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Green technical innovation – RTG crane 'oil changes electricity' in Shanghai Port

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Green Technical Innovation – RTG Crane 'Oil Changes Electricity' in Shanghai Port

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Declaration

I certify that all the material in this research paper that is not my own work has been identified, and that no materials are included for which a degree has previously been conferred on me.

The contents of this research paper reflect my own personal views, and are not necessarily endorsed by the University.

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Supervised by
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Written by Li Qianjing(Sarah)
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Abstracts

The price of crude oil which is a kind of non-renewable resources has been keeping rising. In order to guarantee the national energy security, other kinds of energy will be developed to substitute oil. Shanghai Port as well as other ports in China is actively implementing countries to strengthen energy conservation, and build the spirit of saving a harmonious society. They try to solve the problem which container ports are facing when using RTG cranes in that RTG cranes cause high production cost, high energy consumption, serious pollution and so on, thus raising the climate of constructing ‘green port’. By changing its energy of diesel oil into electricity, RTG can save lots energy and the port can be more environmental friendly.

This paper gives analyze of the technologies and machines ports are using for loading and discharging containers and of the situation of RTG ‘oil changes electricity’. More emphasis is put on the recommendation and comparison of different ways of electricity supply RTG crane uses to change oil into electricity. Then the paper gives further details on the real situation of Shanghai Port. According to it, one of the technologies of RTG ‘oil changes electricity’ will be chosen.

In the light of this technology, a financial and environmental evaluation of the effect of RTG crane ‘oil changes electricity’ it to be given in the paper through different kinds of indicators. The comparison of before and after RTG crane ‘oil changes electricity’ is to be demonstrated.

The last two parts of the paper will make an introduction of the ways and effects of other ports in China using RTG crane ‘oil changes electricity’ and of other methods Shanghai port has applied to implement energy saving and environmental friendly.

The innovative of this paper is to put environmental weighting indicators into evaluation of the port.

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List of Abbreviations

RTG	Rubber Type Gantry
E-RTG	Electricity Rubber Type Gantry

Chapter 1 Introduction

1.1 Background of This Thesis

Oil which can be used both in industrial production and daily life is a significantly energy but it is a non-renewable resource, so the price of oil has been keeping rising. From table, we can see that from the beginning of this century, the market price of crude oil in the world has been soaring. Since early 2003, the price of international crude oil has climbed suddenly from about 20 USD dollars per barrel to more than 70 USD dollars per barrel in 2005. In October 2007, the price of it has reached to 98 USD dollars per barrel while in Jun 2008 the price of it has increased to 140 USD dollars per barrel. Though the financial crisis made the price of crude oil decreasing, international oil price stays in high place, at about 100 USD dollars per barrel. Some experts have forecasted that by the end of 2030, the price of crude oil will rocket to 186 USD dollars per barrel. In order to guarantee the national energy security, other kinds of energy will be developed to substitute oil. On the other side, China vigorously promotes the development of electricity, stabilize the price of electricity and improve the energy structure. To respond to the call of national plan, high efficient equipment has been used in newly built project. Great efforts have been put into energy saving and environmental friendliness and remarkable results have been made in China.

Affected by the international crude oil price, the fuel consumption cost has been fastest growing for Container Port Company and has become the largest increase in

cost. Recently, the throughput volume of containers in Shanghai port has been increasing ranking first or second in the world. With the speed of gradual growing big, the topic of how to make the big container port more environmental friendly and energy saving with its high efficiency. To solve the problem of contradiction between port development and energy consumption, many ports have promoted the technological innovation work, including Shanghai port.

Rubber type gantry (RTG) is the mainly equipment for lifting and unloading heavy objects, it is generally powered by the diesel oil generators, but the consumption of fuel is so big and the environmental pollution has made an negative effect in that about 93 tons of hazardous substances and 31000 tons of carbon dioxide are discharged every day. Through the technology of changing the driving energy of diesel oil into electricity, RTG crane can save lots energy and the port can be more environmental friendly.

Besides changing oil into electricity of operating RTG crane, other ways can also be applied into daily operation of port so that the goal of energy saving and environmental friendliness will be reached. Some other improvements such as hybrid power, refreshment of rubber tires, frequency conversion application in port cranes and equipment, and overhead lights with energy saving are used.

1.2 Literature Review

There are not much researches on RTG crane ‘oil changes electricity’, especially from the point of view of environmental friendliness and energy saving, but some researches put their attention on the technology of RTG crane’ oil changes electricity’. Among them, He Qingfen wrote a dissertation about the comparison of the technology of RTG crane ‘oil changes electricity’. In his article, he recommended there kinds of the most common ways of electricity supply of RTG crane, namely electricity supply by cable reel, by low-level slide touching line and by high-altitude

cross-container area slide touching line. Besides, he made an analysis of the comparison of these three technologies from the point of technology, engineering, price of construction, the effect of application, future development and investment and the features.

Zhen Xiaonan mainly recommended the technical solution to RTG crane ‘oil changes electricity’ from voltage levels, way of power-on and made a comparison of these aspects, pointing out the features of different ways of improvement.

The paper of Lu Weili about RTG crane ‘oil changes electricity’ gave ideas mainly from the view of Ningbo port Operation Company. To respond the demand of energy saving put forward by nation and solve the problem of rising price of oil, Ningbo Port conducted the transform operation of 50 tire gantry cranes on the port. Through the comparison of two kinds of cable reels and supply voltage, he chose one kind of improvement which was more suitable to the company.

Also there are not too much researches and articles about RTG crane ‘oil changes electricity’ in Shanghai Port and other ports in China. Reporter Xu Hui Yun introduced the situation of RTG crane ‘oil changes electricity’ in Shanghai Port. In his report, he mentioned how benefit this improvement and transform has brought to Shanghai Port.

1.3 Research Methodology

This dissertation will establish a calculation in which the benefits and advantages of RTG crane changing oil into electricity will be shown, for instance, how exactly cost will be saved by this change. In this paper, two parts of evaluation indicators will be mentioned, namely financial index and environmental index judging whether the effect of transform of RTG crane ‘oil changes electricity’ on the port is positive or not.

Chapter 2 Port Container Handling Technology and Equipment

2.1 Chassis Systems

Chassis system is one of port container handling technology first used by American Seaway Company and is also called Sea-land way. The containers are loaded and discharged through crane in which the imported containers are discharged directly to chassis from ship by quayside container cranes; container tractor drags the chassis loaded with containers to the yard; and when the container is moved outside yard, the chassis is dragged out from the port by container tractors. The contrary procedure is made when the export work is done. The main feature of this system is that containers are always laid on the chassis during the whole period in the yard.

The main advantage of this chassis system:

(1) Reduce the number of operations of the containers in port so that the efficiency of loading and discharging is high and the damage rate of containers is low;

(2) Chassis system can be applied in road transport which is suitable to door to door service;

(3) The wheel pressure of the chassis is little and requirements of carrying capacity on the site is low so that the investment of the ground is costly;

(4) The organization of the work is simple and the demand of the technology skill to the stevedores and managers is low;

(5) The yard doesn't need complex and expensive loading and discharging facilities.

The main disadvantages of this chassis system:

(1) It demands a wider field to operation the work of chassis and trailer;

(2) Big amount of chassis are needed so that the investment is high and the operation may be disconnected because of the lack of chassis or other field facilities;

(3) Automation is hard to achieve;

(4) Huge harbor using this kind of system needs a long distance to drug and may bring congestion in the port.

(5) Frequent repair and maintenance is needed because chassis are used not only in yard but also outside yard.

Applied to :

(1) Container terminal with a small amount of containers and little area;

(2) In the initial period of container terminal, especially the terminal with a high percentage of full containers;

The terminal which is specially demanded by the shipping company and its road transport totally depends on highly efficient road transport.

2.2 Straddle Carrier System

Straddle carrier system is a way of transportation in which crane is used in loading and discharging work. Straddle carriers transport from dock to the yard and do the work of yard stacking and loading and discharging from trucks in and out yard.

The main advantages of straddle carrier system:

(1) The straddle carrier system can do many kinds of works, reducing the kind and amount of machines in the yard which is easy to organize and manage.

(2) With flexible and easy to operate, the straddle carrier system can give full play to the shore container cranes doing discharging work.

(3) The straddle carrier system has high mobility in which it can also move cargo and stack and it has high efficiency in loading and discharging in which working links can be reduced.

(4) Compared with chassis system, the straddle carrier can straddle two to three layers of containers so that the area of field can be saved.

The main disadvantages of straddle carrier system:

(1) The machinery sector of the straddle carrier system is complex and there are hydraulic components which result in a high failure rate, high technical requirements for maintenance personnel and high cost.

(2) High requirement for driver operation.

(3) It is hard to turn and remove containers.

(4) It needs high investment in initial.

This kind of system is applied in the dock where there is a big amount of heavy containers in import and little amount in export.

2.3 Tire Gantry Crane System

The tired gantry crane system is a system in which cranes load and discharge the vessels, the tired gantry crane system do the work of loading and discharging and straddling in container yard and the container trucks do the transport work from the wharf apron to the yard. Tired gantry crane system can cross six lines and one line of container truck lane, and can straddle three to five layers. With turning equipment, the tired gantry crane system can move from one container area to another one.

The main advantages of this system:

(1) The tired gantry crane system can use the yard efficiently.

(2) The tired gantry crane system can reduce the cost of yard pavement.

(3) As the equipment is easy to operate, it requires medium level of skills for the workers.

(4) Compared with chassis system, there is little opportunity in the damage of containers.

(5) Applying the right angle turn and a fixed axis turn, there is little area to be used. Compared with rail mounted gantry crane system, the tired gantry crane system can move from one straddle area to another one without constraint of orbit.

(6) It can apply automatic straight line moving system to realize automatic control of moving in tracks. Using computer to control, it is easy to realize automation of container handling operations.

The main disadvantages of this system:

(1) Compared with the straddle carrier system, the tired gantry crane system is less flexible in which it can only fix in one straddle area while working and needs a long time moving from one area to another one.

(2) Because the tired gantry crane system can cross a long distance and straddle high, it is difficult to take container and sometimes needs remove the containers.

