INITIATE
A STEPWISE PROJECT

Workshop - CCU MODELLING APPROACH FROM MICRO TO MACRO ASSESSMENT

KPIs and Modelling Overview: How to approach the Integration of Innovative Technologies and Define its Objectives

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Presentation outlines

Introduction

- Energy transition is going on and very challenging targets in terms of CO_2 emissions are set;
- Implementation of new plants as well as development of new technologies are needed;
- Several alternative options are available (renewables, CCUS, nuclear, etc);
- A clear methodology to identify the most suitable technology is needed;
- NO SILVER BULLET EXISTS;

Presentation outlines

1. Introduction
2. **Approach**
3. Boundary conditions definition
4. Conclusions

Approach

- The selection of (innovative) technologies shall be based on relevant aspects. Some of these aspects can be:
  - Primary Energy Consumptions per unit of product [MJ_{PEC}/u.p.]
  - Production cost of unit of product [€/u.p.] ;
  - Environmental impact to produce a unit of product [i.e. kg_{CO2}/u.p.];
  - Technology readiness and input availability;
  - Process reliability [i.e. downtime along the plant lifetime];
  - Technology impact on the society;

- Once the criteria(s) is selected a comparative analysis between all the technologies shall be carried out

KPIs

- Energy transition is driven by the necessity to reduce CO_2 emissions, therefore relevant KPIs adopted shall refer to this aspect.
- Three main KPIs are:
  - CO_2 avoidance [%]
  - Specific Energy Consumption of CO_2 avoided [SPECCA] $\left[\frac{GJ_{LHV}}{t_{CO_2}}\right]$
  - Cost of CO_2 avoided (CCA) $\left[\frac{€}{t_{CO_2}}\right]$

$$\frac{e_{ref} - e_{new}}{e_{ref}}$$

$$\frac{PEC_{new} - PEC_{ref}}{e_{ref} - e_{new}}$$

$$\frac{Cost_{new} - Cost_{ref}}{e_{ref} - e_{new}}$$

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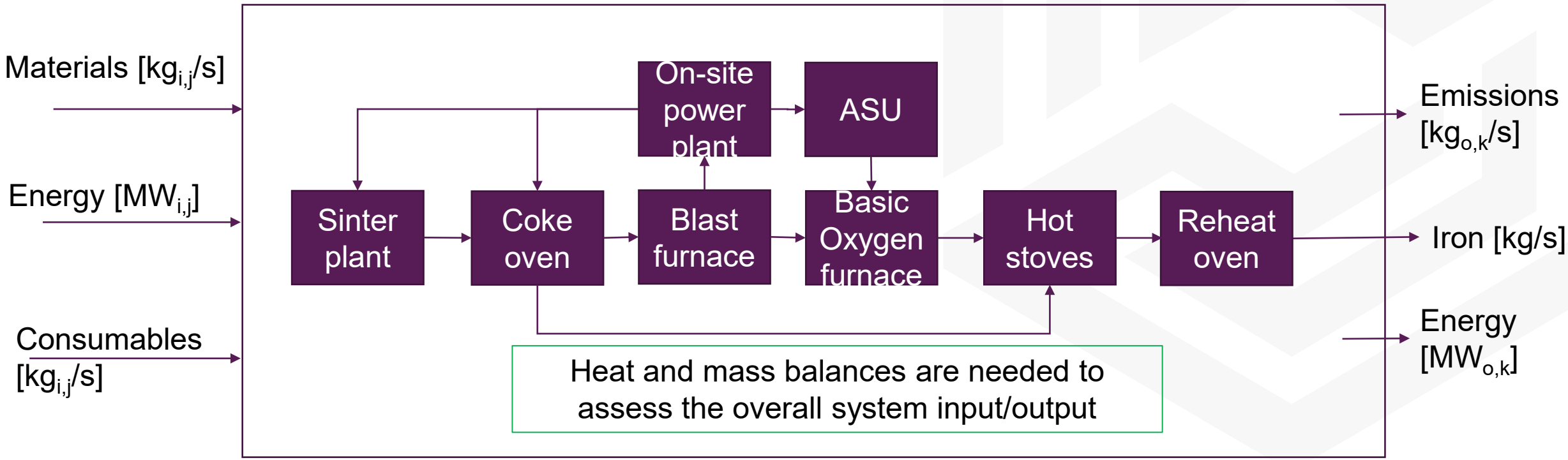
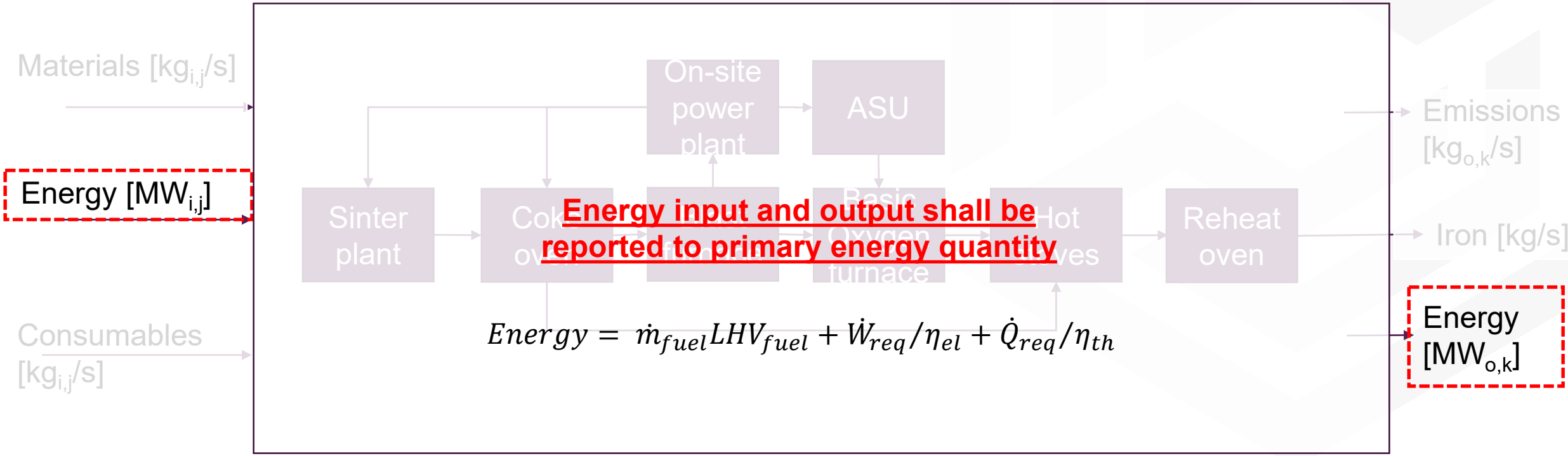
System boundaries (Iron production case)



