

# Life cycle inventory of Baosteel Power Station

## 1 Introduction

At Baoshang Iron and Steel Corporation (Baosteel), the electricity consumed in the steel manufacturing comes from its own power plant. The national electricity grid is used as a backup. Building life cycle inventory (LCI) databases for Baosteel electricity is important in order to improve environmental performance of an electricity generation system itself as well as to provide Baosteel with a basic database required to carry out LCA studies for their own products. European and American energy providers have already conducted extensive LCI researches for energy production system to support the needs of their industries. Some Asian countries, e.g. Japan, Korea, Thailand and Malaysia, have done LCI researches for their electricity supplies.

## 2 Modeling

The LCI of Baosteel electricity was carried out according to the framework and procedures of ISO 14040 and ISO 14041. Fig. 1 is a process tree of the Baosteel electricity generation system. Data for each unit process were collected for the input/output parameters determined by the cut-off criteria in the scope definition. There are four major areas for data collection: upstream processes, transport processes, power generation processes and equivalent processes of by-products.

Life cycle inventory data is the cumulative elementary flow of the functional unit for all foreground and background processes. The cumulative elementary flow  $g$  related to the functional unit is:

$$b_{T,FU,g} = b_{FU,g} + \sum a_{FU,i} b_{T,i,g} - \sum a_{FU,j} b_{T,j,g} \quad (1)$$

Where  $b_{T,FU,g}$  is the cumulative amount of elementary flow  $g$  of the functional unit;  $b_{FU,g}$  is the direct amount of elementary flow  $g$  of the process delivering the functional unit;  $a_{FU,i}$  is the direct amount of consumption of process  $i$  in the product system of the functional unit;  $b_{T,i,g}$  is the cumulative amount of elementary flow  $g$  of process  $i$ ;  $a_{FU,j}$  is the direct amount of by-product  $j$  in the product system of the functional unit;  $b_{T,j,g}$  is the cumulative amount of elementary flow  $g$  of process  $j$ .

For example, if  $g$  is  $\text{CO}_2$ , FU is one 1 kWh and T means total, Eq. (1) became for the case study:

$$\begin{aligned}
 b_{T,1\text{kWh},\text{CO}_2} = & b_{\text{power plant},\text{CO}_2} (\text{g/kWh}) + a_{\text{ship}} (\text{tkm/kWh}) b_{T,\text{ship},\text{CO}_2} (\text{g/tkm}) \\
 & + a_{\text{rail}} (\text{tkm/kWh}) b_{T,\text{rail},\text{CO}_2} (\text{g/tkm}) + a_{\text{truck}} (\text{tkm/kWh}) b_{T,\text{truck},\text{CO}_2} (\text{g/tkm}) \\
 & + a_{\text{coal}} (\text{g/kWh}) b_{T,\text{coal},\text{CO}_2} (\text{g/g}) + a_{\text{chemical}} (\text{g/kWh}) b_{T,\text{chemical},\text{CO}_2} (\text{g/g}) \\
 & - a_{\text{cement}} (\text{g/kWh}) b_{T,\text{cement},\text{CO}_2} (\text{g/g}) - a_{\text{sand}} (\text{g/kWh}) b_{T,\text{sand},\text{CO}_2} (\text{g/g})
 \end{aligned} \quad (2)$$

Completing data collection and computation for each unit process, the LCI results of the Baosteel electricity were obtained by Eq. (1). The calculation is convenient in Microsoft Excel. Table 6 lists the main elementary flows of LCI for Baosteel electricity.

### 3 Result

Completing data collection and computation for each unit process, the LCI results of the Baosteel electricity were obtained by Eq. (1). The calculation is convenient in Microsoft Excel. Shown in Fig. 2, there is the distribution of consumption of water and energy, the emissions of  $\text{CO}_2$ ,  $\text{SO}_x$ , CO,  $\text{NO}_x$ ,  $\text{PM}_{10}$  in different processes.

### 4 Conclusion

The electricity of Baosteel is generated in Baosteel power plant, which is different from the national electricity grid in energy mix, energy efficiency, and pollution control technology. The LCI database of electricity in Baosteel was developed for the first time in 2004. The analysis of data quality indicate that the result of the LCI database in this study is reliable and transparent. Several conclusions are drawn from this study.

(1) For every 1 kWh of usable electricity provided by Baosteel power plant, water consumption, energy consumption and  $\text{CO}_2$  emission respectively are 1.32kg, 10.16MJ, and 1.36 kg.

(2)  $\text{CO}_2$ ,  $\text{SO}_x$  and  $\text{NO}_x$  emissions at the process of power generation (direct emission) to the total  $\text{CO}_2$ ,  $\text{SO}_x$  and  $\text{NO}_x$  emissions are around 97%, 93% and 85%, respectively. Direct consumptions of water and energy are around 75% and 95%.

(3)  $\text{PM}_{10}$  emission at upstream process of coal mining accounts to 23%, relatively large. VOC emission during transportation is 62%.

(4)Anthracite coal is the major source for air and water pollutants emitted in electricity generation. It is the main reason why environmental load of Baosteel electricity LCI is higher than that of the other countries' electricity. Natural gas as an alternative in Baosteel power plant can significantly reduce environmental load for Baosteel electricity.

(5)Emissions of air pollutants at the power generation process (direct emissions) are much higher than those from the upstream processes. Emissions of water pollutants from the upstream processes (upstream emissions) are much higher than those from the power generation process.

(6)Re-use of waster is important to reduce the life cycle environmental load of electricity for Baosteel.

