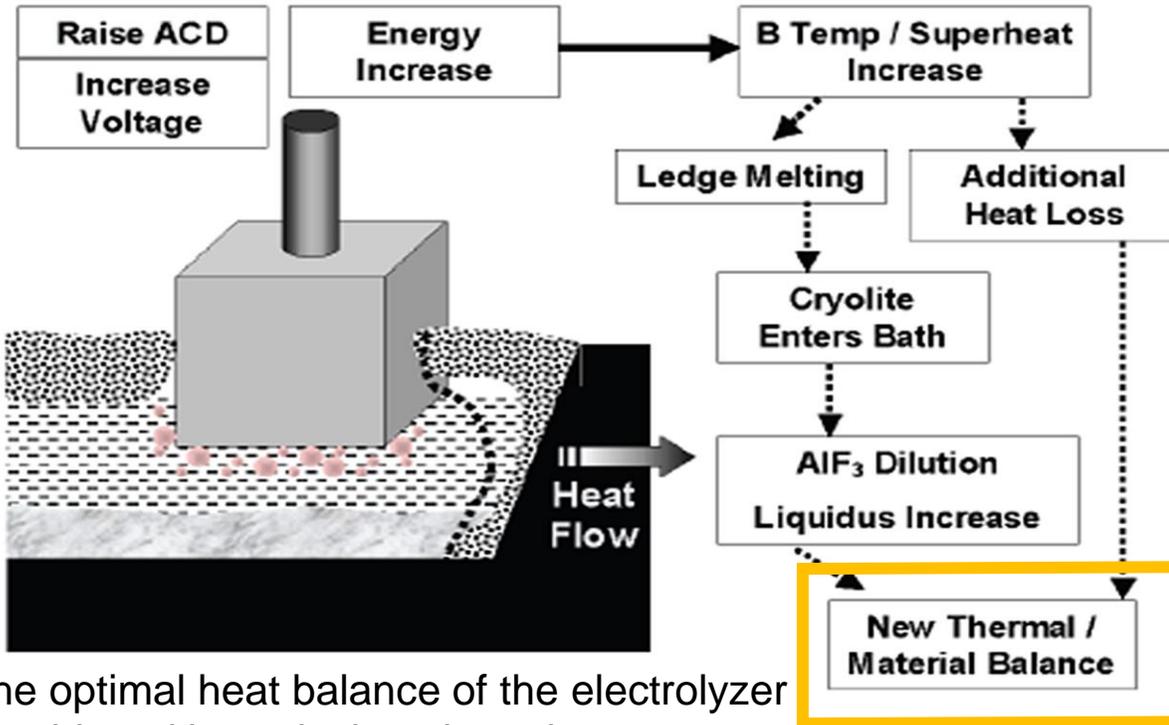


# Automatic selection of the optimal heat balance for an industrial electrolyzer.

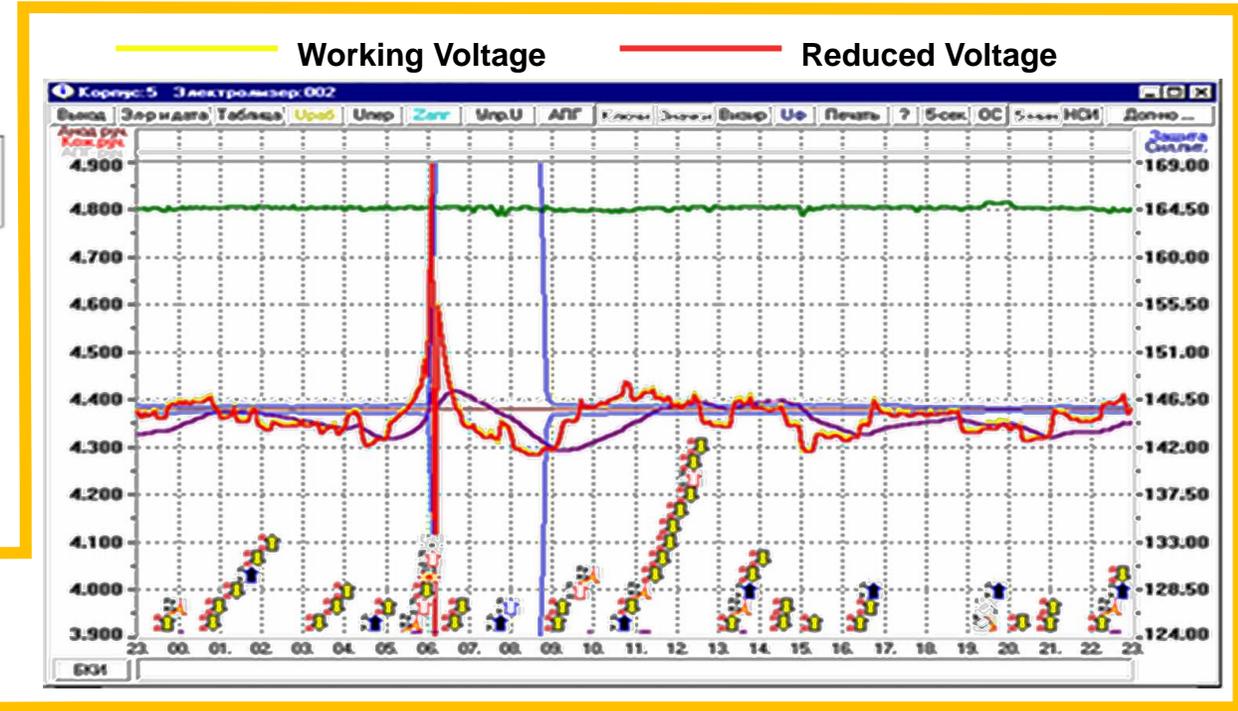
On electrolyzers, it is necessary to select the optimal heat balance and the optimal of material balance to achieve the maximums TEP.