(3) The tired gantry crane system needs container semi-trailer train to transport containers which increase the operation steps and make the operation works complicated.

(4) The tired gantry crane system needs a high initial investment.

This kind of system is applied in the docks where there is little terminal land area and a big amount of transfer in sea-sea transport.

2.4 Rail Mounted Gantry Crane System

The rail mounted gantry crane system is a system in which the cranes do the loading and discharging work of ships, the rail mounted gantry crane system do the loading and discharging and straddling work in the yard and the container trucks do the transport during the yards. Compared with the tired gantry crane system, the rail mounted gantry crane system can cross a longer distance. It can straddle higher in which it can straddle four to six layers of containers and can cross fourteen and more

rows of containers.

The main advantages of the rail mounted gantry crane system:

(1) High utilization of yard area.

(2) With the easy structure of the machine, it is easy to maintain and reliable to operate.

(3) Driven by electricity power, the machinery can save more energy.

(4) Moving along the track and controlled by the computer, the rail mounted gantry crane system can realize the automation of container handling.

The main disadvantages of the rail mounted gantry crane system:

(1) With little mobility, the rail mounted gantry crane system can move only along the track and the operating scope is limited.

(2) The rail mounted gantry crane system can cross a long distance and it is difficult to take and remove the containers.

(3) It needs a high initial investment and has a comparatively high investment same as the tired gantry crane system.

The rail mounted gantry crane system is applied to the docks where there is a limit area of land and there is a comparatively big amount of container throughput of water and land transport.

2.5 Forklift System

The forklift system is a system in which quayside container cranes do the loading and discharging work wharf apron and the forklift system do the transport from quay and freight yard and straddle containers in freight yard.

The main advantage of forklift system:

(1) With a high versatility, the forklift system can be applied to the operation of several kinds of cargoes and can be fully used.

(2) The forklift system is used widely and drivers and maintenance personnel are familiar with this technique. There are little technical problems existing in it.

(3) The price of the forklift system is comparatively cheap and the cost of loading discharging is low.

The main disadvantage of forklift system:

(1) With low efficiency of single machine, the forklift system is not suitable to be applied in the harbor with a big amount of throughput.

(2) The tire of the forklift system load unevenly and the pressure to the tire is big so that it costs server damage to the road and increase the cost of the field.

(3) With a comparatively low utilization of the field, the forklift system needs a wide field.

(4) It is hard to focus the slot while loading and discharging.

2.6 Stacker System

The stacker system is a system in which quayside container cranes load and discharge of ships wharf apron and the stacker system do the transportation between wharf apron and yard, straddle the containers and loading and operate the truck of loading and discharging.

The main advantages of stacker system:

(1) The stacker system can do the work of moving, straddling and loading and discharging, in which it can reduce the kinds of the machinery in the port and it is easy to maintain the machine.
(2) The stacker system can work crossing containers with lifting four or even five layers of containers. Compared with the forklift system, it has a comparatively higher utilization.

The main disadvantages of stacker system:

(1) The stacker system can cross only one or two lines of containers while working so that it needs a small area of container field and many passages. Compared with the gantry cranes, the stacker system has a low utilization of the field because when the containers are lifted by the stacker system, the container is generally needed to be vertical to the stacker system and needs a wider passage.

(2) The stacker system can operate many kinds of work and the efficiency of the single machine is low. The port needs to equip many amount of the machine so the initial investment of the system is big.

(3) When the stacker system moves with lifting the containers, load center of gravity moves back which cause huge pressure on the tire and result in the severe damages to the steering wheel tire and the road.

The stacker system has not been widely applied and just used in the port with a comparatively small amount of container throughputs.

2.7 Mixed System

From the point of view of economy and handling performance, different kinds of loading and discharging systems talked before have their own advantages and drawbacks. At present, some ports in the world use the mixed systems of the above systems, for example, (1) tired gantry crane – track gantry crane mixed system; (2) straddle carriers – tired gantry crane mixed system; (3) straddle carriers – track gantry crane mixed system.

Table1 The Technical and Economical Comparison of Various Kinds of System

System	Chassis system	Straddle carrier system	Tired gantry crane system	Rail mounted gantry crane system	Forklift system	Stacker system	Mixed system
Storage capacity	Bad	Good	Excellent	Excellent	Medium	Good	Excellent
Investment cost	Bad	Good	Good	Good	Excellent	Good	Excellent
Simple process performance	Excellent	Good	Bad	Bad	Excellent	Excellence	Medium
Efficiency of loading and discharging	Excellent	Good	Good	Good	Bad	Medium	Excellent
Mobility	Excellent	Good	Bad	Bad	Good	Excellence	Medium
The less damage to containers	Excellent	Bad	Good	Good	Good	Good	Good
Reduce the	Good	Bad	Good	Excellen	Good	Good	Mediu

cost of maintenance				t			m
Distensibility	Excellent	Good	Bad	Bad	Good	Good	Good
Automatic application	Bad	Bad	Good	Excellent	Bad	Bad	Good
Connect with the railway	Bad	Bad	Good	Excellent	Medium	Good	Good

Source from: international container transport

Chapter 3 the Situation of RTG ‘Oil Changes Electricity’

3.1 The Use of RTG Crane

RTG crane is the most commonly used machine in container port yard in all the ports worldwide. At present, among about 7000 yard container loading and unloading bridges, nearly 95 percent is rubber type gantry (RTG crane). RTG use AC generator driven by diesel engine and become the driving power of the machine after the frequency conversion by thruster. Therefore, RTG can move in the yard without constrains to electric cable and other external power supply. The driving power of traditional yard bridges comes from the electricity provided by the diesel generator, thus bringing out much exhaust gas such as sulfides and nitrides caused by diesel generator when the equipment is operating, high noise pollution and violation. At the same time, waste oil and waste water produced during the process of repair and maintenance of diesel generator sets will also make a second pollution on environment of both the port and the city. Besides, Because while working, RTG has to cross the yard and to equip diesel generator sets by itself, there are several problems and drawbacks in the practical exercise, such as, break in diesel generator sets, breaks in machine’s turning and breaks in other electric control and machinery.

The instability of electricity quantity caused by the problem of fuel oil also makes a negative effect on the reliable operation of the equipment.

3.2 Analyses of Economic Costs of RTG Crane

There are three kinds of operation costs including the initial investment cost, operation cost and equipment depreciation cost. We take the initial investment cost and equipment depreciation cost as a fixed cost and pay emphasis on the cost of daily operation of RTG.

There are several parts of the cost of daily operation of RTG:

(1) Diesel consumption is the main cost of daily operation of RTG

RTG working in the yard is driven by the generator bringing by itself while the generator is driven by high-power diesel engines. The diesel engines needs to burn a large amount of diesel to work. The work of RTG in the yard contains the condition of loading, discharging, picking up container and waiting for containers. Therefore, after RTG begin to operate in the yard, the generator sets have always to be running to keep the move, lighting, air condition and computer of the whole RTG. Even though, when RTG is in the mode of waiting containers, the whole generator sets also have to be in idling invalid state.

(2) Repair and maintenance of RTG is also a big cost

One generator of RTG works almost 20 hours everyday. After it works for 400 hours of 20 days, the generator has to be maintained once according to the requirement of maintenance.

(3) The consumption of tire is a vital cost of daily operation of RTG

The tire of RTG is a kind of large scale engineering tire. There are many factors influencing the service life of the engineering tire such as environmental factor, human factors and structure quantity of the tire. RTG weighs heavy itself and the tire has been in a high pressure. When RTG is turning direction, the tire tread rubber and

the ply shoulder extremely severe friction and distortion. As the driving wheel, the main wheel endure a greater impact and results in tire's inner and outer layers off leather, which is the main cause effecting the service life of the tire of RTG.

(4) The cost of equipment lubrication

Equipment lubrication cost is also a main cost of daily operation of RTG. No matter how the equipment works, one RTG has to be lubricated four times in one year. As the cost of lubrication and manpower has been increasing dramatically, the equipment lubrication cost has become a cost which cannot be ignored.

(5) The cost of changing the oil of the total machine

After the new equipment work through the period of adjustment, the hydraulic oil of RTG has to be changed once a year and the oil of other gear box has to be changed once two year according to the experience of equipment management.

3.3 The Advantages and its Existing Problems of RTG Crane

With the large-scale development of container ports, countries in the world pay more attention to the environmental protection. At same time, the price of the resources as oil which has become less and less is increasing dramatically. As the traditional container yard equipment, RTG shows both superiority and constrains. After many years of using and maintenance, much experience has been collected. There are several major advantages of RTG:

(1) RTG requires not a high demand to the road and the investment of infrastructure is comparatively low.

(2) RTG can move and operate flexibly and in a wide range of area. The port can

drawback the capital of investment quickly.

(3) Compared with other equipment, the speed of RTG is comparatively quick and the efficiency of loading and discharging is high.

Through there are many advantages of RTG, we can not ignore the drawbacks of it as well. No solutions have been found to some problems. For example:

(1) The diesel consumption cost is too high for the high-power engine of RTG and the running cost cannot be controlled.

We can’t solve the problem of the air pollution and noise pollution caused by the diesel generator.

3.4 Other Ways of RTG Crane Energy Saving

3.4.1 Fuel saving (ECO-RTG)

The fuel consumption is wasted when RTG crane is waiting to work with non-load and working with light load. To solve it, Siemens worked out the system called ECO-RTG. It uses a integrated power replacing originally used diesel generator set and most of the electronic control system. It is mainly composed of speed changing diesel generator, speed changing gear box, water-cooled generator, and current changing equipment. The cost of purchasing this equipment is 15 percent higher than the normal RTG. When RTG is waiting to work with non-load and working with light load, DICO will give directions to the diesel generator letting it operate in low speed which can reduce the fuel consumption at work with non-load and light load. When the equipment needs to operate with full power, DICO will give direction to the diesel generator to speed up meeting the requirement of force. ECO-RTG saves the fuel consumption when the machine is at non-load and light load. It reduces the fuel

consumption to the lowest level in these two periods but fuel consumption can not be saved when RTG crane is at normal work. This means that the effectiveness of fuel consumption will be bad when the operation of the crane is busy. As the single generator has been used, spare parts have to be increased and the difficulty of repair and maintenance will be increased.

