RTG "Oil to Electricity" Benefits Analysis and Configuration Optimization Based on Low Oil Price Perspective

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Abstract: With the advent of the era of low oil prices, we have to consider whether the decline in oil prices to affect those which were based on high oil prices and continued to carry out the new technology innovation analysis and research will produce conflict, which eventually led to part of the advantages of offset. This paper selects the green port RTG as the research object, through the introduction of the whole life cycle of carbon emissions accounting model, calculating the cost of diesel RTG and power RTG, the critical oil price, and the economic benefit analysis. In this paper, we select the different oil price level, the power and diesel RTG allocation problem is calculated, and the optimal allocation scheme is obtained. This paper studies the impact of the sharp drop in oil prices on the development of power RTG, and the appropriate measures to deal with the problem of low oil prices.

Introduction

In recent years, along with the increasing emphasis on environmental issues, the nation advocates green port construction in the context of high oil prices. However, from the second half of last year, international oil prices continued to fall. If oil prices continue at a low stage, it is likely that innovation makes little sense to introduce and put into use and the ongoing development of new technologies is expected that based on high oil prices. Green Port "oil to electricity" technology is based on the development of oil prices at 100 dollars per barrel and above historical background and applications, due to a sharp fall in oil prices, economic benefits that "oil to electricity" technology creates may be affected by the fluctuations of prices. 100 days for international oil price chart is shown in Fig.1 and domestic diesel prices fluctuation percentage histogram is shown in Fig.2:

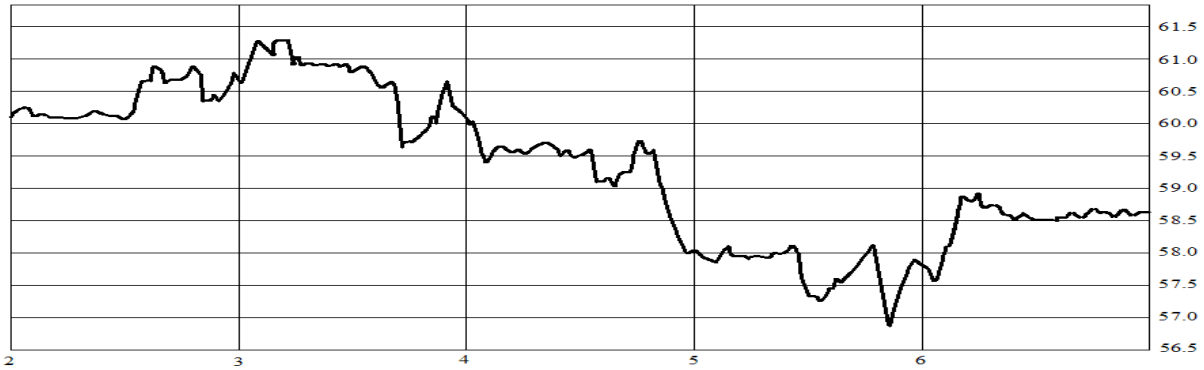

Fig.1. International oil price trend chart

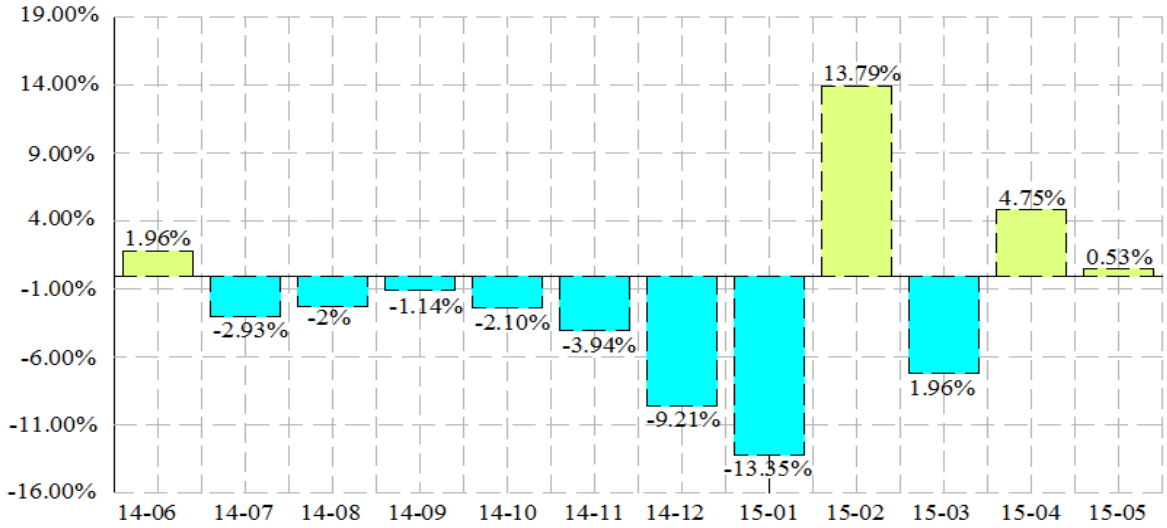

Fig.2. Domestic diesel prices fluctuation percentage histogram

In this paper, we mainly study the sharp decline in oil prices, and whether it will have a greater economic impact and the study of the economic benefits created by RTG "oil electricity", analytical models relating to carbon emissions and to establish the cost accounting of RTG "oil to electricity" program pure diesel fuel and pure electric RTG [1]. Carried out on the basis of the calibration threshold prices, introducing Dalian Port as an example, selecting different levels of oil prices based on calibration results, calculating the corresponding configuration under the establishment of optimal allocation model, what is more, the paper formulates different configuration RTG based on the different oil prices. As a constraint to social benefits, government encourages enterprises from both positive and negative incentives to continue to walk the road of energy saving and environmental protection [2].

RTG "oil to electricity" Configuration Problem Description under the background of the low oil prices

Based on the low rack trolley line program analysis, because this change of RTG itself is small and easy accessibility, so we can consider factors including lower oil prices, which uses diesel engine to achieve RTG job at a low price level through removing under-powered device or setting aside mains-powered equipment [3]. Therefore, if oil prices continue to fall, or chronically at a low level, how to deal with existing RTGs' configuration problem at different levels and to make the economic benefits of low oil prices reaching an optimal state, which is the businessmen worth considerate of the issue, and which is one of the contents of study in this article.

Economic Benefit Analysis about RTG "oil to electricity" based on the low oil background

Carbon emissions accounting model. Since there are a lot of link including the exploitation of oil, coal and electricity produces carbon dioxide emissions, so according to the actual situation of the research object, the paper select to use the whole life cycle method to account the entire life cycle carbon emissions that the diesel and electric RTG energy consumed [4].

Diesel RTG carbon emissions accounting. Diesel-powered RTG involve full life cycle carbon emissions including emissions of carbon dioxide in the process of oil transportation(D_1) ,diesel emissions of carbon dioxide during transport(D_2), diesel RTG carbon emissions at work（D_3）, carbon emissions accounting model of diesel-powered RTG as follows [5]:

$$D_3 = m * N * B \quad (1)$$

D_3: Diesel RTG's carbon dioxide emissions per unit of time on container terminal (kg);
m: Consumption per unit TEU (t);
N: The number of containers operated per unit time;
B: Diesel RTG's emission coefficient ($kgCO_2/t$);

In summary, we can account the RTG whole life cycle of carbon dioxide emissions D_A.

Accounting carbon emissions of power RTG. Electricity RTG involve full life cycle carbon emissions, including coal mining process in the carbon emissions, coal-bed methane emissions carbon emissions, coal spontaneous loss resulting carbon dioxide emissions from coal washing process, carbon emissions during transport coal for power generation and emissions generated in the process of coal combustion for power generation produced. Wherein power RTG's CO_2emission per unit of time at work accounting formula as follows [5]:

$$E = b * B * c \quad (2)$$

E: Power RTG's *carbon* emissions in a unit time (g);
b: Power consumption of TEU (kwh);
B: The number of Container operated by RTG per unit time;
c: Diesel RTG's emission coefficient($kgCO_2/t$);

To sum up， we can calculate the carbon emissions of electricity RTG E_A from the life cycle.