The program of LLC "LUEL" automatically selects the optimal heat balance of the electrolyzer in the existing technological conditions of its operation and at the existing material balance.

Industrial testing at Bratsk aluminium smelter



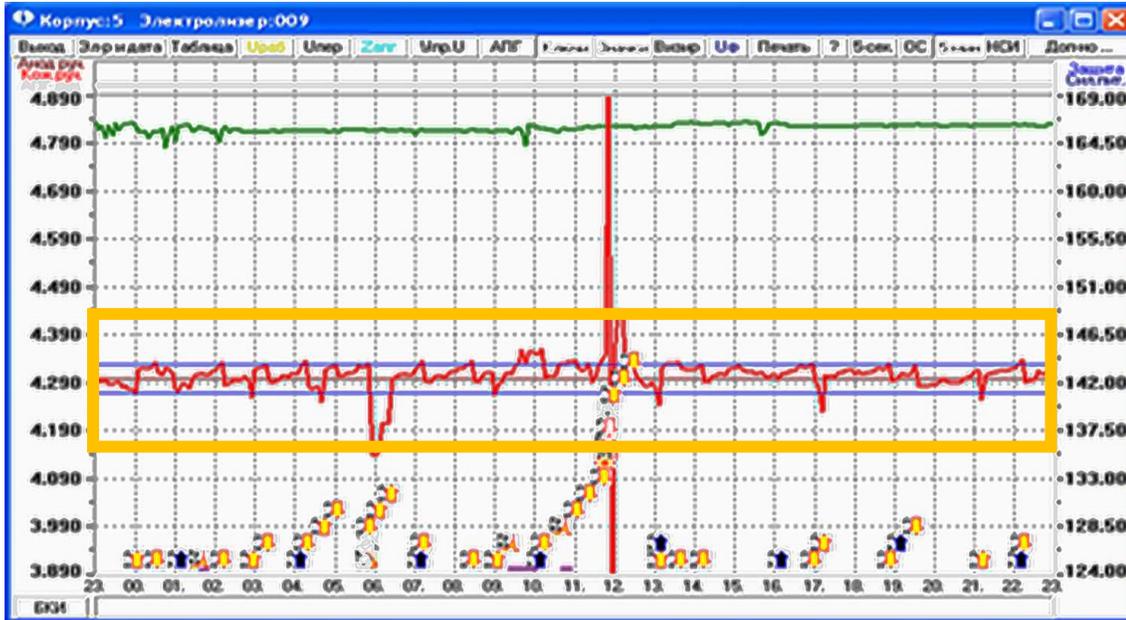
The optimal heat balance of the electrolyzer is achieved by reducing electrolyte overheating.



