

# Hands-on Techno Economic Assessment: HTS Busbar

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**Hi-SCALE**

 **cost**  
EUROPEAN COOPERATION  
IN SCIENCE & TECHNOLOGY

# Objective

- Put into practice all the knowledge obtained during the courses:
  - Introduction to TEA of HTS systems
  - HTS busbar.
- Perform a TEA for the case study proposed by Reiser *et al.* [1]: a system reliant on aluminum compounds used to power potrooms.



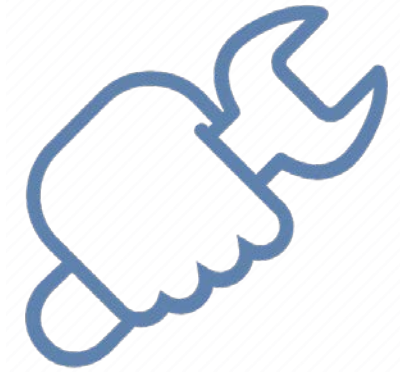
[1] W. Reiser, T. Reek, C. Räch, and D. Kreuter, "Superconductor Busbars—High Benefits for Aluminium Plants," in Light Metals 2021, L. Perander, Ed., in The Minerals, Metals & Materials Series. Cham: Springer International Publishing, 2021, pp. 359–367.

# Content

- I. Phase 1: Goal and scope definition
- II. Phase 2: Inventory analysis
- III. Phase 3: Calculation of indicators
- IV. Phase 4: Interpretation
- V. Phase 5: Reporting

# Hands-on example

- **Excel**: Accessible and friendly tool for calculations.
- Development of the economic and technical models.
- Calculation of the performance indicator



# I. Phase 1: Goal and scope definition

# Case scenario (Reiser et al [1])

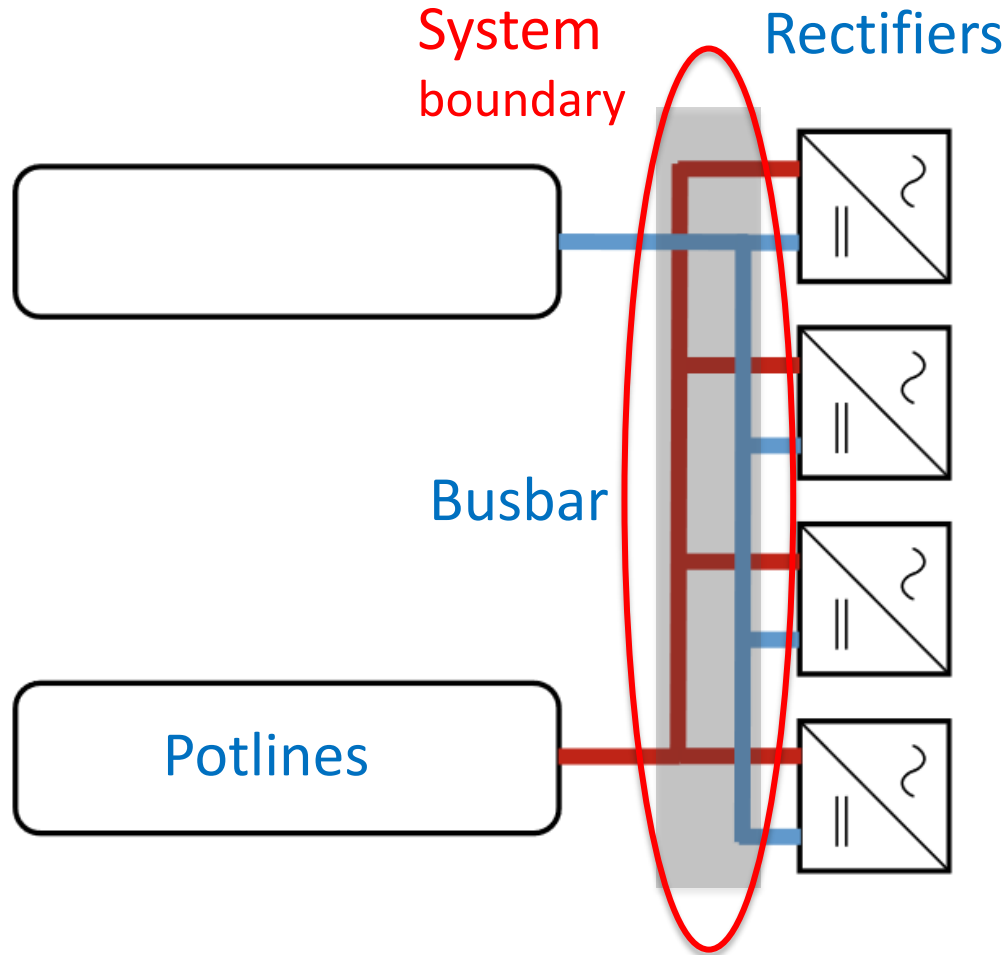
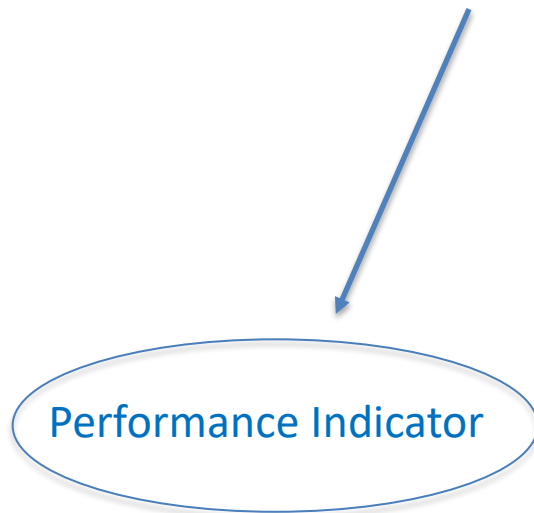