RTG "oil to electricity" program costing

Diesel RTG costing formula is as follows:

$$C_d = P_{d1} * h * Q_d + P_{t1} + P_{c1} + P_{r1} * h \quad (3)$$

C_d: The cost of diesel RTG;
P_{d1}: A unit price of diesel;
T: RTG's life;
h: RTG's annual working time;
P_{r1}: RTG's unit cost of repairs;
P_{c1}: The depreciation costs of device which is idle one year;
P_{RTG}: Existing RTG price after transformation;
P_{t1}: Companies need to hand over the emissions tax per year due to carbon emissions.

Electricity RTG costing formula is as follows:

$$C_e = P_{11} * T_1 * Q_0 + P_t + P_{12} * T_2 * Q' + P * h + \frac{P_{RTG}}{T} \quad (4)$$

C_e: The cost of electricity RTG;
P_{11}: A unit price of diesel fuel;
T_1: RTG's transition time within a year;
Q_0: RTG fuel consumption per unit time for transition;
P_t: Companies need to hand over the emissions tax per year due to carbon emissions;
P_{RTG}: Existing RTG price after transformation;
T_{RTG}: RTG's life;
P_{12}: Unit price of electricity;
T_{op}: RTG's operation time within one year except transition;
Q': RTG's electric consume in unit time for the operation in addition to turn off the power;
P: RTG unit cost of repairs;

h: RTG's operation time per year.

Calibrate the critical oil

Calibration Ideas. In this paper, in order to ensure selecting different levels of oil prices totally in the validity of the science, we can account for the use of the two programs profits by calculating the costs and income through operations generated in the pure diesel and electric RTG program, profit program established equation model of two equal, accounting the final critical oil prices.

Critical oil calibration-A case study of Dalian Port. According to lifecycle formula given above carbon emissions accounting, we can calculate the carbon emissions of each cycle about electricity and diesel RTG on Dalian Port [6].

Diesel-powered RTG's the whole life cycle carbon emissions within an hour as follows:

$$D_{da} = D_1 + D_2 + D_3 + D_4 = 274.74kg / h \tag{5}$$

Electricity-powered RTG's the whole life cycle carbon emissions within an hour as follows:

$$E_A = E_1 + E_2 + E_3 + E_4 + E_s + E_g + E_b = 81.1484kg / h \tag{6}$$

Diesel RTG costing:

$$C_d = P_d * h * Q_d + P_r * h + P_{dc} + \frac{P_{RTG}}{T} + P_{tax} = 57232 * P_d + 289726.25 \tag{7}$$

Electricity RTG costing:

$$C_e = P_d * T_{tra} * Q_{tra} + P_e * T_{op} * Q_{op} + P_r * h + \frac{P_{RTG}}{T} \tag{8}$$

$$C_e = 7154.2 * P_d + 482945.92 \tag{9}$$

Critical oil Calibration (Set the same efficiency of the power and diesel RTG):

Order, namely: $C_e = C_d$

$$C_e = 7154.2 * P_d + 482945.92 = 57232 * P_d + 289726.25 \tag{10}$$

Solution: $P_d = 3.86 yuan / L$

Therefore, we choose $P_d = 3.86 yuan / L$ as the critical diesel prices.

RTG "oil to electricity" Configuring Optimization Model

Objective Function:

$$MinC_a = X_1 + X_2 + X_3 + X_4 + X_5 \tag{11}$$

$$= N * \left(C_d + C_1 + C_0 + P_1\right) + M * \left(C_e + C_2 + C_r\right) \tag{12}$$

X_1: It represents the cost of electricity RTG;

X_2: The cost of diesel RTG;

X_3: Total carbon tax;
X_4: Total maintenance costs;
X_5: Total depreciation costs;
N: The number of diesel RTG;
M: The number of electric RTG;
C_d: Single-diesel RTG's costs;
C_e: The cost of single electricity RTG;
C_0: Carbon tax diesel RTG needs to pay;
C_1: Carbon tax power RTG needs to pay;
P_1: Maintenance costs of diesel RTG;
C_r: Maintenance costs of electric RTG;
C_2: The existence of depreciation expense;
$i = 1,2..., n; j = 1,2,3 ..., m$.

The planning model has the following three constraints, the results of the three constraints are rounded.

$$N + M \le Q \tag{13}$$

$$0 \le N * C_e + M * C_d + C_r + C_t \le Z \tag{14}$$

$$N * Q_{dc} + M * Q_r \le Q_N \tag{15}$$

$$N \ge 0; M \ge 0 \tag{16}$$

Q: The total amount of RTG wharf owned;
Z: Business equity capital for wharf;
Q_N: Carbon emissions the national limited.