3.4.2 SC-RTG

This solution is to add a super capacitor energy storage device and a corresponding control loop on RTG. The electricity power generated by potential energy can be stored in the super capacitor energy storage device. This process is controlled charging through converter. When RTG crane works in full power, the energy saved in the capacitor energy storage device will return to the current making up the lack of electricity which is regarded as saving the operation cost. Charging and discharging of the capacitor energy storage device is a controlled forward and reverse process, so the life span of it is about 10 years in theory. Practically, the life span of it has not a standard time. The power provided by the capacitor energy storage device can compensate the set of the system, so it can appropriately reduce the power of diesel generator. But the purchasing cost of the equipment is also 20 percent higher than the normal RTG crane.

3.4.3 TM GE

When the RTG crane needs little power, speed changing generator, current changing device and rotate device will be applied to reduce the fuel consumption, noise and the cost of maintenance.

3.4.4 The Green RTG Crane by ZPMC

This system applies super capacitor energy storage device which is used as a

component saving energy to save fuel consumption.

3.5 The Situation of RTG Crane ‘Oil Changes Electricity’

3.5.1 The Development of RTG Crane ‘Oil Changes Electricity’

With the soaring global fuel prices and the increasingly rising demand of energy saving, the technology of RTG Crane ‘oil changes electricity’ has been developing quickly. RTG crane ‘oil changes electricity’ means the RTG is driven by electricity not by diesel power. There are two advantages of these changes: first, electricity as a clean resource is kind of environmental protection and energy saving; second, it can make RTG move in the field flexibly. Because of its incomparable superiority, eRTG has been promoted in many ports.

Because RTG crane ‘oil changes electricity’ is a newly developed technology, the development and improvement of the new technology is a step-by-step development process. The technology of it is improved gradually when people know and improve it.

Driven by the diesel generator, RTG consumes a large number of oil. Diesel engine capacity must cover the maximum power of the crane, and the maximum power of the crane is only used when the overloaded containers are enhanced to accelerate the running which endures only a few seconds and is about 1% of the working time of the crane. However, when the crane is not in maximum power running, the diesel generator also has to be running in full power. After few years of development and improvement, many ways has been worked out to solve the low efficiency of RTG such as diesel generator speed control, diesel generator with high and low power, diesel generator with two speeds and diesel generator with mixed energy power. The objection of them is to raise the efficiency or use rate of the diesel generator (generally 10% to 30% of raise). However, compared with the big scale electricity

generator made by city electricity, the efficiency is also low and the cost is high. The best method is to use city electricity replacing diesel to drive the machine which is so called ‘oil changes electricity’. RTG of low efficiency has a wide area to improve and the running cost saving by RTG crane ‘oil changes electricity’ is about 60% to 80%.

The original technology of oil changing electricity is considered from the lifting of the energy saving effect of the lifting. At beginning, the technology is to add a electricity supplier system on the RTG. When RTG is doing straddle on the yard, diesel generator will be turned off and electricity supplier onshore will be used; when RTG needs to turn to other field, the electricity supplier onshore will be changed into diesel generator. However, the changes of power and turn on and turn off of the diesel generator has brought many inconvenience to RTG and that’s why the technology of RTG ‘oil changes electricity’ has not been promoted.

In practice, for there are more and more modern large scale container terminals, the mobility of the machine is also needed to be considered besides its advantage of energy saving. Therefore, turning problems and driving problems of RTG have been put more emphasis on. The ideal condition is that when the machine is turning, the electricity is still on which will save more effort on turning on and off the power.

3.5.2 The Situation of RTG Crane ‘Oil Changes Electricity’ in Other Ports in China

3.5.2.1 Tianjin Port

The project of RTG crane ‘oil changes electricity’ in Tianjin Port began from 2008. After about 2 years, 57 RTG crane in 48 container fields have been transformed. Now they are driven by electricity and the port has become a real environmentally friendly port. Tianjin port is accelerating the RTG crane ‘oil changes electricity’ project, thus about 13300 tons of coal will be saved every year.

After a period of test run, the effectiveness of RTG crane ‘oil changes electricity’ has shown up in that the energy consumption has been reduced while the effect of the port operation on water quantity has been decreased. Through this project, Tianjin port declined the risk of operational cost added by the increasing price of fuel. At the same time, the new technology realized zero-emission of exhausting smoke and dust from generator and the noise of the machine has reduced significantly.

The investment of this project costs 400 million yuan, among which Container Company, Oriental Sea-land Company and Union International Company used the technology of electricity supply by low-level slide touching line while Pacific International Company used the technology of electricity supply by low-level public direct current. In the process of transform, different ports carried out technological innovation and improved their technical level with its own characteristics. Container Company independently researched and developed automatic electricity acceptance device realizing the function of automatic electricity acceptance when the RTG crane of low level slide touching line moves to another container field; Oriental Sea-land company researched and developed automatic moving field device realizing the objective of zero-emission of RTG crane; Pacific International Company researched and developed energy returning direct current system realizing automatic electricity acceptance. The average energy consumption of the RTG cranes after transformation by different companies has been reduced about 80% practically realizing the environmentally friendly objective of low energy consumption, low emission and low noisy, thus Tianjin Port gradually becomes to a green ecological port.

3.5.2.2 Ningbo Port

Ningbo Port has done well in changing port into a environmental friendly port. The project of RTG crane ‘oil changes electricity’ has a widest scale and coverage among all the ports in China. Nowadays, 173 sets of RTG cranes have been transformed

accounting more than 15 percent of all the RTG cranes nationally.

3.5.2.3 Taicang Port

By the end of 2008, 35 RTG cranes in Taicang Container Port have been totally transformed. Taicang container port tried the project of RTG crane ‘oil changes electricity’ from 2007 after multiple research and scientific proof. During the process of project implementation, the relevant personnel in the Taicang Power Company discussed on the demonstration of the transform project, the design of power supply, the selection of machine and cable and test and equipment of the machine. After one and a half year of effort, the port invested 80 million yuan transforming 35 RTG to eRTG and set power supply facility on 64 container fields. In the second half of 2008, Taicang Port became the first ports who transformed RTG cranes.

According to the test, originally, lifting one container cost 2.1 to 2.5L fuel. With 6 yuan per liter of diesel oil, the cost of fuel consumption will be 13 yuan. After transformation, lifting one container costs 3.1 to 3.5 kWh of electricity with the cost of 3 yuan. The cost of lifting has been saved about 10 yuan reducing about 77 percent. The project of RTG crane ‘oil changes electricity’ not only saved cost, but also makes Taicang Port a ‘green port’. Shown as the statistics, the exhausting pollutant emission has been reduced about 90%. After emission being declined, the failure rate of the machine has been declined, stability of the operation has been increased and the efficiency of work has been leveled up.

3.6 The Advantages of RTG Crane ‘Oil Changes Electricity’

ERTG not only applies the energy saving technology on its power generator set, but also absorb the advantages of RTG, which is using cheap but clean city power to drive the machine. That is what we call RTG crane ‘oil changes electricity’. As driven by city power, the feedback energy produced when RTG crane works can also apply

energy feedback technology that has high energy utility and won't produce any pollution. When using city electricity, eRTG has not only saved the all the function of its original one, but also changed the way of power supply of RTG from original diesel generator with high power to city electricity supply. Only those diesel generators set with lower power is equipped for RTG to provide energy moving to other container yards which not only keep the mobility and flexibility of original RTG, but also makes it environmental friendly and energy saving. The energy saving cost of per teu can be reduced by about 70 percent. But the project of RTG crane 'oil changes electricity' has to add the investment of power facility in port and has to put the problem of power supply of the total port into consideration when the facility construction is invested.

In the background of ever higher oil price, the technology of RTG crane 'oil changes electricity' has significant big cost advantage, and has a good effectiveness of environmental friendliness. It has following advantages:

1) Saving the operation cost of machine

According to the preliminary statistics, the present energy consumption of per TEU is: at normal terminal, the energy consumption of RTG is 2 to 2.2L of diesel fuel or 2 to 3 kWh of city electricity. In the condition of the present market price of oil and city electricity, the consumption cost of per TEU has been reduced by 70 percent, which makes eRTG using city electricity has a very strong advantage in cost.

2) It can move to other container field with a comparatively good mobility.

3) It realizes green RTG without exhaust pollution and noise of the diesel generator. During operation, the diesel generator set of eRTG is turned off where no exhaust gas pollution and noise of the diesel generator set has been produced and no vibration to the whole RTG crane has been made which greatly improve the

operation environment of RTG crane driver. At the same time, compared with the diesel generator set, city electricity net is more stable, thus the operation ability of RTG has been enhanced.

4) Stability is high and it has a low working volume of maintenance.

Technologically, eRTG can apply diesel generator set of comparatively low power replacing diesel generator with big power conventionally used on RTG. Because the frequency of use has been reduced with big margin, the use interval of the diesel generator has been lengthened only when RTG moves to other container field, which makes the stability of RTG higher and save big amount of maintenance cost.

The addition of power feedback system can furthermore save energy. The energy of hoist down can return back to electricity net through feedback energy, consisting more than 20 percent of total electricity consumption thus further saving energy.
This part should introduce 2 groups. One is to the easy chemical market another one is to the high standard cargo. The different requirement and different quantity allowed us to divide the market.

3.7 Different Ways of Electricity Supply of E-RTG Crane

3.7.1 Electricity Supply by Cable Reel (Moving in the Single Container Area)

This technology has been first applied in the RTG ‘oil changes electricity’. Many small-scale ports at board which are demanded environmental protection like the port of Oslo in Norway have used this technology since 2003. In the end of 2003, some ports in Shenzhen and Shanghai have used this technology as well. The technology of electricity supply by cable reel is that the cable reel is set up on the tired crane and city power is collected onto the crane by electricity supply line. There are several

typical characteristics of it:

1） On the basic of original RTG crane, to add a set of equipment of power supplier by city power will add wear and tear of the tire and add driving battery.

2） On the track of tired gantry system, cable trench shall be dag. The operator has to take care to prevent the trucks or the tired gantry system from pressing the supplier cable which will lead to the damage of the supplier cable. Usually, anti-collision devices and deceleration devices have to be equipped on the tired gantry system. Once collision happens, the cost of maintenance will be relatively high.

