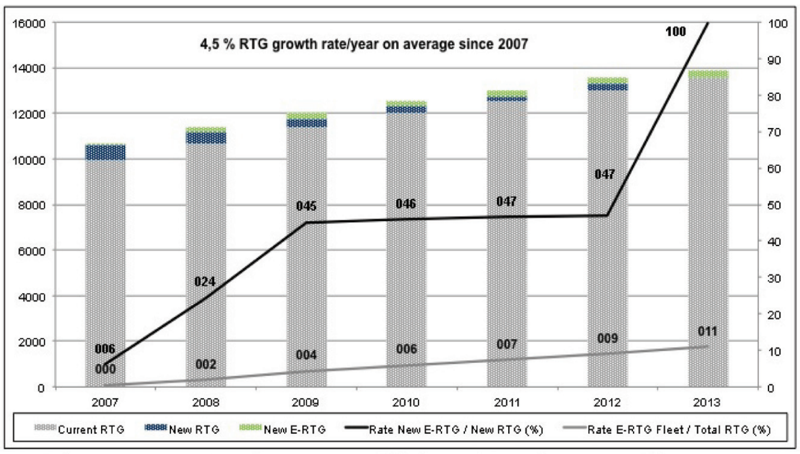
The RTG Evolution and Electric / Automatic Revolution

Dr. Lawrence Henesey provides an overview of the development of RTGs.

Since the first Rubber Tyred Gantry Crane - RTG was deployed in the late 1950's by Matson Marine on the west coast of the United States, the number of RTGs is nearly 13,000 worldwide. As one of the most ubiquitous pieces of equipment used for container handling in container terminals world wide, the RTG is argued to be the workhorse of the container terminal industry. The choice of a terminal operating system can influence the performance of a container terminal.
A container terminal can improve its productivity by increasing the efficiency and effectiveness of cargo handling and storage equipment. In the development of RTGs, the cranes are primarily employed for the vertical movement of containers, e.g. stacking. Main challenges for RTGs have been on how to interface with a number of yard terminal tractors in the transportation of containers. Currently, the average number of gross container moves per hour is 8. Obviously, with the increasing demands for faster productivity and efficient safe operations, many terminals are seeking ways to improve.

Table 1 . RTG Fleet Characteristics; Growth rate and number of RTGs electrified.



- RTGs becoming more Electrofied representing **11%** of the 2013 Fleet from less than 1% in 2006.
- Around 75% of all converted and newly supplied E-RTG systems are electrified by conductor rails

In recent years due to the high costs of fuel, attempts have been made to reduce the consumption of RTGs. For many container terminals, RTGs constitute one of the largest users of diesel fuel, which can represent upwards to 50% of the total energy costs. Some of the major attempts have been to introduce hybrid motors and electrification. In Table 1, an illustration is given in which data from a real container terminal was analysed and compared with its current fleet of diesel powered RTGs to having them all retro-fitted to being electric. In electrifying cranes, much work has been performed in other industry fields, such as shipyards and mining in which some of the demands are similar to that of container terminals. The introduction of cables and reels to electrify RTGs was first considered in China. The first electrified rubber-tyred gantry cranes (eRTG) in China were unveiled at SheKou container terminal (SCT) in August 2008. As China is considered the largest market for RTGs representing nearly 60% of the world's fleet, the main motivation has been on identifying improvements. One technology that was considered early and then later implemented was the use of "high wire" systems that was initially proposed by Prof. Dr. Quinn F. He. The port in Shanghai installed 40km of overhead wires for 130 RTGs. The main obstacle in further developing this type of technology was the large costs for the civil works required for installation of steel towers to hang overhead wires throughout the footprint of the container yard. Hence other solutions for full electric RTGs were quickly identified and implemented, such as cable reels and conductor bars. The use of cable reels and then conductor bars were both considered by container terminal port operators for various reasons. Depending on the type of operations and number of block changes from one container block to another, the configuration has to suit the container terminal yard management requirements. The concept of an eRTG with a plug connection is relatively simple. Electrical energy is provided through a conductor rail system running alongside the container block. The support structure of the conductor rails also includes guidance for a collector trolley. A towing rope attached to the travelling RTG pulls the trolley, which holds the current collectors for 3-phase and earth connection. A cable and a plug realise the connection between the RTG and the rail system. Hence, the plug-in systems are proven as a practical, safe and reliable system, with several hundred installations world-wide. Many container terminal operators view conductor rail solutions as a significant benefit. With advances made in smarter TOS (Terminal Operating Systems), improved education and training for the RTG staff, the management of container terminal yards is viewed as complex, requiring smart solutions that are part of the system rather than stand-alone. The importance of RTG solutions to integrate easily and seamlessly with current RTG systems is deemed by many experts to be paramount for any retrofitting project.
As the retrofitting of an existing RTG can be a complex project, the container management decisions are driven by operational requirements. Some of the major challenges raised by container terminals in using cable reels include:

- ☛ Significant additional weight and possible mechanical structural modifications on the RTG
- ☛ The need to unplug and plug in again to change aisles
- ☛ Cable alignment between RTG and container stack and additional cable protection

to avoid damage

- Additional measures have to be taken if a number of RTGs are to operate in any one lane.