Configuration Optimization based on Dalian Port RTG "oil to electricity". Different level of oil prices RTG "oil to electricity" configuration optimization, which is shown in Table1.

Table1. Calculation data

Price level	RTG electricity costs	RTG diesel costs
$P_1 = 4.8 yuan / L$	520755.58	651128.62
$P_2 = 3.8 yuan / L$	510131.88	507207.85
$P_3 = 3.4 yuan / L$	507270.27	484315.05
$P_4 = 3.0 yuan / L$	487620.57	472350.48

RTG configuration under different level of oil prices in the following Table2:

Table2. RTG configuration under different level of oil prices

Price level	Configuration (diesel / electricity)
$P_1 = 4.8 yuan / L$	0/50
$P_2 = 3.8 yuan / L$	21/29
$P_3 = 3.4 yuan / L$	23/27
$P_4 = 3.0 yuan / L$	24/26

Analysis. According to the calculations, we came to the following conclusions: when the oil prices above the critical level of oil prices, the cost of electricity RTG calculated is significantly lower than the cost of diesel RTG, taking into account the economic and social point of view, companies will choose electricity RTG for the operation, when the price is lower than critical oil prices, the cost of diesel RTG is below the electricity costs, companies can choose to use diesel RTG as a part of section work, and the specific configuration must to be calculated according to the specific oil background, analysis results calculated in accordance with: below the critical oil, with the fall in oil prices, it can indicate the advantages of increased diesel RTG, which costs less than the cost of electricity, there has a good economic returns by using diesel RTG for operation, therefore, the configuration program to configure the number of diesel RTG will increase as oil prices fall.

Design the Government Regulation Mechanism

Mechanisms for government financial subsidy. Refers to the cost of government subsidy mechanism for different levels of diesel oil and electricity RTG configuration program calculating various government financial subsidy given to different business [7]. In this paper, the government subsidy program under the selected level of oil prices is shown in Table 3. Among them, the price of oil above the critical level of oil prices (including critical oil) and electricity cost RTG significantly higher than the cost of diesel fuel, from the viewpoint of economic and social point of view, companies will choose electricity RTG to conduct operations, the government may choose not to give financial subsidies, it may also be appropriate to give financial subsidies, to be rewarded.

Table3. Government subsidy program under different level of oil prices

Price level	Subsidy program
$P_1 = 4.8 yuan / L$	Indefinite
$P_2 = 3.8 yuan / L$	300,000 yuan
$P_3 = 3.4 yuan / L$	600,000 yuan
$P_4 = 3.0 yuan / L$	900,000 yuan

Mechanisms for government emission limits. Emission limits for government mechanism, refers to the government by raising taxes or strict carbon emissions as the target [8]. China's carbon

emissions smaller tax credits, ports carbon tax accounts for only a small part of the total cost, there are minor effects by enhancing carbon tax credits for companies [9]. However, it is able to play a role for enterprise port limit carbon emissions constraint.

Conclusions

This paper which calculated the critical oil prices, and did some configurable calculations by taking different level of RTG's oil prices, concluded as follows: configuration schemes vary with the level of oil prices at different; above the critical level of oil prices, the calculated costs of power of RTG are significantly higher than the cost of diesel RTG, from economic and social point of view, companies will choose to conduct electricity RTG operation, when the oil price is lower than the critical oil prices ,and the cost of diesel RTG bellows the electricity costs ,what's more, the carbon emission is within the permissible range which is permitted by the state, companies can choose partially to use diesel RTG to work. Government may take a positive or negative incentive measures to control its trend. However, oil prices which continue to fall or rebound is still an open question, point of view on the current price of oil, if oil prices continue to fall, oil prices (mainly diesel) need for a long period of time in order to fall to less critical, or the period no arrival, oil prices rebounded. Either way, the construction of green port is still evergreen, the idea of environmentally sustainable construction will continue, enterprises and government should deal with the era of low oil prices appear now or in the future, together, and overcome the economic benefits of low oil prices and develop the green port better.

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