**FORECASTING FOR BIOETHANOL PRODUCTION IN TURKEY**

SUMMARY

Biofuels, as a clean alternative to the fossil fuels, are of wide interest according to the raising global energy demand and high fossil based fuel prices. Today, within the scope of renewable energy technologies research and development studies on biofuels gradually increasing in both world and our country. As a result of biorefinery technologies, biofuels are predicted to take place in our lifes. Presently, first generation biofuels, which are biodiesel and bioethanol, have been used commercially. In this thesis, forecasting study to be made was to be taken as an aim for biothanol production in Turkey. By appraising the future and potential amounts of the feedstocks which are used for bioethanol production and which are also possible to be used, the forecasting of the bioethanol production in Turkey will to be forward. Addition to bioethanol production and its feedstocks supply forecasting, gasoline consumption forecasting was also carried out. With this, it has been estimated that the forecasted bioethanol production provides how much of the bioethanol demand for the forecasted gasoline consumption. Then, emissions based on forecasted gasoline consumption were estimated according to several blend mandates in the perspective of environmental assessment. In this study, based on three issues, energy, agriculture and low carbon economy, a roadmap was adviced for bioethanol production and assessment policy of it.

Biofuel technology is one of the driving powers of sustainable energy production and green growth for today and future. Sustainability of biofuel production process depends on available resource management and continuity of feedstock supply. Thus, an appropriate tool for forecasting agricultural feedstock supply and so potential of bioethanol production are so significant for policy making. It was seen that higher potential of bioethanol production and the possible use of main agricultural products as the most suitable feedstocks to produce bioethanol in Turkey show the importance of bioethanol production and its forecasting in Turkey. As an alternative to fosil based fuels, there are also many advantages of bioethanol production and use such as domestic resources use in energy production, energy and agricultural economics, environmental benefits and increase in energy supply security.

In the first part of thesis, it is presented that linear and non-linear model approaches to forecast annual potential of the feedstock supply as wheat, corn, barley and sugar beet that could be used to product first generation bioethanol. The linear model as Auto-Regressive (AR) Model and non-linear models as Auto-Regressive eXogeneous (ARX), Auto-Regressive Moving Average eXogeneous (ARMAX) and Artificial Neural Networks (ANN) were performed. Recursive method was also used to improve only the model performances belong to AR, ARX and ARMAX models even if recursive method could not be used to forecast. Firstly, model order determination and modelling of feedstock production were studied. The model orders belonging to wheat and barley production data were 2, while those belonging to corn and sugar beet were 1 according to major model order selection criterias; Akaike Information Criteria (AIC) and Final Prediction Error (FPE) in AR model. The same model orders were also used in ARX model to compare, while model orders were selected due to model performances in ARMAX model. In recursive model applications; model orders were used according to which model's performance is improved. On the other side, the numbers of nodes in input layer (k) were selected as 1, 2, 3, 4 to examine the effects of numbers changes in input layer and neurons in the hidden layer for ANN correlated to model orders in AR model. Second, model performance tests were performed with Root Mean Square (RMS), *R*2 and Chi-Square (χ2) in optimum model orders for each serie. *R*2 was found mainly near to 1, while χ2 and RMS results were within the acceptable limits in all models. Then, forecasts were estimated for each of feedstocks and it was found that forecasts decreased due to declines in model performances for several prediction horizon values (1, 5, 10, 15 and 20 years). Because selected models were generally used to estimate the next value in time series. The variations have a great effect on Turkey's supply of feedstock and potential amount of bioethanol that can be produced. In ANN, forecast changings were not the same as in other models. Feedstock forecasts were determined to be quantitatively consistent for each model and with legal authority predictions. There were negligible small differences ranging from 0.8% to 2%. Besides, the forecasting study on gasoline consumption in per year was also given to calculate the amount of required bioethanol blending taking into account today's legal obligation and possible alternatives to have the bioethanol blending values per liter of consumed fuel. As in feedstock predictions, the same linear model and non-linear models were performed to forecast annual gasoline consumption of Turkey. Model order is estimated as 8 according to major model order selection criterias; Akaike Information Criteria (AIC) and Final Prediction Error (FPE) in AR model and also used in other models considering model performances, while nod number was 4 in ANN. Then, model performance tests were performed with Root Mean Square (RMS), *R*2 and Chi-Square (χ2) in optimum model order. Performance tests results showed that the models are available for determining on gasoline consumption forecasting for fifteen years (prediction horizon is twenty years in feedstock forecasting) although fuel consumption data set was too short for modeling. In following step, considering the bioethanol feedstocks production values, how many liters of bioethanol could be produced per ton of selected feedstocks were also determined using references. On the other side, bioethanol demands were estimated for several blend mandates values of forecasted gasoline consumptions. Forecasted bioethanol productions per tonne of selected feedstocks' predictions were compared whether supply with or not bioethanol productions are required for the forecasted gasoline consumption values according to the several bioethanol blend mandates. According to those; Turkey's total feedstock production could be used to produce bioethanol is sufficient to demands of bioethanol blend ratios such as 1%, 2%, 3%, 5%, 10%. Barley and especially wheat potentials could be seperated for bioethanol production also seem as preferable because their potentials are enough for bioethanol production demand. However sugar beet and corn are mainly used to produce bioethanol. Finally, CO2 emissions were calculated as environmental assessment study to put forward that environmental impacts of forecasted gasoline consumptions and the emission decreases from bioethanol blended-gasoline consumption (in several ratios 1%, 2%, 3%, 5%, 10%). Declines in emissions were increased with incremental bioethanol blend ratios. In the perspective of green economy, sustainability and energy production; Turkey has a significant potential to produce bioethanol without affecting their uses in main areas as food, feed and export and decreases in emissions resulted from gasoline consumption could be provided through this environmentally-friendly fuel use as fuel additive. Namely, sustainability could be provided in the perspective of both energy source production and low-carbon economy. The consistency of the forecastings has been made supports the sustainability of bioethanol production and resource management.