3） Owing to the limit of cable reel, the system adds a certain electrical cables and transformers which is about 10% to 15% of the total power.

4） Moving will be limited. At present, it can only be operated in the single container area. When it is moved to another container area, it needs to switch the power and turn on the diesel engine which will add additional time. Normally, it will take 20 to 30 minutes to move the equipment between neighboring container areas.

5） The power plugs are waterproof. Turning on and off the power is so technical that person from engineer and technology department will be asked to help.

6） The power plugs have to be convenient and quick to operate, so imported components are used which is hard to control.

7） The cable reel will occupy the operating safety space which is about 30 to 40cm. If it is set inside the gantry, it may be collided by hoisting mechanisms and containers. If it is set outside the gantry, it may affect the safety of the operation of tired gantry system.

8） As shown in the past application, anti-collision device is very important equipment. But not like the low-level touching sliding line, it can’t use the fixed board as the basic line and the present ways such as laser and ultrasonic wave have not found a good solution.

9） The anti-collision device can reduce the collision accidence but the inconvenience in driving exists as well. Normally, the speed of driving will be slowed down which will influence the efficiency. As to this problem, auto-driving technology has been worked out which by the way, needs certain expenditure.

10) An effective reversing device is needed to ensure using relatively fewer cables.

11) Components on the machine are complex and the life span of them is limited in which part of the main components can only be used 5 to 10 years. When the cable is tilted or aging, the cost of maintenance is relatively high.

12) The cost of transform is high.

13) Most of this technology is not operated on land. The transformation of the tired gantry crane doesn’t occupy the working field which places a relatively small effect on the yard.

14) The use of this technology is relatively complete and individual to the tired gantry crane and the equipment can be transformed individually. It is easy for the tired gantry crane to transfer and use in the future.

15) This technology can be applied in different kinds of container yards, especially small yard.

This technology has been applied for a long time and has been promoted by many customers.

3.7.2 Electricity Supply by Low-Level Slide Touching Line (Moving in the Single Container Area)

This technology was put forward and used in Qingdao Port in 2006 and was promoted widely and quickly. In Qingdao, there were 60 tired gantry cranes were transformed. With the promotion and application of the RTG ‘oil change electricity’, more and more ports have been using this technology.

This technology is using rigid material slide touching line as the conductor of the electricity supplier of RTG crane. The characters of this technology are:

1) Normally, it is set at the height of 2 to 3m and there a telegraph pole is put to support the slide touching line at the interval of about 3m. As to the height limit, slide touching line has to apply safety slide touching line and the electricity supply voltage is normally the machine voltage (such as 460v).

2) Safety slide touching line frame is needed to be set on the track of the tired gantry crane. The operator has to prevent the truck or the crane from colliding the electricity supply frame which will damage the slide touching line. Protection devices and deceleration devices are equipped on the tired gantry crane. Once the collision happens, the cost of maintenance will be high.

3) The movement is limited and can only be operated in the single container area. When RTG crane is changed to another container area, the battery is needed to be switched and turn on the diesel engine which will take additional time about 10 to 20 minutes between the neighboring container areas.

4) In the consideration of safety, the line power switch must be cut off before the power is plugged. At present, person from engineering technology department are asked to help.

5) The electricity collection device needs to ensure supplying electricity and pulling safely which is comparatively comprehensive and high demanded in quantity. Most of the components used now are imported from aboard.

6) Safety slide touching line frame occupies operating safety space at about 50 to 100cm which affects the safety of driving. In the existing application, the protection devices such as laser and ultrasonic wave have been the necessary device which will add a part of cost.

7) Besides, the protection device can reduce the collision accidence but the inconvenience in driving exists as well. Normally, the speed of driving will be slowed down which will influence the efficiency. As to this problem, auto-driving technology has been worked out which by the way, needs certain expenditure.

8) Because this technology of electricity supply originated from industry driving, to save the cost, aluminum slide touching line is used. Compared with the copper line, the damage of aluminum slide touching line is bigger and the life span of is shorter.

9) The cost of the transform is relatively low.

10) The transform work occupies wide land and put a relatively big affect on the field. The RTG cranes are being transformed in small quantities.

This technology can be applied in wide areas. For those yard where there are 10 to 20 cranes in medium size, this technology has a relatively high cost-effective.

3.7.3 Electricity Supply by High-altitude Cross-container Area Slide Touching Line (Moving Cross the Container Areas)

This technology was first put forward and used by Shanghai port in 2007 and was promoted widely. The principle of this technology is that copper slide touching lines is set on the top of RTG crane as current-carrying conductor, loading strand as loading device of slide touching line. The weight of loading slide touching line ensures the horizon of the line and auxiliary measures are used. All these keep the RTG crane supply electricity. The characteristics of this technology are:

1) The voltage of the copper slide touching lines is normally the machine voltage (such as 460v) and the copper slide touching lines is set at above 25m. Because the height exceeds the height of tired gantry crane and other port moving equipment, it doesn't impede the port equipment and can avoid a high maintenance fee caused by collision.

2) The drivers of the RTG crane don't have to change the habit of driving. This technology has a good operation performance and is safety.

3) RTG crane with high-altitude cross-container area slide touching line can move between the container areas freely with electricity which meet the demand of most RTG moving to another container area. Therefore, this technology can totally saves the problem of diesel generator while other two ways mentioned before cannot achieve and can save a lot of cost of maintaining the diesel generator. Besides, as the diesel generator has been moved away, the weight of RTG has been reduced, thus inducing the wear and tear of the tire.

4) When RTG crane switches power, because the safety distance of power switch is 2m, the safety of this system is high, but it is inconvenient for the operator has to

climb to the top of the crane to switch the power. However, this opportunity is rare and auto switch system can be applied.

5) The high-altitude cross-container area slide touching line is set through high transmission tower. The towers are 35 to 45m high and at the interval of 100 to 300m, so it will not influence the operation of the equipment.

6) Most of the main components have a long life span of 30 to 50 years and are produced nationally. To plus, the maintenance cost is low.

7) The price of transform is medium.

8) This technology doesn't occupy much land areas and puts a medium effect on the field. The transform work needs to operate in small quantities.

9) This technology has to be applied to a certain ports. It is highly cost-efficiency in the ports where it is medium-sized and has a medium working density.

The disadvantages of high altitude cross-container area slide touching line lie in the problem of lightning protection, anti-typhoon and anti-ice. But this problem can be solved specially in the design.

3.7.4 The Comparison of Different Ways of Electricity Supply of RTG Crane 'Oil Changes Electricity'

At present, there are three ways of electricity supply of RTG crane 'oil changes electricity' respectively using cable reel, high-altitude slide touching line and high-altitude cross-container area slide touching line.

Table 2 Comparison of Different Ways of E-RTG

	Electricity Supply	**Electricity Supply**	**Electricity Supply**

	by Cable Reel	by Low-level Slide Touching Line	by High-altitude Cross-container Area Slide Touching Line
Occupation of the field	Cable trench must be dig. The technology occupies a certain field of safety distance.	Set cable pole every 3m, this technology occupies a certain field of safety distance.	Few cable pole is set and this technology occupies few field.
Efficiency of power supply	Comparatively low about 66% (because of the damage of lines, voltage exchange device and self weight)	Aluminum material is low about 61% while copper material is high.	Copper material is good about 77%.
Maintenance work	Dragged on the land, the cable is easy to damage and the life span of the equipment on machine is short.	Carbon brush needs to be changed on time and workload is low, but maintenance work is needed.	Carbon brush needs to be changed on time and workload is low. The life span of the system is long.
Reliability of system	The quantity of power supply is high, but as cable drag on the land, accident is easy to happen.	The quantity of power supply is high, but as the amount of cable poles is big, it is easy to collide and safety is poor.	The quantity of power supply is high, but high level of design is needed to prevent lightening, typhoon and ice.
Driving operation	Comparatively poor and easy to collide. Ways of auto-driving device can be used, but the cost is high.	Poor and very easy to collide. Anti-collision device must be set. Auto-driving device is also needed.	Good and the operation of driving is the same as before.
Complex of the system	complex	easy	Easy
Ability of moving to another container yard	Not good	Not good	Comparatively good
Operate on the field	Affect little, but the workload of	Affect greatly.	Affect in medium

	transform is big.		
Return of investment/ life span of equipment	3.5-4years/ 10 years =35%-40%; bad	1.3-1.4years/ 15 years=8.5%-9.5%; comparatively good.	1.9-2.2years/ 30 years=6.5%-8%; very good
Suitable occasion	Wide coverage, especially for small port with few RTG.	Medium coverage, good cost-efficient for medium sized port.	Has demand on the field.
Use of resources in the future	No	Anti-collision and auto-driving device.	Tower can be used as lightening tower and monitor which can greatly reduce the comprehensive cost of the port.

CHAPTER 4 RTG Crane ‘Oil Changes Electricity’ in Shanghai Port

4.1 The Real Situation of Shanghai Port

Now there are five container docks in Shanghai:

4.1.1 Shanghai Pudong International Container Terminal

Shanghai Pudong International Container Terminal (W1) is located in the south of the Yangtze and the Waigaoqiao Free Trade Zone. It is adjacent to the Shanghai Outer Ring Road, Pudong Yang Gao Road and the Shanghai Sung Su Yuejiang Project which is to be built. The total length of the quay of this dock is more than 9000m. This terminal has three container berths where the container ships of the fifth and the sixth generation can call at.

With 500,000 square meters of land area and 8200 container slots on the yard plane, 30000 TEU of containers can be laid at the same time. It is a fully functional modern container terminal with full facilities where there especially set a freezer containers area, a dangerous cargo containers area and a warehouse container can be assembled.

There are 147 machine equipment on the Shanghai Pudong International Container Terminal including 10 container bridges, 36 rubber type gantries (RTG crane), 73 container trucks and 11 container forklifts. Through scientific development and technical innovation, the systems such as CTMS real-time production, full regulation of container trucks in yards, loading and discharging with the times and intelligent

yard have been applied in the container production and operation, thus becoming one of the modern container terminals with comparatively high technological content in nation.