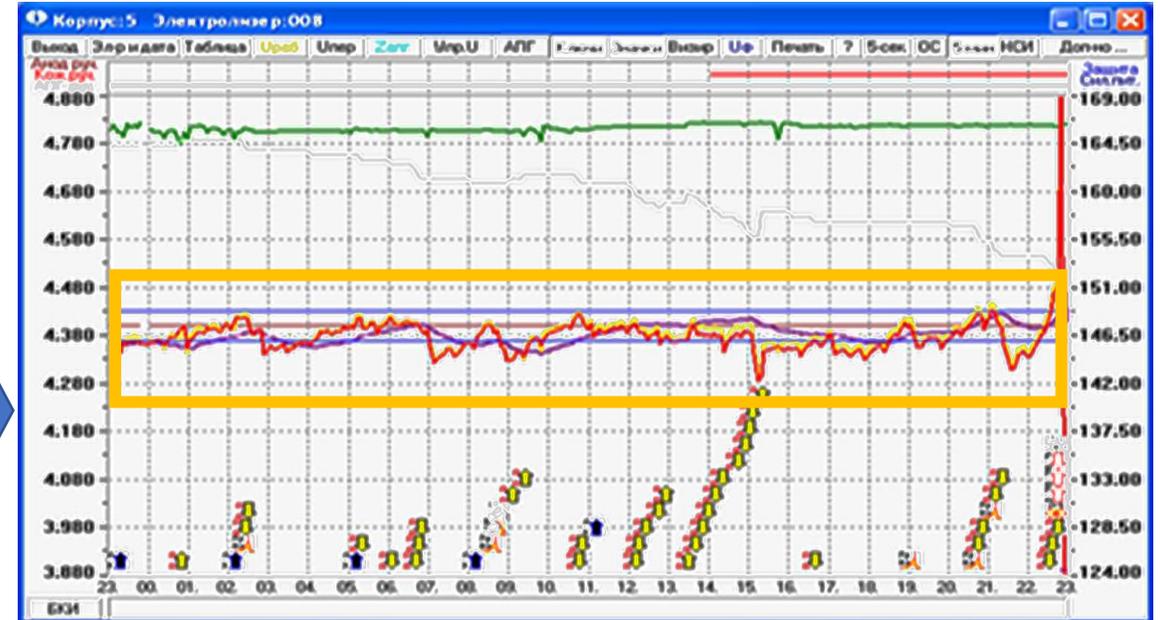
After the anode effect with the maximum heat release, as well as under the current operating conditions of the electrolyzer, the control program automatically selects the optimal parameters to reduce electrolyte overheating, energy consumption and increase the metal current efficiency.

# Automatic selection of optimal parameters at the Bratsk aluminum plant.

## Graph 1: Standard Control



## Graph 2: New Logical Control LUEL



Standard control on all types of electrolyzers requires the participation of a person who cannot promptly select the optimal thermal state of the electrolyzer, maintain optimal conditions of the technological process in each period of time for maximum metal production, of reduce the consumption of electricity, ALF3 and cannot reduce the labor intensity of work performed by technological personnel.

Control of 15 parameters makes it possible to evaluate the technological state of the electrolyzer from all sides and automatically select the optimal conditions of the technological process for maximum metal production, reducing voltage and energy consumption on the electrolyzer, aluminum fluoride and labor intensity of technological operations to achieve maximums TEP.

# Raising the technological indicators of industrial electrolysers to achieve maximums TEP

Comparative results of graphs 1 and 2 show the achievement of the maximums TEP at each electrolyzer

Control Parameter	Regulation of the Electrolyzer with Standard Control	Regulation of the Electrolyzer with “LUEL” Logic Control
Number Anode Movements per Day	63	37
Total Anode Movement per day (seconds )	110	46
Deviation of the operating voltage from voltage setpoint for regulation (mV)	(+19)	(-17)
Achievement of maximums TEP	Random selection	In each period of operation of the electrolyzer

