To enhance the electrical power contract capacity by leveling production schedule based on data-driven

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***Abstract*—The scarcity and potential shortage of major energy resources currently used in manufacturing has become a focus of attention (Sun A. 2013). Severe carbon dioxide emissions cause global warming. The main source of carbon dioxide emissions is the production of fossil fuels and the burning of coal, most of which is used to provide electricity. In the past few decades, 75% of anthropogenic greenhouse gas emissions have been produced by burning fossil fuels, accounting for 38% of fossil fuels using fossil fuels (Boden et al., 2010). The object of this paper is based on the foundry industry. According to previous studies, industry planning in the form of production in line with orders is generally based on the lack of production capacity to account for the level of power required for different orders resulting in wasted power and high demand for instantaneous power. This study invested the leveling production concept of TPS (Toyota Production System) and applied power saving as a resource for scheduling production plans. It will provide better resource planning and results, reduce contractual capacity under the same production conditions and meet product requirements. This study contributed to the literatures by proposing a methodology to even out peak power consumption and developed optimal contract capacity which can reduce carbon emissions by 5,431 tons in one year. The methodology proposed by this study provided a simple way to execute the planned production orders.**

Keywords—Contract capacity, Energy saving, Planning schedule, Electricity planning, Power management, Green management

I. INTRODUCTION

The scarcity and potential shortage of major energy resources currently used in manufacturing has become a focus of attention (Sun A. 2013). Severe carbon dioxide emissions cause global warming. The main source of carbon dioxide emissions is the production of fossil fuels and the burning of coal, most of which is used to provide electricity. In the past few decades, 75% of anthropogenic greenhouse gas emissions have been produced by burning fossil fuels, accounting for 38% of fossil fuels using fossil fuels (Boden et al., 2010).

The object of this paper is based on the foundry industry. According to previous studies, industry planning in the form of production in line with orders is generally based on the lack of production capacity to account for the level of power required for different orders resulting in wasted power and high demand for instantaneous power.

This study invested the leveling production concept of TPS (Toyota Production System) and applied power saving as a resource for scheduling production plans. It will provide better resource planning and results, reduce contractual capacity under the same production conditions and meet product requirements. The proposed method is being used in automotive parts foundry manufacturing companies and achieves significant energy savings. This study contributed to the literatures by proposing a methodology to even out peak power consumption and developed optimal contract capacity which can reduce carbon emissions by 5,431 tons in one year. The methodology proposed by this study provided a simple way to execute the planned production orders.

The rest of this article is organized as follows. Section 2 describes previous research. Section 3 identifies the proposed method. Section 4 presents data collection and describes the results of the analysis. Finally, Section 5 presents a discussion and provides a conclusion.

II. RELATED WORK

The research on power saving is mainly divided into two categories, namely, supply and demand.

From a supply perspective, Yaisawarng et al. (1994) propose to reduce investment in redundant power distribution systems and increase the utilization of existing power equipment. Fang et al., (2012) argue t smart grid to be a widely distributed automated energy transfer network for two-way flow of electricity and information (Wang, et al., 2009, Molderink, et al., 2010). In order to make better use of power generation equipment, some studies have proposed algorithms for calculating the contractual capabilities that power suppliers can provide (Hogan, 1992; Lee, & Chen, 1995; Shahidehpour et al., 2003;).

On the demand side, many studies were devoted to using various algorithms to find the optimal contract capacity or reduce power consumption. Reducing contact is the ability to design algorithms to find a viable power cap to control electricity bills. (Srinivas, N., & Deb, K. 1994; Wardlaw, R., & Sharif, M. 1999; Cai, LJ, Erlich, I., & Stamtsis, G. 2004; Pai, PF, & Hong, WC 2005; Nolde, K , et al., 2010, Chen, Z., Mi, et al., 2014).

In the above literature, some research on energy in the past was for regional power loss planning. Some research on production planning was to reduce power loss by passively reducing the power of idle power or equipment. The study of contract capacity development was based on existing production conditions to calculate optimal contract capabilities.

III. Research Methodology

The spirit of lean production is to average production to daily delivery requirements and remained at a lower stocked. This study divided these projects into three production types, daily, weekly, and monthly. The daily production types include items that must be produced each day; weekly production types include items that must be produced on certain days of the week. And the monthly production type, including items with a small order quantity, is usually not considered in the production plan.

This study applied the DBSCAN grouping method to segment the production of the same material as much as possible, the weight of the molten iron, the production line and the project of the same customer. The goal of the parameter setting is "Select the maximum number of groups under the minimum noise point".

$$\text{Data} = \frac{\text{Data}}{(max(Data) - \min(Data))} \qquad (3.1)$$

After the completion of the DBSCAN grouping method, the selection of the required item numbers from each group was selected according to the scheduling requirements, and was used as the basis for planning. Therefore, it is proposed to design a model based on the Mathematical Programming model to define the restriction and optimization model.

In order to reduce the regular contract capacity, it is planned to interleave the furnace heating power during the peak period of electricity consumption. After calculating the amount of molten iron that can be produced in a day, the total weight of production required for the month and the number of production days required are as follows.