4.1.2 Shanghai Zhengdong Container Terminal

Shanghai Zhengdong Container Terminal (W2) is located in the Yangtze River West Bank of the north bank of Waigaoqiao in Shanghai Pudong New Area. It is about 6km distance of Wusongkou from west direction and about 85 km distance of Yangtze River estuary.

It is an automatic non-person container yard and it's the first automatic non-worker container yard in nation. The containers are discharged from container truck through low-level crane, placed on a transit platform, lifted from transit platform by highway crane and then put in the yard. The capacity of piling high in the yard can reach to the eighth layer.

4.1.3 Shanghai Hudong Container Terminal

Shanghai Hudong Container Terminal (W5) is jointly invested and constructed by Shanghai International Port (Group) Limited Company and the biggest shipping company- A.P. Moller-Maersk Group.

With the quay length of 1250m, this terminal has 4 container route berths and 2 inside line berths. With the terminal area of 1550000 km2, this terminal has 13 bridges and 48 rubber type gantry (RTG crane). The front-line depth is 13m and the designed annual throughput volume is 1800000 TEU of containers. In 2003, the terminal will set another 82 container machines, including 4 quayside container cranes and 12 container rubber type gantry (RTG crane). Three container operation lines are newly added.

4.1.4 Shanghai Mingdong Container Port

Located in the Waigaoqiao Fourth Phrase downstream of the Yangtze Delta V groove region, Shanghai Mingdong Container Port (W5) covers an area of 1.63 million square meters. The distance between it from Wusongkou is about 15.5km and it is on the northern river side of Changqing Island. It is adjacent to the fifth dig from south-easterly direction and to Shanghai Hudong Container Terminal Limited Company from north-westerly direction. The port road is connected to outer line and Wuzhou Lane. It is very convenient in and out the port.

With the quay length of 1110m, Shanghai Mingdong Container Port has 4 container ports with the capacity of 50000 tons. With the quay length of 190m, two other insider line berths with the capacity of 3000 tons have been set. The depth of the forefront of the container terminal is minus 12.8m and the depth of the forefront of insider line terminal is minus 4m. There are 12 large-scale container bridges which can load and discharge the container ships with the width of 20 layers. The depth of land area is 1200m and the total area is about 365000 square meters. The construction of corresponding supporting supplies drain, electricity and lightening, communication GPS supply, computer management, environmental protection and other auxiliary facilities; equipped with 6 container loading and discharging bridges and the corresponding horizon transportation equipment, the designed annual capacity is 8300000tons (including 700000 nominal TEU of containers.

4.1.5 Shanghai Yangshan Deepwater Terminal

Yangshan Deepwater Terminal is located at the sea area of rugged archipelago. The distance from Shanghai Luchao Port is about 32km from north-westerly direction and it is about 104km from international ocean waterway of which the depth is more than 16m. it is the closest site to be chosen from natural deepwater port in Shanghai. The

first phrase of the project in Yangshan Deepwater Terminal consists of three parts, namely the first and second port, Donghai Bridge and Luchao logistic zone. The total shoreline of the first phase and the second phase port is 3000m and the depth of ocean is minus 16m. This terminal has 9 container berths equipped with 35 bridge cranes and 120 rubber type gantry (RTG crane) which can hold the berth operation of the biggest container vessel in the world at present. Among them, the first phase terminal has a length of its length of 1600m and has 5 container ship berths which the container ships of the fifth and the sixth generation can call at. At the same time, container ship with 8000TEU of containers can call at this terminal. The designed annual throughput volume is about 2200000 TEU of containers. With the land area of 24 million square meters, the area of yard is 1.39 million square meter where 1.5 million TEU can be laid including 2556 TEU of freezer containers and 1000 TEU of dangerous cargo containers. The main equipment of Yangshan Deepwater Terminal is 34 bridges, 108 rubber tire gantry and 220 container truckers. Started from Donghai Bridge Luchao Port in Nanhui District and eneded to Xiaoyangshan Island, the total length of Donghai Bridge is about 32.5km. There are 6 two-way high way lanes. According to the normal highway design, the designed driving speed is 80km/hour, and the capacity of annual through is more than 5 million TEU of containers. The Logistic Zone is located near the start of Donghai Bridge in Nanhui District Shanghai, and the work of which includes port inspection area, auxiliary operation area and dangerous cargo operation area. The total area is about 1.12 million square metes and its main function is to provide supporting service for Yangshan Terminal.

Yangshan Terminal District is a natural good deepwater terminal and is the first bonded port area in nation. As the operator of the first phrase and the second phrase terminal, Shengdong Company has mature production and organization system, complete computer management system, advanced facility equipment and worker team with high quantity.

4.2 The Volume of Throughput in Shanghai Port

In September 1978, using general cargo terminal at Jungong Road Terminal, M/V Ping Xiang of Shanghai COSCO Transportation Company started China's first international container line from Shanghai to Australia. The virgin trip is calling at Sydney and Melbourne loading 162 TEU of containers. In 2000, the throughput volume of containers in Shanghai Port broke 5 million TEU of containers, reaching 5.612 TEU of containers with an increase of 33.1% compared with the last year. In 30th November 2003, the throughput volume of Shanghai Port broke 10 million TEU of containers reaching 11.282 TEU of containers with an increase of 31% compared with the last year. In 2006, the throughput volume of Shanghai Port broke 20 million TEU of containers with an increase of 20.1% compared with the last year which kept three years overhead 3 million TEU of containers. In 2010, the throughput of Shanghai Port broke 29 million TEU reaching 29.069 million TEU of containers which made Shanghai Port become the first container port in the world exceeding Singapore Port.

Table 3 The Throughput Situation of Shanghai Port

	2011	**2010**	**2009**	**2008**	**2007**
TEU(million teu)	3173.9	2906.9	2500.2	2800.6	2615.2
Throughput of cargos (million ton)	48442.3	42835.1	36501.5	36913.3	35278.9

4.3 The Situation of RTG Crane 'Oil Changes Electricity' in Shanghai Waigaoqiao Port

To solve the problem of RTG crane such as high oil consumption, big noise problem and environmental pollution, Shanghai port began to research on RTG crane ' oil changes electricity and made technological analyze on several ways of electricity

supply. The technology of electricity supply by high-way touching slide line has the obvious advantage on product effectiveness, energy saving and safety production.

The arrangement of Shanghai Waigaoqiao Port yard is like that 6 container strips plus 1 passageway plus 1 overtaking lane with the width of 7m or 6.5m plus 1 passageway plus 6 container strips. The safety space between two neighboring RTG cranes is about 4 m.

To meet the demand of draining water, the traditional method Shanghai Waigaoqiao Container Port applies is to arrange yard draining digs in the 4m typhlosolis. As if using the technology of electricity supply by reel cable and by low-level slide touching line, the draining digs in the typhlosolis, wind-tight lock basis, streamer tank (touching slide line), and power box will be crossed and effected by each other and the arrangement will be comparatively difficult. Furthermore, the problems of cable reel dragging cable cross vertically the channels as well as the difficulty of the roll cable hanging deviation is also more difficult to resolve. On the other hand, the project of using low-level slide touching line has to be cut off when through the port longitudinal road which is very inconvenient for the E-RTG crane moving into other yard in straight line. Moving in different horizontal yards, E-RTG has a comparatively low efficiency.

Furthermore, the real situation of Shanghai Waigaoqiao Port is the container yard is structured, has a long working line (normally more than 800m) and has a high utilization rate. RTG doesn’t have to move to another container yard in at right angles. Considering above situation and the high efficient operational demand of the port and operation habit (the technology of electricity supply by high-way touching slide line basically does not change the habit of port operation), the technology of electricity supply by high-way touching slide line is a better choice.

The technical point of the technology of electricity supply by high-way touching slide

line includes self transform, tower basis and steel structure, electricity supply system and lightning protection. 1) The project of RTG transform consist the following content: making and equipping the platform of electricity collection, installing integrated circuit products, switch box of added power, line junction box with 460v power, watertight switch box, limit line on the machine, high pressure sodium lamp, indicator light and so on. 2) Tower basis and steel structure: in consideration of the geology condition in port, tower infrastructure is designed. The design of tower steel structure mainly include the main tower, tower bar, oblique rod, cross arm, bearing cable, wind cable, wire lightning cable. 3) electricity supply system: firstly, electricity supply volume of port is to be calculated, ensuring sufficient electricity supplied in port to realize RTG crane ‘oil changes electricity’; secondly, according to the real situation of port, the design of electricity supply system it to be finished. In the container yard, electricity supply facility is to be added according to demands. 4) Lightning protection: according to the third category of building lightning protection design requirements in design specifications on lightning protection of building of GB 50057-2000, the whole grounding and lightning protection system is to be designed. 5) Others: the safety operation protection device of tired gantry crane and warning device of anti-collision of high-way touching slide line input tower.

CHARPER 5 Analysis of Financial and Environmental Effect on RTG Crane ‘Oil Changes Electricity’

5.1 Financial Evaluation

5.1.1 Definition of Financial Evaluation

On the position of the enterprise, financial evaluation is to analyze and estimate profit and cost of the project from financial view according to national current price and to investigate the financial situation such as ability of profit, ability of pay-off and the effectiveness of foreign exchange judging the feasibility of the project and the effect of this project on the viability and financial soundness of the enterprise.

Generally, financial evaluation is to make analysis and assessment on the project financial effectiveness on the point of enterprise. In the financial analysis of investment project, project itself is made as an economic subject to evaluate the financial situation. Principally, to rationally assess resources in national scale, the choice of the project should put the result of national economic assessment into consideration. However, in the background of market economy, enterprise is an independent financial individual operating and self-financing and is direct shoulder of the investment result. Therefore, financial evaluation is the basis of corporate investment decisions.

5.1.2 The Objective and Main Contents of Financial Evaluation

The objective of financial evaluation contains the following contents:

(1) From the point of enterprise and project, to analyze the investment effectiveness of the project adjusting the factual profit the enterprise will achieve

(2) To make a plan of capital for enterprise

(3) To provide the basis for the coordination between enterprise interest and national interest.

