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Author:	Patrick Bass, Head of Research & Development and Product Lifecycle Management, ThyssenKrupp
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Energy-Efficient Elevator Solutions for High-Rise Buildings
高层建筑电梯节能方案

Patrick Bass

Patrick Bass

ThyssenKrupp
ThyssenKrupp Allee 1
Essen
Germany, 45143

tel (电话): :+49201844533427
email (电子邮箱): Patrick.bass2@thyssenkrupp.com
www.thyssenkrupp-elevator.com

Patrick Bass is the Head of Research & Development and Product Lifecycle Management departments at ThyssenKrupp Elevator AG, Essen, Germany and has held this position since October 2013. With customers in 150 countries and sales of 6.2 billion euros in fiscal 2012/2013, ThyssenKrupp Elevator is one of the world's leading elevator companies.

In his current position he is responsible for the Global Research and Innovation Activities, coordinating the Global Product Designs and driving Global Product Strategy.

Before his current function he was responsible as Senior Vice President for Research & Development and Product for ThyssenKrupp Elevator AG since January 2012.

Mr. Bass is an expert in the area of passenger transportation, spending his whole career in the elevator industry since 1988. Patrick Bass joined ThyssenKrupp in 1999, holding various positions in the United States as well as at the headquarters in Germany.

From 2007 to 2012, Mr. Bass worked for ThyssenKrupp Elevator Manufacturing Inc., Memphis, Tennessee, USA as Vice President Engineering U.S. Manufacturing and Executive Vice president of Research & Development for the Americas leading the engineering teams responsible for the elevator and escalator products in New Yorks World Trade Center project.

作者简介。

Abstract

Maximizing capacity with smart and energy-efficient elevator solutions for the high-rise buildings of the world's inaugural metropolitan century.

Keywords: Energy; Efficiency; Capacity; Increasing; Floor-space; Elevator

摘要

用智能和节能电梯方案实现大都会时代下高层建筑容量最大化。

关键词: 能源; 效率; 容量; 增长; 楼层面积; 电梯

In 1950, rural populations accounted for 70% of the global population. By 2050, urban populations will account for the same percentage, with the vast majority of growth expected in Africa, Asia, and South America. The 21st century is the world's inaugural metropolitan century, with cities prospering in the new global economic order. Keeping these figures in mind, and factoring in the challenges that urbanization represents for natural resources, space, and energy –40% of the global energy is consumed in buildings–, it is more important than ever that the choices made today about developing increasingly densifying cities are sustainable ones, and leave a lasting positive impact on the future generations. New elevator technologies provided by ThyssenKrupp are capable of energy savings by up to 27%, while also increasing usable floor space by up to 30%.

In Figure 1, "Evaluation of Energy Consumption Project X," TWIN is compared to Double-Deck with equal traffic demands and similar quality of service. Both systems are VDI 4707 energy efficiency class A certified.

1950年农村人口占全球人口的70%。随着非洲、亚洲、和南美洲人口的大幅增长，2050年，世界农村人口将与城镇人口持平。21世纪是大都会时代的开端，城市在全球新的经济秩序下繁荣发展。记住这些数据,将它们计入城市化对自然资源、空间和能源所提出的挑战中，其中40%的全球能源消耗于建筑物中。因此比以往更重要的是今天做的关于发展绿色密集城市的决定,将对后代持续产生正面影响。蒂森克鲁伯公司提供的新电梯技术可以节约高达27%的能量,同时提高至30%的楼层使用面积。

图-1中的能量消耗评估项目X，对比了双子电梯和相同客流量及类似服务双轿厢电梯。两个电梯系统均为VDI认证的能效A级。

用巴黎办公大楼Tour项目来说明如何提高楼层使用面积。用双子电梯取代普通电梯将减少如下所述的井道数量:

