The global cement market size has passed the value of USD 355 billion in 2014 and continues to grow due to the growing requirement for the construction of institutional and healthcare buildings. Megaprojects all around the world such as China’s One Belt and One Road program increases the demand for cement. In Turkey, cement industry had sold over 70 million tons (wt) and exported more than 10 million mt.

In cement production, majority of the costs come from energy consumption (around 65%) and improvements that target the efficiency in energy consumption can contribute greatly to the profit of the company as well as environment through decreasing the special energy consumption. Since cement is produced through a continuous production line, any malfunctioning in the critical equipment can cause greater, unexpected costs.

In the project, we have used the advancements of digitalization by implementing sensors to the critical equipment. These sensors continuously monitor the temperature, vibration, input current and enable us to gather data to have a better understanding of the root cause of breakdowns. The collected data will be used to predict an upcoming breakdown in critical equipment and decrease the downtime in cement plant. Our motivation is to improve the predictive maintenance policies with continuously monitoring the vertical grinding mill and crushers. Through controlling the operational parameters used to decrease the special energy consumption in equipment, therefore, decrease the energy costs.

The raw mills are big grinding facilities and there are many different parameters affecting the grinding behavior of the unit. Mill size, ball charge rate, shape, temperature and humidity of the entering raw materials, circulating load within the system, ambient air conditions, rotational speed of the mill, temporary stops for the periodical maintenance of the system, chemicals used to speed the pulverization and to eliminate the clogging problem, efficiency and performance of each machinery used, the microstructure of the raw materials and vibration characteristics of the system are some of these parameters. Detailed examination of these parameters in terms of correlation coefficient give insight about the improvement of energy consumption.

Main objective of this project is to minimize the specific energy consumption by controlling the operational parameters without sacrificing the quality of the product. In cement production, majority of the cost comes from energy consumption and every improvement that decreases the consumption will also contribute to the environment as well.

Collected the data using sensors with digital twinning methodology will be used to predict an upcoming breakdown in the critical equipment beforehand. Improving the predictive maintenance policies will also contribute to the energy savings since any breakdown will cause a complete system failure. Reinitiating any equipment needs high amounts of energy, therefore, any improvement in the prediction methodology has the potential to improve the profits as well as environment conditions.

COMMON ENERGY CONSUMPTION IN EQUIPMENT, THEREFORE, DECREASE THE BREAKDOWNS. THE COLLECTED DATA WILL BE USED TO PREDICT AN UPCOMING BREAKDOWN IN CRITICAL EQUIPMENT AND DECREASE THE DOWNTIME IN CEMENT PLANT. OUR MOTIVATION IS TO IMPROVE THE PREDICTIVE MAINTENANCE POLICIES WITH CONTINUOUSLY MONITORING THE VERTICAL GRINDING MILL AND CRUSHERS. THROUGH CONTROLLING THE OPERATIONAL PARAMETERS USED TO DECREASE THE SPECIAL ENERGY CONSUMPTION IN EQUIPMENT, THEREFORE, DECREASE THE ENERGY COSTS.

Figure 1 - The use of electrical energy as cement production

About one third of the electrical power is consumed during the fan's operation in a conventional cement factory as it is seen in the above representation. In a manufacturing point of view Farine is the semi product of clinker thus is an important material. Even though the production of fan is composed of only grinding with the improvement of machine design and choosing optimal operating conditions, new approaches toward energy saving in cement production might be developed. According to Kasiroti M, Triakirdin PE, Giannatos P, Tsibouki Z, Marinos I (2009) About 2% of the electricity produced in the whole world is used during the grinding process of raw materials. While total electrical energy consumption for cement production is about 100 kWh/ton of cement, roughly two thirds are used for particle size reduction. About 65% of the total electrical energy used in a cement plant is utilized for the grinding of coal, raw materials and clinker.

Efficient usage of energy during grinding process will lower the production cost considerably and the carbon dioxide emissions rate. A wide range of options exists to reduce carbon dioxide emissions but this is out of the scope of this project. Nevertheless it would not be appropriate to not mentioning the effect of energy consumption in carbon dioxide.

On the other hand, the correlation analyses between energy consumption and vertical raw mill parameters are carried out with respect to different types of vertical raw mill equipment.

The effect of ball charge tonnage to vibration is examined while keeping the production capacity, humidity and size of the feeding materials constant. The gradual increase in tonnage leads to an increase in vibration of motors. In general, if machine has an unexpectedly high vibration level, the special energy consumption level increases accordingly. The same effect can be seen in here. Increase in tonnage leads to an increase in energy consumption rate.

It is intuitive that the size and the moisture content of the feeding material should be low as possible in order to improve performance and quality of the product. The reduction in moisture content of raw material decreases the vibration and driving motors so the SEC decreased accordingly. It is crucial to emphasize that the moisture level of raw material and the humidity inside the vertical raw mill are different aspects. The humidity level or the water injection rate into the plate of the mill decreases the vibration regardless the fact that the low moisture level of raw material decreases it too.

One of the major non physical parameter is the periodical maintenance of the unit. With the help of strictly ensured maintenance, the vibration values on the main driving motors might be reduced up to 20%. Keeping all the variable constant, periodical maintenance decreases SEC and annual carbon dioxide emission per ton farine.

REFERENCES