All in all, casting is the first process of a casting part. It takes a while to cool down after the casting process is completed. The production controller settled the safety stock, production conditions (eg recipe, temperature, etc.). This study used the DBSCAN method to cluster projects to obtain a production plan for each swift and to implement a power saving plan for the furnace. If the demand for a power saving plan is lower than the contract capacity, the melting plan is accepted.

Input : M_{times} (the times of the melt work per hour),
L_{melt} (the lines of the melt),
Q_{melt} (the tons of the melt)
H_{day} (the hours of day shift)
H_{night} (the hours of night shift)

Output : W_{night} (The Quantity of melted iron per day)
W_{aday} (The Quantity of melted iron per day)
D_{proc} (The days need to work)

WorkDay$(M_{times}, L_{melt}, Q_{melt})$:

$W_{day} \leftarrow \frac{H_{day} \times M_{times} \times Q_{melt}}{L_{melt}} \times 0.9$ *// The output of day shift*

$W_{night} \leftarrow H_{night} \times M_{times} \times Q_{melt} \times 0.9$ *// The output of night shift*

$W_{aday} \leftarrow W_{day} + W_{night}$

$D_{proc} \leftarrow \left\lceil \frac{W_{total}}{W_{aday} \times L_{melt}} \right\rceil$

Return $D_{proc}, W_{aday}, W_{night}$

IV. Data Collection and Analysis

A. Data Collection

The data collected in this study is the production materials ordering materials and electricity consumption information of the foundry department of major auto parts manufacturers located in Taoyuan, Taiwan from July 1, 2016 to June 30, 2017. The auto parts automaker is the first-order supplier of Toyota, Nissan, Ford and other automakers. This supplier mainly produces aluminum alloy wheels, brake parts, engine parts and so on. The casting process is the first manufacturing process for alloy wheels, brake components and engine components.

This study will plan the production of each production project in a matrix. To apply the algorithm 3.1 and the parameters of this algorithm are set as follows: a total of two production lines, the furnace can produce 4 tons of molten iron at a time, the furnace output one furnace takes 1 hour, the total weight of molten iron of furnace 2L production line 1,325 tons, and the total weight of molten iron of production line o8T is 1,296 tons. The two production lines require at least 21 days of production in June and produce 65 tons of molten iron per day.

This study planned the production of each production project in a matrix. The furnace can produce 4 tons of molten iron per hour. The total weight of the production line o8T molten iron is 1,296 tons. The production line requires at least 21 days producing 65 tons of molten iron per day.

Table 1 DBSCAN Results of Production Line 08T

08T	Eps	minPts = 2	minPts = 3
Daily	0.3	noise point = 6 , Groups=3	noise point = 8 , Groups=2
	0.35	noise point = 2 , Groups=3	noise point = 2 , Groups=3
	0.4	noise point = 2 , Groups=2	noise point = 2 , Groups=2
Weekly	0.3	noise point = 7 , Groups=3	noise point = 9 , Groups=2
	0.35	noise point = 4 , Groups=3	noise point = 8 , Groups=1
	0.4	noise point = 4 , Groups=2	noise point = 6 , Groups=1
Month	0.3	noise point = 0 , Groups=6	noise point = 6 , Groups=3
	0.35	noise point = 0 , Groups=5	noise point = 4 , Groups=3
	0.4	noise point = 0 , Groups=4	noise point = 2 , Groups=3

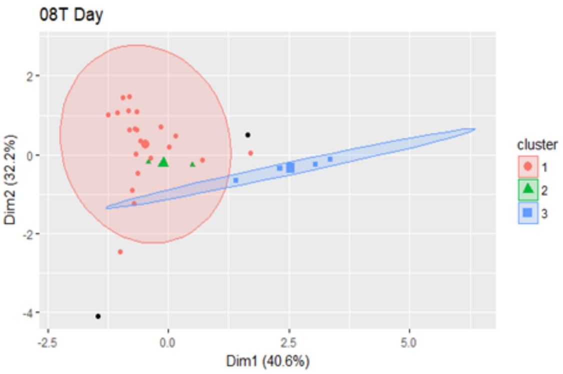

Fig 1 Clustering Results of Daily Production Items of Production 08T

Then, build a matrix] and each single-weight matrix plans each production line for the production line. In this study, the output of each of the 35 projects that must be produced each day was evenly distributed in the matrix to approximately 16.2 tons of residual iron produced per working day per working day. Finally, the matrix is completed by calculating the items generated each month based on the distribution of each group. At the same time, we show the matrix the daily production distribution status of the month.

V. Conclusion and Future Research

This study invested the leveling production concept of TPS (Toyota Production System) and applied power saving as a resource for scheduling production plans. It will provide better resource planning and results, reduce contractual capacity under the same production conditions and meet product requirements. This study contributed to the literatures by proposing a methodology to even out peak power consumption and developed optimal contract capacity which can reduce carbon emissions by 5,431 tons in one year. The methodology proposed by this study provided a simple way to execute the planned production orders.

By reducing the demand for electricity in manufacturing, reducing carbon emissions can not only bring economic returns but also environmental benefits. This aspect of the extension can consider other service-oriented performance metrics.

However, this analytical method can be widely applied to various industries other than the foundry industry. In particular, the rapidly rising demand for electricity in the electric vehicle industry is quite high. Implementing this concept and recharging at night to reduce regional power generation and corporate electricity prices will also be a good research topic.

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