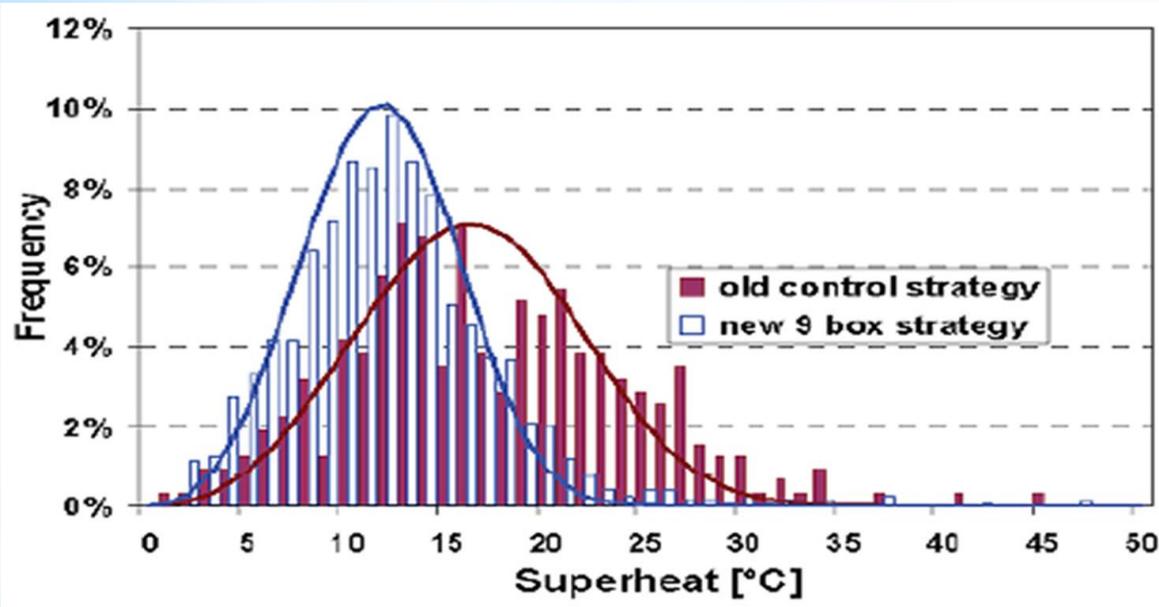
The stability of maintaining the MPR increases by 30-40%, the voltage on the electrolyzer decreases by 30-40 mV, the maximum TEP are achieved in each time period of the operation of the electrolyzer



# Achievement of maximum TEP on all types of electrolyzers

Automatic selection of the optimal parameters for the minimum power reduces the range of changes in the electrolyte overheating, which increases the current output of the metal, reduces the voltage on the electrolyzer and energy consumption.

Tests at RUSAL-Bratsk showed a decrease in the voltage across the electrolyzer by 50-70 mV, electricity consumption by 250-300 kWh / t of aluminum, the increasing of the current output of metal by 0.3 - 0,5%.



Source: Light Metals Report with results from Essen smelter

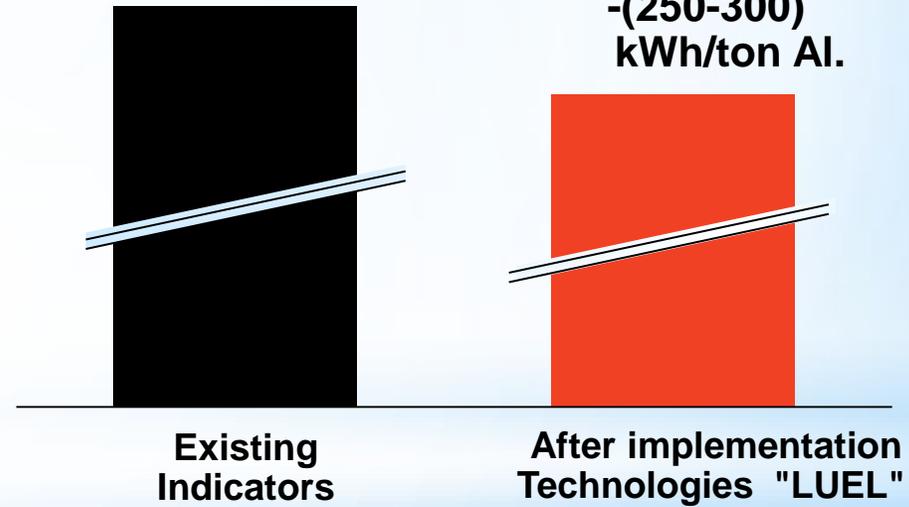
EI-r 350kA  
 U = 4.2V  
 13000 kWh/ton Al.

for all types of electrolyzers

-(1,5-2)%

-(50-70)mV  
 -(250-300) kWh/ton Al.