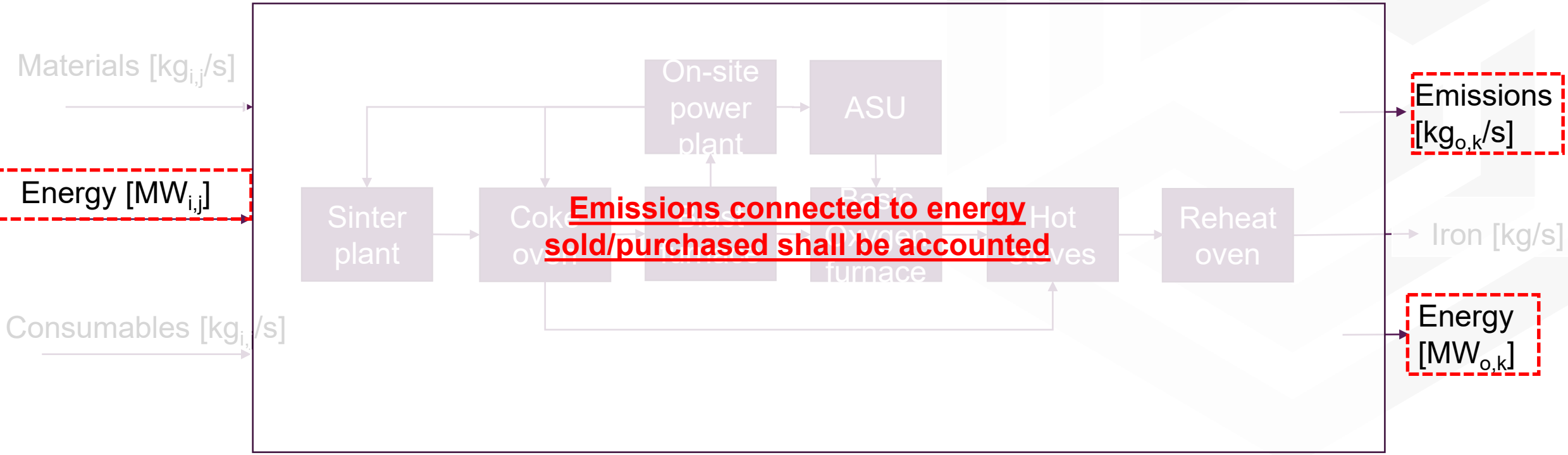
System boundaries (Iron production case)

$$\text{SPECCA}\left[\frac{GJ_{LHV}}{t_{CO_2}}\right] = \frac{PEC_{new} - PEC_{ref}}{e_{ref} - e_{new}}$$



System boundaries (Iron production case)

$$CO_2\ avoidance\ [\%] = \frac{e_{ref} - e_{new}}{e_{ref}}$$



System boundaries – cost analysis

Cost of CO_2 avoided (CCA) $\left[\frac{€}{t_{CO_2}}\right]$ $\frac{Cost_{new} - Cost_{ref}}{e_{ref} - e_{new}}$

From the heat and mass balances, the sizing of the components and cost assessment can be done

$$Cost_i \left[\frac{€}{t_{iron}}\right] = \frac{CAPEX}{m_{iron,lifetime}} + OPEX$$

$$OPEX_i \left[\frac{€}{t_{iron}}\right] = \frac{Fuel + material + consumables \pm electricity}{m_{product}}$$

$$CAPEX_i \left[\frac{€}{t_{iron}}\right] = \frac{\sum_{j=1}^{n} Equipment_j + installation + contingency + owner's\ cost}{m_{iron,lifetime}}$$

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Conclusions

- The selection of relevant KPIs is the first step to identify the most suitable technology
- Modelling of conversion processes is necessary to determine the KPIs parameters
- Input and output shall be referred to primary energy consumptions
- Emissions connected to input and output shall be accounted for


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