Fig. Potlines feeding system [1].

# Goal

- The goal of the study is to evaluate the economic feasibility of the implementation of HTS technology in aluminum busbar systems.
- Compare the **Life cycle cost** of a conventional and HTS busbar system in the **same operation conditions**.



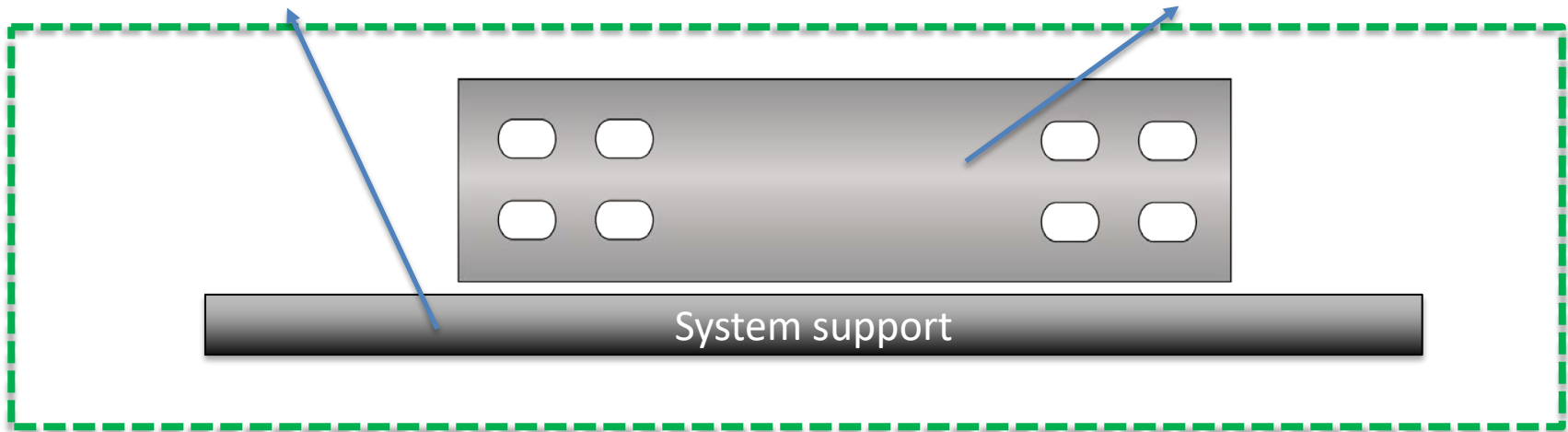
# I. Phase 2: Inventory analysis



# Conventional busbar system

Supports and fixation material

Conductor: Aluminum busbar



## CAPEX

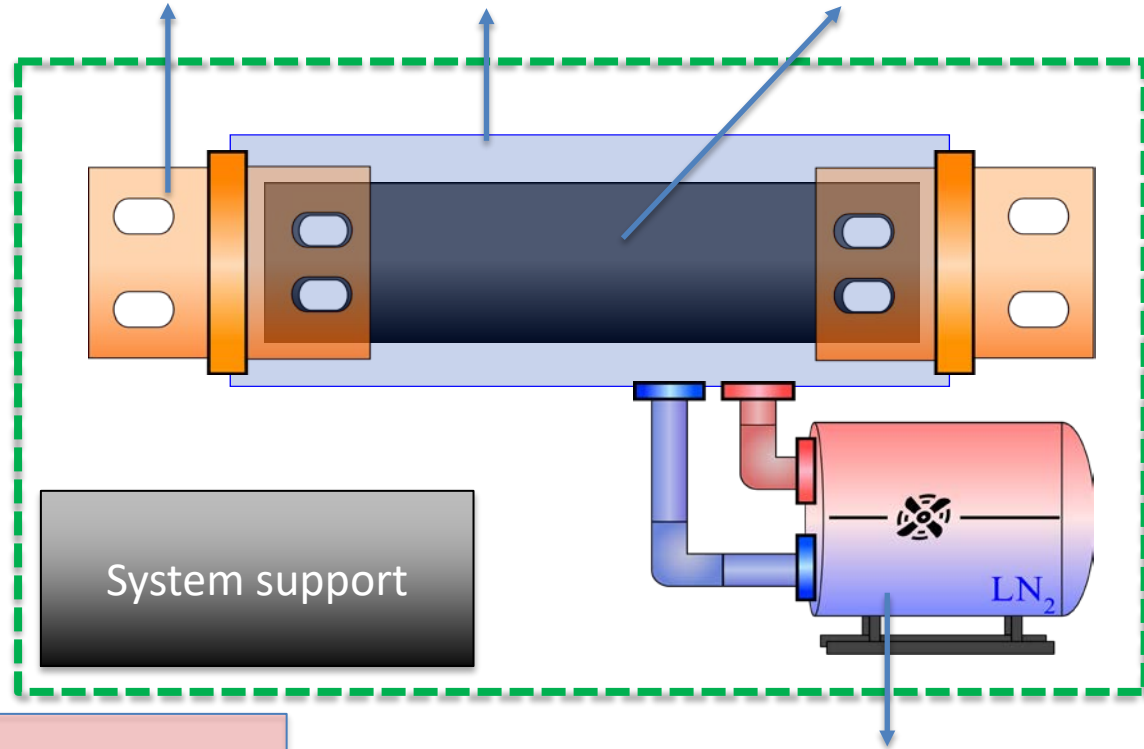
- Conductor cost
- Support cost

## OPEX

- Conductor resistive losses

# HTS Busbar system

Current leads      Cryostat      Conductor: HTS busbar



## CAPEX

- Conductor cost
- Current leads cost
- Cryostat cost
- Cooling machine cost
- Support cost