**RESULTS**



The indicators achieved at the Bratsk Aluminum Smelter show the efficiency of achieving maximum TEP for all types of electrolyzers, as well as the possibility of achieving the maximum current output of metal up to 97% and higher, reducing energy consumption to 11,500 - 12,000 kWh / t Al. on modern electrolyzers for a current strength of 400 - 500 kA.

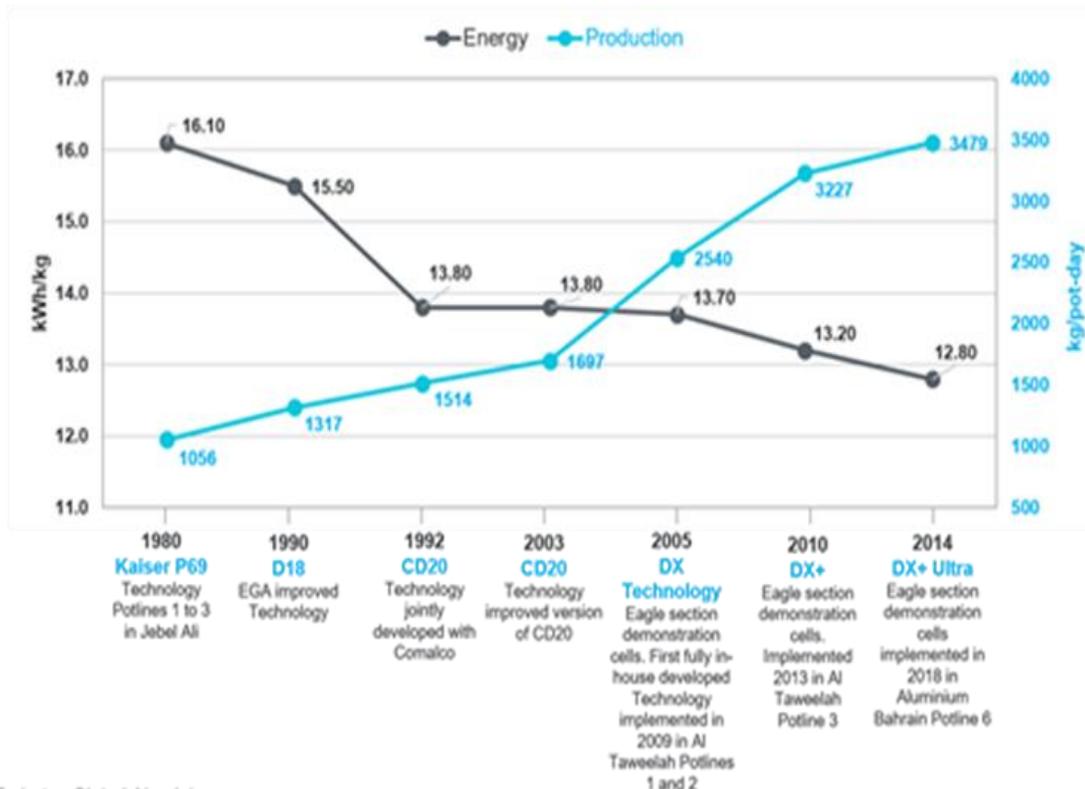


# EGA - Emirates Global Aluminium

## Development of world technology EGA.

### Evolution of net specific and pot productivity

EGA technologies are UAE designed, modelled, tested and optimised



Emirates Global Aluminium

## New in the world logical control LUEL to improve the efficiency of EGA technology

- LUEL logic control improves the efficiency of the Potion EGA control system and allows on all EGA electrolyzers:
- increase the metal current output by 0.3-0.5%,
- reduce the voltage on the electrolyzer by 50-70 mV,
- power consumption 250-300 kW. hours per ton of metal,
- consumption of aluminum fluoride by 1-3 kg. per ton.
- labor intensity of technological operations by 5-10% which were achieved at the Bratsk aluminum plant.