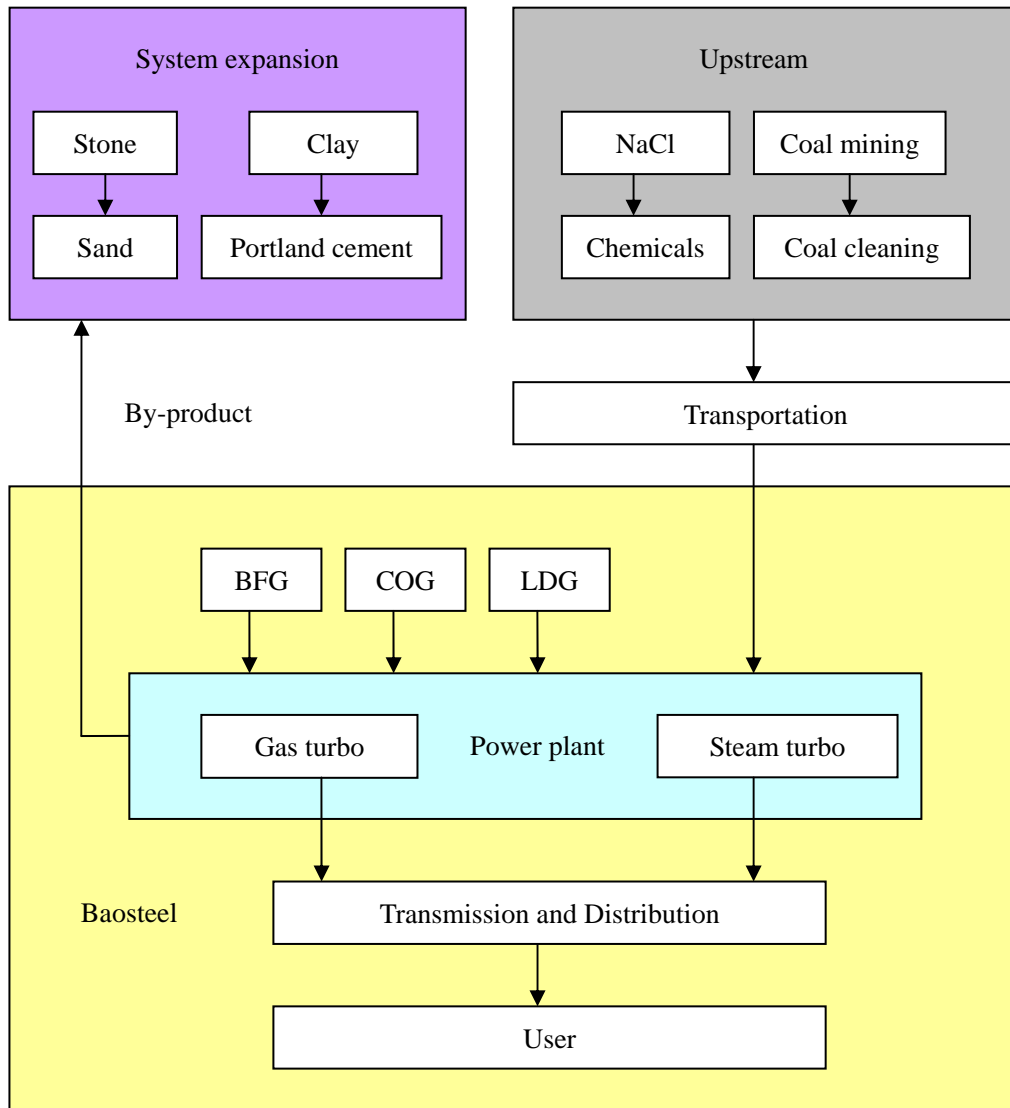


Fig 1 Process tree for Baosteel usable electricity

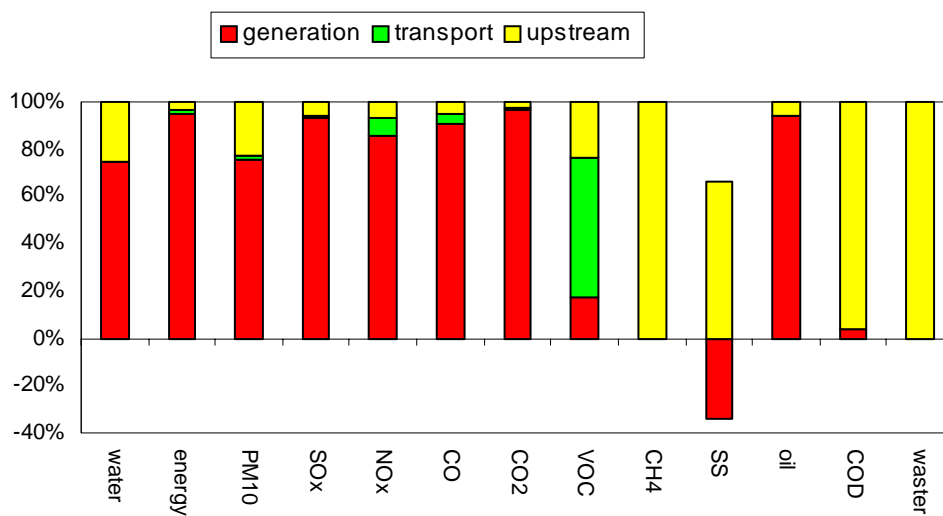


Fig.2 the contribution of elementary flow in life cycle

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