As identified from various sources and presented in Table 1, conventional wisdom gained from the identifying the number of RTGs deployed since 2007 and then electrified has shown that of the current fleet of 13,000 RTGs, nearly 11% are now electrified. Interestingly, the number of RTGs electrified that incorporate the use of a conductor bar represents 75% of all electric RTGs. The main explanation for this is the need for fast block changing and reduced cycle times when compared to other types of electrifying methods. The current challenge for container terminal operators is information transmission alongside the electric transmission solutions, such as cables or conductor bars. Many container terminal operators are initially considering low-density 'process' data being transmitted to the terminal operating system (TOS) or other control software. This seems to be a step on the way to full automation of eRTGs.

Figure 1. Data on eRTG Energy Savings and CO_2 Reduction at a Container Terminal

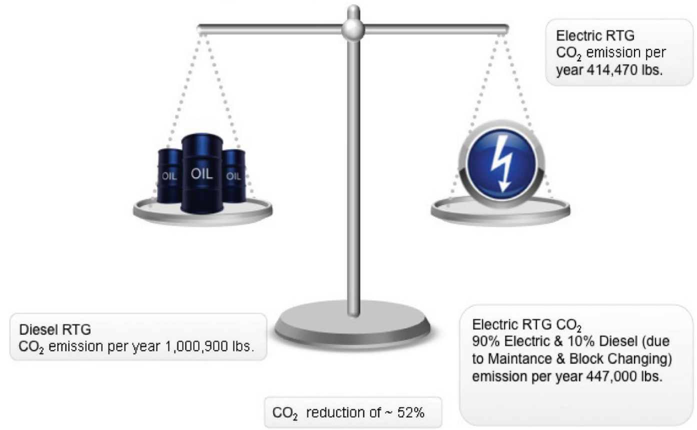


Figure 2. Three steps from Electrification, Communication to Automation

As illustrated in Figure 2, the technology for electrification with the integration of communication systems can lead to the final step for automation of RTGs. Therefore a key issue is to help ports put in place a system that is not just able to be integrated into the TOS as it stands, but can also be a platform for the further development of remotely operated, semi or fully automated eRTGs; position control already being a function of TOS systems. To this end, ports are looking at a high data transfer rate, around 100mbps, which can send real, lifelike images to the control room that could enable the eRTG to eventually be driven remotely. One technology that is being considered for the automation of RTG cranes is data communication using SMG. (Slotted Microwave Guide) data transmission system. SMG has been proven in automation technology for contactless and interference-free transmission at high data rates up to 100mbit/s and opens up a wide range of applications through its variable design. This can be done parallel to the conductor rail system. This development for RTGs made possible based on the experience of over 1,000+ applications worldwide using conductor systems and SMG. Some of the key features of the SMG - Slotted Microwave Guide are:

- Immunity to interference due to isolation of the SMG profile from the surroundings.
- Maintenance-free due to contactless transmission technology.
- Error-free transmission of high data rates up to 100 Mbit/s.
- Simultaneous transmission of up to six data channels full duplex.
- Transmission paths of up to 1000m without intermediate amplification due to high dynamic response of transceivers.
- EMERGENCY-OFF transmission according to stop category 1, safety level 3.
- Coupling of several mobile subscribers to one SMG profile.
- Transmission independent of travelling speed of mobile subscriber.
- No negative effects on transmission quality due to environmental influences, e.g., temperature, humidity, clouds, dust, etc.

In conclusion, we identify that e-RTGs are a light-type of RTG, and posses advantages over traditional RTGs that include for example: purchase price, maintenance costs, and energy consumption. Often the operating power of e-RTGs is provided by an external electric power supply, instead of a large diesel generator, this will not only reduce purchase cost and largely eliminate maintenance costs, but also enhance environmental protection. Further research by Taiwanese academics have yielded results that are based on a case study performed on the port of Kaohsiung, in which it was found that conversion of diesel RTGs to electric power can save a total of TWD 55 million or $1,825,000 annually. If investment cost is TWD 120 million or $ 4 million, the investment payback period was expected to about 2.2 years. This indicates that an RTG conversion project is not only beneficial for the environment, but is also an optimal means of avoiding the impact of high diesel fuel prices in the shipping industry. Future work for RTG electrification development will be on lighter components that are more robust with smart technologies installed. This will allow for remote maintenance and improved performance on the yard operations. In addition, integration of the software(s) will require more open source applications achieving results such as better visibility of containers and the terminal's assets which implies that optimisation can be employed fully. WPD