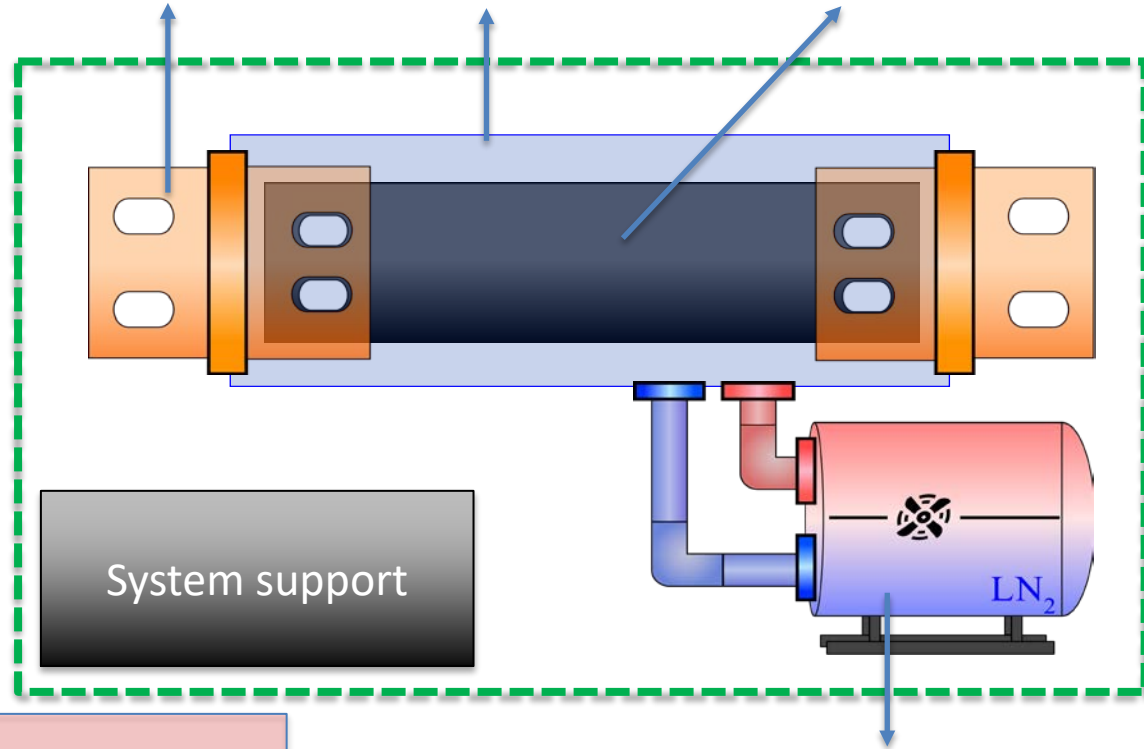
## OPEX

- **Conductor resistive losses**
- Current lead losses
- Cooling machine power input

Cooling machine

# HTS Busbar system

Current leads      Cryostat      Conductor: HTS busbar



## CAPEX

- Conductor cost
- Current leads cost
- Cryostat cost
- Cooling machine cost
- Support cost

## OPEX

- **Conductor resistive losses**
- Current lead losses
- Cooling machine power input

