Periodic Inventory Management for Bamboo Biomass Power Plant

Praephun Pongtaveesub[1)], Prachya Boonprasurt[2)]

1) Logistic Management Program, National Institute of Development Administration (E-mail: peachpop.gp@gmail.com)
2) Department of Mathematics and Statistics, Thammasat University,Thailand (E-mail: prachya@tu.ac.th)

Abstract

The purpose of this research is to propose a model in the inventory of the periodic inventory planning for the use of raw materials in biomass power plants. It consists of two parts: Management of the preparation of the material dry enough for the electricity produced by gasification system. The restriction is the humidity. And inventory management in the supply of raw materials to meet sufficient to produce electricity consistently.

From the result of the research, If using bamboo as raw material, we can see that the total cost of preparing the raw material for power generation of 1 MW has been fixed. Can be reduced by 27.44 percent compared to the raw material used is wood chips.

Introduction

In the past 10 years of Thailand. It has supported the investment in biomass power plants in the private sector. Due to geographical conditions, it is suitable for the use of agricultural wastes such as rice husk, corn, sugar cane, etc. However, these industries are shortages of raw materials at some point due to fluctuations in price or moisture of raw materials that affect the production process.

The research is concerned with the moisture of raw materials affecting the process of producing electricity. By using bamboo as the main raw material in the case study to make a first model. Bamboo is a plant that can be grown all season and good for the environment. And type of biomass power plant is a gasification system.

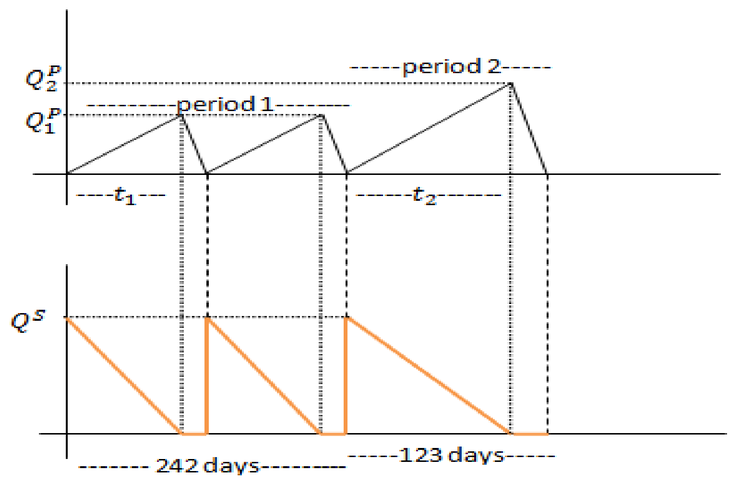
Problem statement

1. Raw material prices fluctuate according to demand and economic conditions.
2. The supply of raw materials fluctuates due to the shortage of raw materials in some areas due to environmental and disasters.
3. The moisture content of raw materials exceeds the standard, so it is not immediately available. It takes time to dry. The moisture content of raw materials in rainy season is higher than other season.

Methodology

The procedure will be divided into 2 parts as follows.

- The first part is to manage the preparation of dry raw materials ready for the electricity generation process. With restrictions The moisture content of biomass raw materials must not exceed 15 percent.
- The second part is Inventory management in supplying fresh raw materials to sufficient in the first part.



Parameter

i	season period
t_i	number of days for a production run at period i
P_i	production rate at period i (ton/day)
d	demand (ton/day)
Z^P	total cost in drying stage
h_i	% moisture of the raw material
dr	drying rate of 1% moisture loss per 1 ton capacity load in drying process
H	% moisture of product
W^P	maximum capacity for raw material loading into the drying process
T	number of working day per year
C_h	annual cost of holding one unit in inventory (baht/unit/year)
C_o^P	annual set up cost per production run (baht/number of times)
C_o^S	annual ordering cost (baht/number of times)
C_i^P	production cost to produce 1 unit of 15% moisture product at period i per ton (baht/hr/ton)
C_E	energy cost of drying 1 unit of product per 1 ton weight capacity (baht/hr)

Decision Variable

Q_i^P the production lot size at period i

Stage 1

$$Z^P = \frac{1}{6}\left[2\left(1-\frac{d}{P_1}\right)Q_1^P + \left(1-\frac{d}{P_2}\right)Q_2^P\right]C_h + \left[\frac{1}{3}Td\frac{2}{Q_1^P}+\frac{1}{Q_2^P}\right]C_o^P + \left[\left(\frac{2Td}{3Q_1^P}\right)t_1\right]C_1^P + \left[\left(\frac{Td}{3Q_2^P}\right)t_2\right]C_2^P$$

by

$$t_i = \frac{Q_i^P}{P_i},\ P_i = \frac{W^P\left(\frac{(100-h_i)}{100-H}\right)}{(h_i-H)dr},\ C_i^P = \frac{W^P \cdot C_E}{P_i}$$

Stage 2

Total Cost

$$= \left[\frac{1}{3}(Q_1^s + \frac{Q_2^s}{2})\right]C_h^s + \frac{d}{3}\left[\frac{2T}{Q_1^s}+\frac{T}{Q_2^s}\right]C_o^s$$

Economic Production Quantity

period 1: $Q_1^P = \sqrt{\frac{2TdC_o^P}{(1-\frac{d}{P_1})C_h}}$

period 2: $Q_2^P = \sqrt{\frac{2TdC_o^P}{(1-\frac{d}{P_2})C_h}}$

Case study

From the introduction of the mathematical model above, calculated using bamboo and wood chips. It was found that the costs of bamboo and wood chips for a 1 MW biomass power plant as follow:

Raw material	Heat value (MJ/kg)
Bamboo	15.7
Wood chips	18.0

Moisture (%)	Production rate (ton/day)
40	50.82
50	30.25

- Total cost by using bamboo is 9,962,731.81 baht.
- Total cost by using wood chips is 13,731,214.52 baht.

Result

Total cost of preparing raw materials for produce 1 MW biomass power plant of bamboo compared to wood chips can be reduced by 27.44 percent

Suggestion

In this research, the periodic inventory model is presented for inventory planning in biomass power plants. If using this mathematical model should consider additional transportation costs.