When the financial effectiveness of the project conflicts with the effectiveness of national economy, nation needs to adjust through economic instruments. Through the investigation of the effectiveness of changes in economic parameters, financial evaluation can find the way of economic adjustment and margin, bringing corporate and state interests into line.

The main contents of financial evaluation contain the following contents:

(1) On the basis of general understanding of the investment project and the full investigation of market, environment and technical plan, basic statistics of forecast of financial analyses will be collected. These statistics include: estimation of the sale volume of the products and output of the products in different years; estimation of the product price consisting of the current price and the estimated changing margin of the price; fixed assets, current capital investment and other investment evaluation; cost and its composition estimation. Most of this data are forecasted. This step is also called financial forecast. The quantity of financial forecast is the key to financial evaluation. The result of financial forecast can be expressed by several financial auxiliary statement and financial basic statement.

(2) Work out capital plan and investment plan. The possible capital source and

amount is to be investigated and evaluated such as the type and amount of bank loan which can be collected and bonds and stock which can be issued, self-owned capital amount the enterprise can invest and the capital amount enterprise can use to pay off the debt. According to the complement plan of the project, the investment volume of every year is to be estimated and a debt repayment of every year is to be calculated. Based on it, the capital resource and using plan in the period of the project is to be worked out. A good plan cannot only satisfy the demand of capital balance, but also guarantee the income and pay all the cost and capital can be collected in different conditions. Therefore, capital plan is an important mean to ensure the feasibility of the project and increase the financial effectiveness.

(3) Calculate and analyze the financial result. According to financial basic data and self planning, several financial statements are made through which economic impact indicators can be worked out.

5.1.3 The Index of Financial Evaluation

According to the provisions of Economic Evaluation Methods and Parameters jointly promulgated by the State Planning Commission and the Ministry of Construction, at present there are several major evaluation index of financial assessment of investment project:

(1) Payback time, Return on Capital Employed(ROI,ROR)

The payback time is the length of time it takes to recover an initial investment or break-even point. The payback time is therefore the time k when:

$$\sum_{i=0}^{k-1} A_i \le 0 \quad \text{and} \quad \sum_{i=0}^{k} A_i \ge 0$$

With A—Cash flow

i—Period

k—payback time or break-even point

The advantages of payback method:

i. Easy to calculate;
ii. Avoid long term forecasting;
iii. Useful tool in capital rationing situation (liquidity indicator).

The disadvantages of payback method:

i. Does not consider the time value of money;
ii. Requires an arbitrary cut-off point on what is the optimal payback time;
iii. Does not consider the cash flows arising after payback time

The Return on Capital Employed is the ratio of the accounting profit generated from an investment to the required capital outlay. The accounting profit is generally taken as the profit after depreciation and before taxation and interests (EBIT). The required capital outlay can either be the initial capital employed (Return on Investment – ROI) or to the average capital employed (Rate of Return – ROR).

The Return on Investment (ROI):

Return on Investment = EBIT p.a / Initial Capital Employed *100

Rate of Return (ROR):

Rate of Return = EBIT p.a / Average Capital Employed *100

= EBIT p.a / (Initial Capital + Scrap Value) / 2 *100

Advantages of ROR and ROI methods:

i. Easy to understand and to communicate with as expressed as a%;
ii. Easy to use when comparing alternative investment

Disadvantages of ROR and ROI methods:

i. Many different indicators for Profit can be used such as EBIT;

ii. Need an arbitrary benchmark when deciding on the ROI or ROR;

iii. Does not consider time value of money

Payback time, ROR and ROI are usually used in conjunction (pay back of less than 5 years and ROI higher than 12% for instance). The methods are still widely used. However, and since the late 1970's, inflation has called for the use of alternative tools that take into consideration the time value of money.

(2) Net Present Value (NPV)

Money has a time value as an amount of money held now worth more than an equal amount to be held in the future. This is particularly true when considering inflation that significantly reduce the value of money over time. It leads to the distinction between 'real' and 'market' interest rate (Fisher effect) so that:

(1 + Market interest rate) = (1 + Real interest rate) * (1 + Rate of inflation)

To account for these effect and when moving from future to present, future cash flows

need to be discounted.

The Net Present Value (NPV) of an investment is then the sum of discounted net cash flows so that:

$$NPV = \sum_{i=1}^{n} \frac{A_i}{(1+r)^i} - C$$

Where: n — project life;

Ai — net cash flows at the end of year i

R — discount rate

C – initial capital expenditure

A project is accepted (rejected) if its NPV is positive (negative). When positive, it means that your money generate more returns than if you were investing the same amount in a bank account with an interest rate I equal to r. when capital is to be invested several times or induces loan repayment occurs, C refers to principal and interest repayments.

To calculate the discount the cash flows, two ways can be used.

(1) If a project generates irregular future cash flows, meaning An only one time in n years' time and for a discount rate equal to r, then its present value (PV) is:

$$PV = \frac{A_n}{(1+r)^n} = A_n(1+r)^{-n}$$

(2) If a project generates future cash flows in constant annuity always equal to a constant An during n consecutive years, then three configurations exist:

a) An from year 0 till N, you are then dealing with annuity due (ad)

$$PV_{ad} = A_n + A_n \cdot \frac{1-(1+r)^{-(N-1)}}{r}$$

b) An from year 1 till N, you are then dealing with immediate annuity, (ai)

$$PV_{ai} = A_n \cdot \frac{1-(1+r)^{-N}}{r}$$

c) An from year d till N, you are then dealing with deferred annuity (da)

$$PV_{da} = A_n \cdot \frac{1-(1+r)^{-(N-d)}}{r} \times \frac{1}{(1+r)^d}$$

These formulae are often used to build the amortization table from a loan.

Advantage of NPV method:

i. Does consider time value of money

Disadvantage of NPV method:

i. The discount rate is hard to select. Normally, the London Interbank Offer Rate (LIBOR) is to be selected.
ii. Another limitation from the NPV is that it can be only used as criteria to compare projects only under specific conditions: projects with similar size and risk.

a) Discounted Payback Time

The discounted pay back rule states that an investment is eligible when the discounted pay back is less than a given number of years set up by the management. We look then for k, the period time for which:

$$\sum_{i=0}^{k-1} \frac{A_i}{(1+r)^i} \leq 0 \quad \text{and} \quad \sum_{i=0}^{k} \frac{A_i}{(1+r)^i} \geq 0$$

With A – Cash flows;

I – period;

R – Discount rate;

K – payback time or break-even point

Advantages of payback method:

i. Easy to calculate;
ii. Avoid long term forecasting
iii. Useful tool in capital rationing situations (liquidity);
iv. Does consider the time value of money.

Disadvantages of payback method:

i. Still require an arbitrary cut-off point (10 years max or another value);
ii. Still does not consider cash flows arising after the pay back time (short period criteria)

b) Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is derived from NPV. IRR is the discount rate for which NPV is equal to 0. An investment is eligible if the IRR exceeds the interest rate of return you can expect from another investment. We therefore look for IRR = r so that:

$$NPV = \sum_{i=1}^{n} \frac{A_i}{(1+IRR)^i} - C = 0$$

Where: n – project life:

Ai – net cash flows at the end of year I;

R – discount rate;

C – initial capital expenditure.

Two ways of calculating IRR:

i. Calculate the NPV of cash flows using different discount rates. When the zero NPV is bracketed (- and + value), use a linear interpolation to find the discount rate equal to zero (IRR).

ii. Calculate IRR with software (excel spreadsheet for instance).

Advantage of IRR:

i. Closely related to NPV;
ii. Easy to communicate as expressed in %.

Disadvantage of IRR:

i. Closely related to NPV when comparing projects (similar size and risk);

Dose not always provide as much information than NPV

5.1.4 The Financial Evaluation on RTG Crane ‘Oil Changes Electricity’

According to the real situation of Shanghai Waigaoqiao Port, we transform 30 RTG cranes into E-RTG in which the power of the crane is supplied by electricity instead of diesel oil. In order to compare and know the answer whether the investment of transformation is rational and good, we assume at the same year we purchase the same amount of RTG cranes. Then we make the calculation to find out the answer.

5.1.4.1 The Important Assumption

a. The depreciation of the project investment is calculated at 16 years and the depreciation rate is 10%.

b. The discount rate is calculated at 6%.

c. The energy price is calculated according to the price in Mar 2012: the price of diesel oil is 8 yuan/l and the price of electricity is 0.6 yuan/Kwh.

d. The energy using rate is calculated at 20% of power consumption using fuel and 80% using electricity.