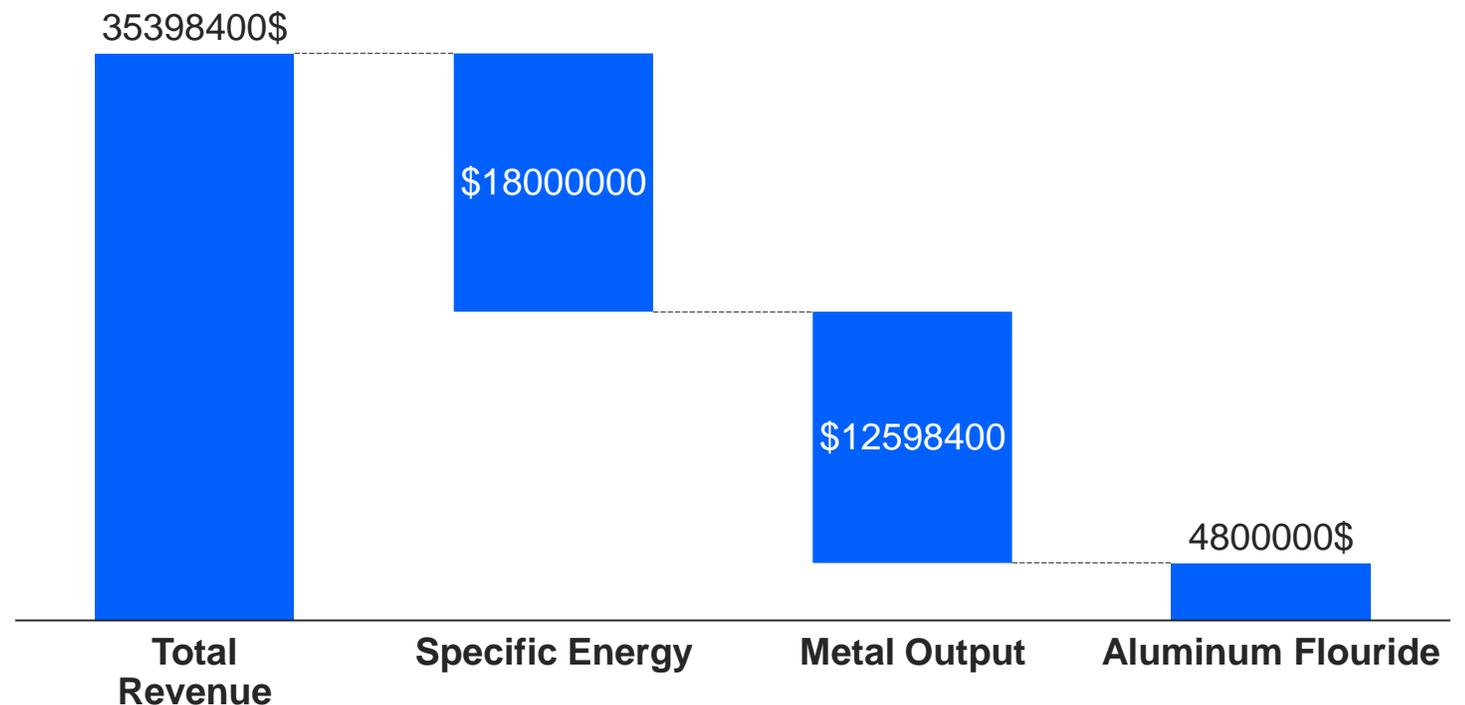
The achieved indicators allow reducing the energy consumption in EGA electrolyzers to 12,500 kW. hours per ton of metal and increase production.

# Estimated benefit of Emirates Global Aluminium from the implementation of LUEL logic control

## Assumptions

- Revenue displayed accounts for savings after full implantation of LUEL's technology.
- Assumed the volume of aluminum production is 2400000 tons per year.
- Assumed prices for Emirates Global Aluminium
  - kWh = \$0.03<sup>1</sup>
  - Aluminum tons = \$1750<sup>2</sup>
  - Aluminum fluoride kg = \$2.00<sup>3</sup>

## Breakdown of revenue increase for LUEL's technology on whole plant for one year (365 days), \$



Implementation costs are minimal, electrolyzers do not stop, there are no operating costs, which ensures minimal risks, long-term profit for the entire period of operation and high profitability of the introduction of new technology.