Cooling machine

# System information

**Industrial Consultant**

**Literature**

**Specialists**

# I. Phase 3: Calculation of indicators

# Performance indicator: Life cycle cost

$$LCC = CAPEX_0 + OPEX_t \sum_{t=1}^T \frac{1}{(1+r)^t}$$

$$CAPEX_0 = C_{cond} + C_{cryo} + C_{cl} + C_{cool} + C_{sup}$$

$$OPEX_t = (P_{cond} + P_{cl} + P_{cool}) * nhpy * C_{en}$$

System Losses

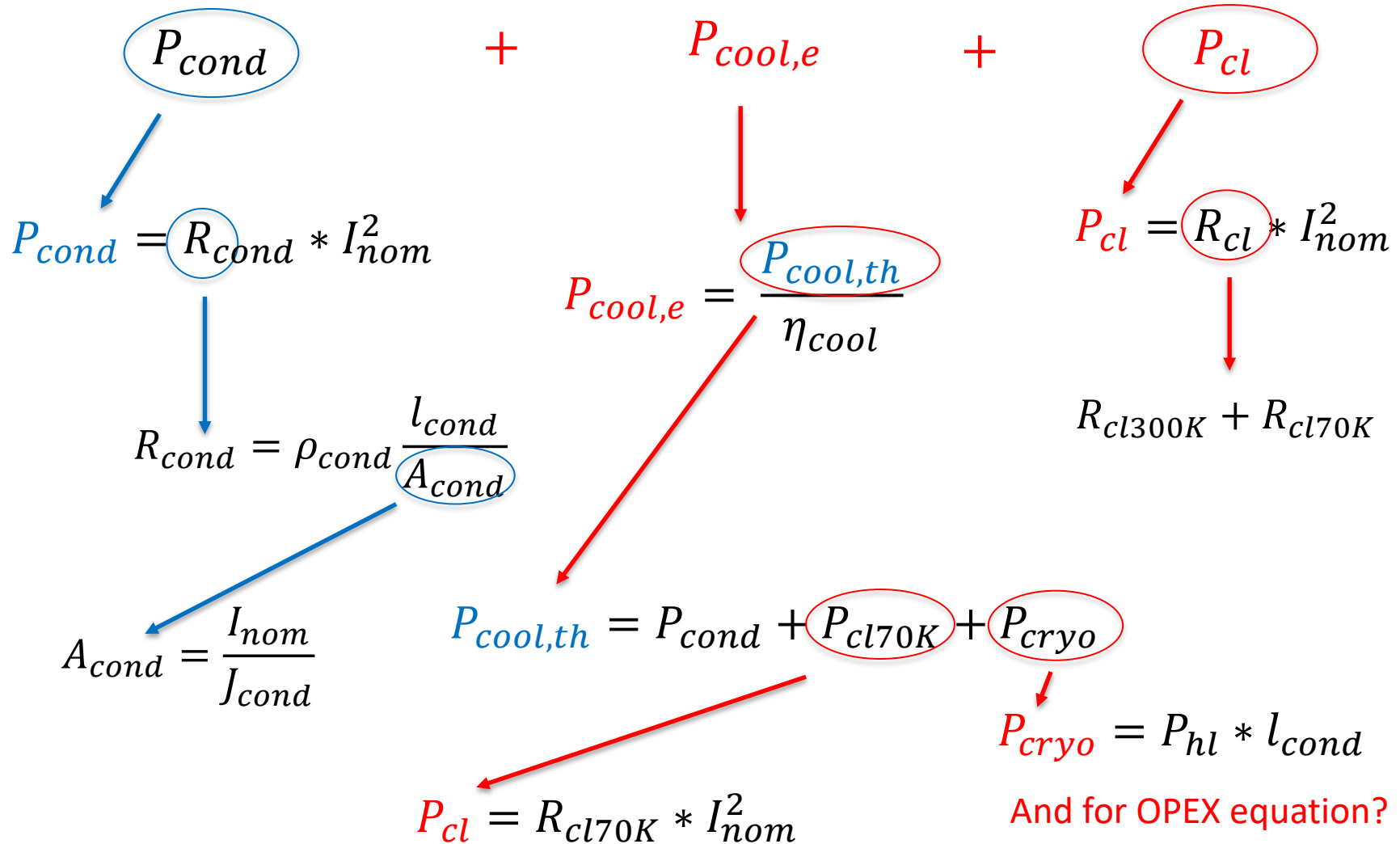
Operation hours  
per year

Cost of electricity  
(€/MWh)

# Models

- Economic model:
  - CAPEX, OPEX, LCC
- Technical model
  - System losses

# Technical Model





## Performance indicator: Life cycle cost

- NPV -> Net Present Value excel function
- Excel Financial function that will calculate the Net Present Value (NPV) for a series of cash flows and a given discount rate.

$$NVP = \sum_{i=1}^n \frac{Values_i}{(1 + rate)^i}$$

- =NPV(discount rate, vector values)