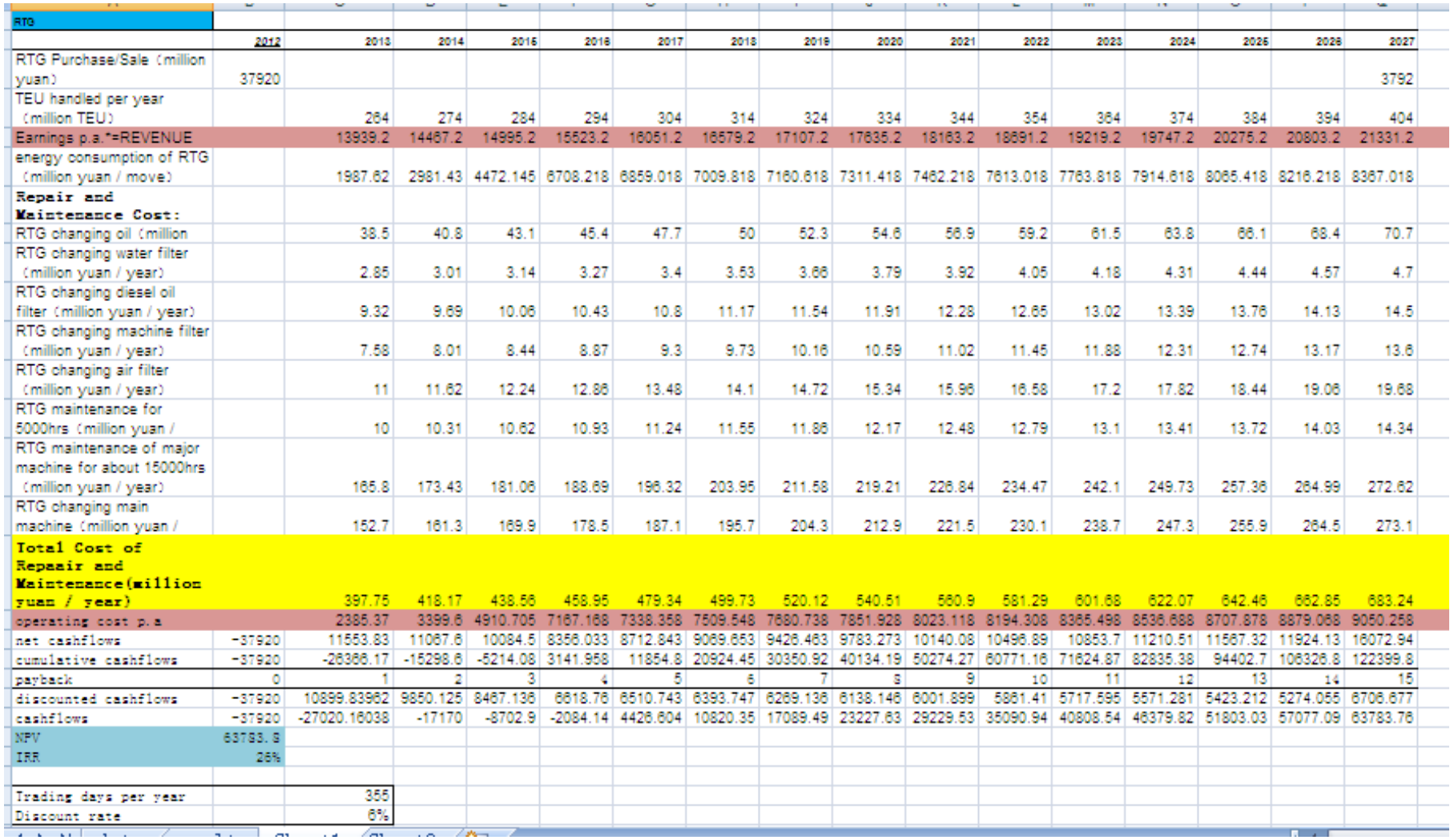
e. With the period of equipment using extension, the energy consumption has been increased gradually. We assume that the energy consumption of each RTG crane has been increased by about 4.5%.

f. The maintenance cost is assumed to be decreased after the project is put into use. But in lack of the data, we do not take the changes of maintenance cost into consideration.

g. Among all the containers handled in the port, containers of domestic trade occupy 20% and containers of international trade occupy 80%. The revenue of handling each container of domestic trade is 160 and the revenue of handling each container of international trade is 300. The revenue of this project is about 20% of all the revenues.

5.1.4.2 The Calculation of Financial Evaluation of RTG 'Oil Changes Electricity'

Table 4 The Calculation of Purchasing RTG Crane



RTG

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
RTG Purchase/Sale (million yuan)	37920															3792
TEU handled per year (million TEU)		264	274	284	294	304	314	324	334	344	354	364	374	384	394	404
Earnings p.a.*=REVENUE		13939.2	14467.2	14995.2	15523.2	16051.2	16579.2	17107.2	17635.2	18163.2	18691.2	19219.2	19747.2	20275.2	20803.2	21331.2
energy consumption of RTG (million yuan / move)		1987.62	2981.43	4472.145	6708.218	6859.018	7009.818	7160.618	7311.418	7462.218	7613.018	7763.818	7914.618	8065.418	8216.218	8367.018
Repair and Maintenance Cost:																
RTG changing oil (million		38.5	40.8	43.1	45.4	47.7	50	52.3	54.6	56.9	59.2	61.5	63.8	66.1	68.4	70.7
RTG changing water filter (million yuan / year)		2.85	3.01	3.14	3.27	3.4	3.53	3.66	3.79	3.92	4.05	4.18	4.31	4.44	4.57	4.7
RTG changing diesel oil filter (million yuan / year)		9.32	9.69	10.06	10.43	10.8	11.17	11.54	11.91	12.28	12.65	13.02	13.39	13.76	14.13	14.5
RTG changing machine filter (million yuan / year)		7.58	8.01	8.44	8.87	9.3	9.73	10.16	10.59	11.02	11.45	11.88	12.31	12.74	13.17	13.6
RTG changing air filter (million yuan / year)		11	11.62	12.24	12.86	13.48	14.1	14.72	15.34	15.96	16.58	17.2	17.82	18.44	19.06	19.68
RTG maintenance for 5000hrs (million yuan /		10	10.31	10.62	10.93	11.24	11.55	11.86	12.17	12.48	12.79	13.1	13.41	13.72	14.03	14.34
RTG maintenance of major machine for about 15000hrs (million yuan / year)		165.8	173.43	181.06	188.69	196.32	203.95	211.58	219.21	226.84	234.47	242.1	249.73	257.36	264.99	272.62
RTG changing main machine (million yuan /		152.7	161.3	169.9	178.5	187.1	195.7	204.3	212.9	221.5	230.1	238.7	247.3	255.9	264.5	273.1
Total Cost of Repair and Maintenance(million yuan / year)		397.75	418.17	438.58	458.95	479.34	499.73	520.12	540.51	560.9	581.29	601.68	622.07	642.46	662.85	683.24
operating cost p.a		2385.37	3399.6	4910.705	7167.168	7338.358	7509.548	7680.738	7851.928	8023.118	8194.308	8365.498	8536.688	8707.878	8879.068	9050.258
net cashflows	-37920	11553.83	11067.6	10084.5	8356.033	8712.843	9069.653	9426.463	9783.273	10140.08	10496.89	10853.7	11210.51	11567.32	11924.13	16072.94
cumulative cashflows	-37920	-26366.17	-15298.6	-5214.08	3141.958	11854.8	20924.45	30350.92	40134.19	50274.27	60771.16	71624.87	82835.38	94402.7	106326.8	122399.8
payback	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
discounted cashflows	-37920	10899.83962	9850.125	8467.136	6618.76	6510.743	6393.747	6269.136	6138.146	6001.899	5861.41	5717.595	5571.281	5423.212	5274.055	6706.677
cashflows	-37920	-27020.16038	-17170	-8702.9	-2084.14	4426.604	10820.35	17089.49	23227.63	29229.53	35090.94	40808.54	46379.82	51803.03	57077.09	63783.76
NPV	63783.8															
IRR	26%															

Trading days per year	365
Discount rate	6%

Table 5 The Result of the Calculation

	buy	TC p.a	Opex p.a.	EBIT	ROI	ROR
RTG	37,920	17635.20	7200.02	8159.99	21.52%	39.13%

Table 6 The Calculation of Transforming RTG Crane into E-RTG

ERTG																
	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
E-RTG	41658.2															
service car	98															
investment of electricity system	3287															
Total Investment	45043.2															4504.32
TEU handled per year (million TEU)		264	274	284	294	304	314	324	334	344	354	364	374	384	394	404
Earnings p.a.*=REVENUE		13939.2	14467.2	14995.2	15523.2	16051.2	16579.2	17107.2	17635.2	18163.2	18691.2	19219.2	19747.2	20275.2	20803.2	21331.2
Energy Consumption																
E-RTG electricity consumption(million yuan / move)		98.63	187.4	302.85	323.63	344.41	365.19	385.97	406.75	427.53	448.31	469.09	489.87	510.65	531.43	552.21
E-RTG auxiliary diesel oil consumption(million yuan / year)		98.65	107.28	115.91	124.54	133.17	141.8	150.43	159.06	167.69	176.32	184.95	193.58	202.21	210.84	219.47
Total Energy Consumption		197.28	294.68	418.76	448.17	477.58	506.99	536.4	565.81	595.22	624.63	654.04	683.45	712.86	742.27	771.68

Table 7 The Calculation of Transforming of RTG Crane into E-RTG

Repair and Maintenance Cost																
maintenance of auxiliary diesel oil（million yuan / year）		92.36	96.48	100.6	104.72	108.84	112.96	117.08	121.2	125.32	129.44	133.56	137.68	141.8	145.92	150.04
maintenance of electricity system and landing（million yuan / year）		15.6	16.94	18.28	19.62	20.96	22.3	23.64	24.98	26.32	27.66	29	30.34	31.68	33.02	34.36
E-RTG changing machine oil（million yuan / year）		1.12	1.19	1.26	1.33	1.4	1.47	1.54	1.61	1.68	1.75	1.82	1.89	1.96	2.03	2.1
E-RTG changing water filter（million yuan / year）		0.06	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.2
E-RTG changing diesel oil filter（million yuan / year）		0.26	0.27	0.28	0.29	0.3	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.4
E-RTG changing air filter（million yuan / year）		0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.4	0.41	0.42	0.43	0.44	0.45	0.46	0.47
E-RTG maintenance for 5000hrs（万元/年）		0.28	0.29	0.3	0.31	0.32	0.33	0.34	0.35	0.36	0.37	0.38	0.39	0.4	0.41	0.42
E-RTG changing main machine（million yuan / year）		5.23	5.46	5.69	5.92	6.15	6.38	6.61	6.84	7.07	7.3	7.53	7.76	7.99	8.22	8.45
Total Repair and Maintenance Cost		115.24	121.04	126.84	132.64	138.44	144.24	150.04	155.84	161.64	167.44	173.24	179.04	184.84	190.64	196.44

Table 8 The Result of Calculation of E-RTG (1)

service car fee																
oil consumption (million yuan / year)		7.83	8.13	8.43	8.73	9.03	9.33	9.63	9.93	10.23	10.53	10.83	11.13	11.43	11.73	12.03
labor cost(million yuan / year)		231.65	240.57	249.49	258.41	267.33	276.25	285.17	294.09	303.01	311.93	320.85	329.77	338.69	347.61	356.53
maintenance cost(million yuan / year)		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Total Fee of Delivery Truck		249.48	259.7	269.92	280.14	290.36	300.58	310.8	321.02	331.24	341.46	351.68	361.9	372.12	382.34	392.56
operating cost p.a.		562	675.42	815.52	860.95	906.38	951.81	997.24	1042.67	1088.1	1133.53	1178.96	1224.39	1269.82	1315.25	1360.68
net cashflows	-45043.2	13377.2	13791.8	14179.7	14662.3	15144.8	15627.4	16110	16592.5	17075.1	17557.7	18040.2	18522.8	19005.4	19488	24474.8
cumulative cashflows	-45043.2	-31666	-17874.2	-3694.54	10967.7	26112.5	41739.9	57849.9	74442.4	91517.5	109075	127115	145638	164644	184132	208606
payback	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
discounted cashflows	-45043	12620	12274.6	11905.5	11613.9	11317.1	11016.7	10714	10410.4	10106.7	9804.11	9503.37	9205.27	8910.46	8619.54	10212.5
cashflows	-45043	-32423.2	-20148.6	-8243.03	3370.84	14687.9	25704.6	36418.7	46829	56935.8	66739.9	76243.2	85448.5	94359	102979	113191
NPV	113191															
IRR	32%															

trading days per year	355
discount rate	6%

	buy	TC p.a	Opex p.a.	EBIT	ROI	ROR
ERTG	45,043	17635.20	1025.51	13907.09	30.88%	56.14%

Table 9 The Result of Calculation of E-RTG(2)

	buy	TC p.a	Opex p.a.	EBIT	ROI	ROR
ERTG	45043	17635.2	1025.515	13907.11	31%	56%

5.1.4.3 The Result of the Calculation

Table 10 The Comparison of These Two Projects

	buy	TC p.a	Opex p.a.	EBIT	ROI	ROR
RTG	37920	17635.2	7200.02	8159.99	22%	39%
ERTG	45043.2	17635.2	1025.51	13907.1	31%	56%

According to the calculation, as for buying the same number of RTG cranes, the capital of investment will be returned back in five years and as for transforming RTG cranes into E-RTG, the money will be paid back in three years.

As higher and higher the oil price, the E-RTG powered by electricity will save more operating cost compared with the RTG crane though the initial capital is higher.

We can see from the tables above that different kinds of financial indicators show the project of transforming RTG crane into E-RTG is a good and economic project. The IRR of buying RTG is 26% and the IRR of transforming RTG crane into E-RTG is 32%. Return on investment (ROI) of transforming is 31%, about 10 percent higher than the project of purchasing.

5.2 The Environmental Evaluation on RTG Crane ‘Oil Changes Electricity”

5.2.1 The Definition of Environmental Evaluation

In 1st September 2003, China Evaluation Method on Environmental Effect was taken into effect. An important content of this evaluation method is to bringing the comprehensive planning and specialized planning drawn up by the government and its related department into the scope of the environment effect assessment objects.

With the rapid development of our national economic construction, port does not only provide the service of loading and discharging of cargoes, passengers boarding and disembarking the vessel and ship calling, but also becomes an important place where processing industry, commercial industry, financial industrial, tourism industry and information industry. Port is of vital resource of the city, occupying a significant place in the national economics.

5.2.2 The Objective of Environmental Evaluation

The environmental objective in the port planning environmental effect evaluation includes the environmental protection objective in the area which is planned and environmental objective set by the planning. Environmental indicators are the specific description of environmental objective. Environmental indicators can be qualitative or quantitative which can be inspected and checked. According to the Specification of Assessment of Environmental Impact of Port Construction Project, the evaluation indicators of port construction project EIA include two aspects, namely natural environment and ecological environment. Regarding to the social economical and environmental assessment, it only covers the short-term and direct effect of landscape and land acquisition. The port planning environmental effect assessment should evaluate the comprehensive effect of nature, ecology, resources and social economics on the port and its area from the height of strategic development. It should not only consider the direct and short-term environmental effect, but also should fully take its cumulative environmental effect of long-term and indirect effect into consideration and analyses. Therefore, the evaluation indicators of port planning environmental assessment should only include resource and social economic indicators besides the EIA indicators.

5.2.3 The Indicators of Environmental Indicators

Hereafter it is about the environmental objective and evaluation indicators of port

planning.

(1) The objective is to control the water environmental pollution and protect the water environment of coastal waters. The indicators related to water are:

a. the annual emission volume of major water pollutants (t/a)
b. per capita daily waste water discharge volume L (l *d)
c. waste water emission volume/ ten thousand tons of throughput volume (t/ten thousand tons)
d. the compliance rate of water quantity (%)
e. the coverage rate of the management of waste water (%)
f. the treatment rate of waste water and standard discharge rate (%)
g. the effect degree on water environment

(2) The objective is to control the emission of air pollutants and to protect the air quantity.

a. the annual emission volume of major air pollutants (t/a)
b. the annual daily average concentration of the major emitting air pollutant (mg/m3)
c. the total annual emission volume of pollutant / ten thousand tons of throughput volume (t/ten thousand tons)
d. the coverage of air pollutant effect

(3) The objective is to control the noise level of area environment and protect the quantity of sound environment

a. the noise value in the port during day and night (dB(A))
b. the noise value in the dredging road during day and night (dB(A))
c. the scope of standard area of environmental quantity
d. the proportion of exceeding standard noise area to the area (%)

(4) The objective is to decrease the generating rate of solid pollutants, making the solid pollutant reducing and resource and promote concentrated handling.

a. the annual emission volume of solid pollutant (t/a)
b. per capita generating volume of solid pollutant (kg/ per capita *d)
c. the generating volume of solid pollutant / ten thousand tons of throughput volume (t / ten thousand tons)
d. the annual generating volume of dangerous solid pollutant and the handling rate of non-dangerous solid pollutant

(5) The objective is to decrease the harm it may does on sensible resource and protect the area natural resource and ecological system
a. the minimum proximity of the port to its sensible objective
b. the area of natural protection zone and its protected area with special value (km2) and the proportion of it to the total area (%)
c. the effecting level of reclamation on the ecological system
d. the vegetation coverage rate of before and after the area planned
e. the greening rate in the port (%)
f. the occupation rate of land resource the daily water using volume in port

5.2.4 The Environmental Evaluation of RTG Crane 'Oil Changes Electricity'

Before RTG crane has been changed into E-RTG crane, the average diesel consumption of every TEU is 2.1 liters (about 2.6 kg standard coals). After transform, the average electricity consumption of every TEU is 3.5 Kwh (about 1.4 kg standard coals). Compared with using diesel oil, about 46% of standard coals can be saved.

Each RTG crane can reduce 137t of CO_2, 56t of SO_2 and 37.4t of CO.

CHAPTER 5 Other Ways to Realize Energy Saving and Environmental Friendliness

At present, there are 4 categories of technologies of energy that major costal port enterprises apply to realize energy saving. They are the technology of RTG crane ‘oil changes electricity’ as discussed before, the technology of bulk yard emission reduction, the technology of power harmonic treatment and the application of renewable resources in port.

The technology of bulk yard emission reduction includes the transformation technology of belt transmission machine, the transformation technology of the end-door loading and discharging craft and the construction technology of windbreak net.

Now the transformation technology of belt transmission machine in some ports can basically achieve the objective of reducing energy consumption and raising utility of machine. At the same time, in the transformation of belt transmission machine, the technology of quality control of machine operation has been widely applied and the more mature controlling technology of machine operation quality will make a greater achievement. The end-door loading and discharging craft is that the switch set on land controls open and close of automatic end-door truck. The truck can automatically load and discharges while it moving ahead. Now the end-door technology has been very mature which can ensure open and close of the door. It has advantage of investment cost saving in equipment and land investment, system maturity, security, reliability, easily operation, highly efficiency and low cost of operation. Compared with car

dumper craft system, the end-door discharging car system is comparatively simply and the quantity of end-door discharging car system is less. The work of operator is simple who has only to operate on the load switches. The transportation way of end-door hopper car transporting bulk cargos like coals, orals by railway is a comparatively economic transportation way. With the port development, the dust caused from the loading and discharging and storage operation of bulk cargoes in port has been increasingly serious. The technology of windbreak net in port bulk cargo yard has been a major technological way of bulk cargo terminal yard recently. The measurement such as spraying water, spraying dust dose and covering windbreak net has a certain effect of dust proof, but also cannot totally solve the problem of environmental pollution caused by dust. Windbreak net is a kind of obstacle with porous forming low speed wind area on its back, thus reducing the movement of dust. The application of windbreak net is widely which can be used in the environmental protection in port and its surrounding areas, thus reducing the proliferation of sand and dust in the process of storage and loading and discharging. Windbreak net has a good effect on starting and proliferation of dust of bulk cargoes in port and its effect of dust protection has been widely recognized. The construction of windbreak net has significant meaning on the government of bulk cargo dust in port.

The port auxiliary production construction consumption occupies a certain percentage of port enterprise consumption, especially the consumption from the heat and cold of the buildings. Therefore, the main point of the energy saving work in the port enterprise is how to apply new energy saving technology to realize energy saving of port auxiliary production and life construction. Against to this situation, ports like Tianjin Port and Dalian Port have carried on the promotion work of re-new able resource, using the technology of solar energy, ground source heat pump and ocean water source heat pump into heater and cold conditioner.

CHAPTER 6 Conclusions

Affected by the international crude oil price, the price of oil production in nation has been keeping increasing, which makes the fuel consumption cost become the fastest growing and the largest increase of cost for container terminal companies. At the same time, now the nation continuously promotes the construction of energy saving society.

This paper makes an analyses and research especially on Shanghai Container Port. In recent years, company production tasks have been increased year by year and the container throughput volume has been raised up rapidly. Container terminals are using rubber type gantry (RTG crane) to load and discharge cargoes. The RTG crane is driven by diesel generator. With the fluctuation of international crude oil market and the increasingly rising fuel price, the operational cost of RTG crane has been soared. At the same time, a large amount of exhaust black smoke emit and huge noise caused during the operation of diesel generator set is not beneficial to environmental protection.

To response the call of national energy saving and meet the demand of enterprise's long-term development, RTG crane 'oil changes electricity' not only shows the effect of energy saving (compared with other two ways, electricity supplied by cable reel and by low-level touching slide, because there are no such factors such as the damage of transformer and lines and the high power, the energy saving rate can reach to 78% higher than 60-65%), but also shows the mobility in that it can move through different container areas), safety of driving and economy in that the life span of equipment is long and it is easy to maintain and its comprehensive economy is also very good.

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