# I. Phase 4: Interpretation

# Life cycle cost

Variable	Symbol	Al busbar	HTS busbar	Units
<b>Capital expenditure</b>	CAPEX <sub>0</sub>	6225.8	17115.5	k€
<b>Yearly operational expenditure</b>	OPEX <sub>t</sub>	1505.9	405.7	k€/year
<b>Life cycle cost (T=40y, r=0,1)</b>	LCC (r=0.1)	20386.6	19527.1	k€



# Sensibility analysis

Variable	Symbol	Al busbar	HTS busbar	Units
Life cycle cost (T=40y, r=0)	LCC 1	66.46	33.34	M€
Life cycle cost (T=40y, r=0.05)	LCC 2	31.77	23.26	M€
<b>Life cycle cost (T=40y, r=0.1)</b>	<b>LCC 3</b>	<b>20.39</b>	<b>19.53</b>	<b>M€</b>
Life cycle cost (T=25y, r=0)	LCC 4	43.87	27.26	M€
Life cycle cost (T=25y, r=0.05)	LCC 5	27.15	22.02	M€
Life cycle cost (T=25y, r=0.1)	LCC 6	19.33	19.24	M€
Life cycle cost (T=10y, r=0)	LCC 7	21.29	21.17	M€
Life cycle cost (T=10y, r=0.05)	LCC 8	17.56	19.43	M€
Life cycle cost (T=10y, r=0.1)	LCC 9	14.91	18.05	M€



**Obrigado!**