- 小提升高度电梯群井道数从八个减少到五个
- 大提升高度电梯群井道数从八个减少到六个

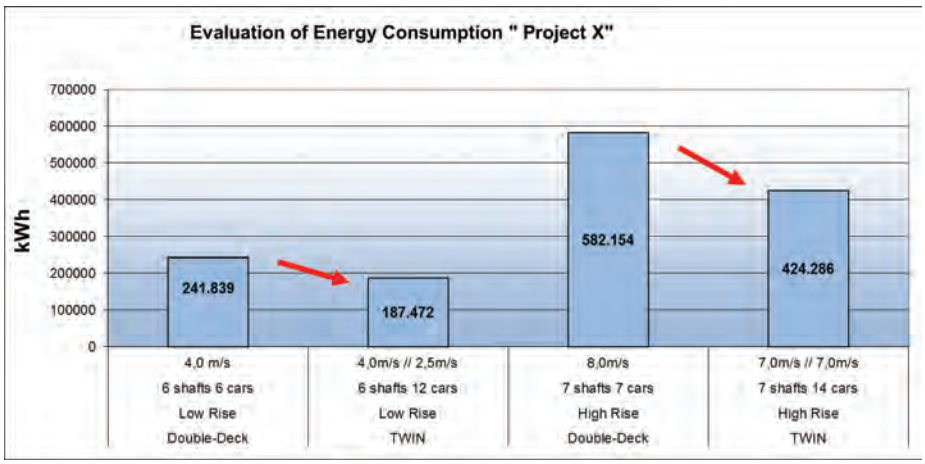

Figure 1. Evaluation of Energy Consumption
图-1. 能量消耗评估

To demonstrate the increase of floor space, an example is the Office Tower Project Tour D2 in Paris. Applying TWIN instead of conventional lifts will reduce the number of shafts as described in the following:

- Low rise group from 8 shafts to 5 shafts
- High-Rise group from 8 shafts to 6 shafts

by considering satisfying results for traffic performance (see Figure 2).

Building construction involves several stakeholders, all of whom have varying interests. These interests are not always in line with sustainability goals. Two goals, however, are common to all stakeholders – cost and usage floor space: both of which can be optimized with new ThyssenKrupp Elevator Technologies, unique especially in regards to the TWIN system, a system only available at ThyssenKrupp Elevator.

Beyond cost and space usage, the public perception and recognition of a building is incredibly important. This is especially true for landmark tall buildings, such as projects like Shanghai World Financial Center and One World Trade Center, both with cutting-edge ThyssenKrupp Elevator products. The interior concept and functionality has to reflect the uniqueness as well of the outside shell of the building. Distinctive elevator and escalator solutions can help contribute to driving a functional and aesthetically pleasing building core.

In an increasing urbanizing and densifiying world, smart, green, and efficient vertical transportation systems are the new ultimatum inside and outside of mega-cities.

Energy Savings, Intelligent Systems and Costs

Revolutionary elevator technologies, like the ThyssenKrupp TWIN, can save up to 27% of energy when compared with other technologies and reduce the electrical power required by 50%. TWIN achieves this by operating two independent cabins operating in the same shaft across different floors as depicted in figure 3. The result is lighter and simpler power supply systems required for buildings. According to the energy efficiency guidelines for elevators established by the Association of German Engineers in 2009 (VDI 4707), the most efficient elevator technology configurations can save up to 70% on energy consumption of a building. The TWIN also delivers more flexibility. The height of floors and different heights of floors in modern building can easily be covered by the 2 independently operating cabins. Additionally, interfloor traffic and distribution of passengers in many floors adds higher efficiency.

In addition, energy in a building could be saved either by more energy efficient motors or energy recuperation. Small innovations can have huge effect. For example, standby mode for elevators allows for a mode that turns lights off and puts controllers in a state of less energy consumption. These types of innovations were pioneered in other industries, and their application to the world of vertical transportation continues to improve products and their impact on operational efficiency. (see Figure 3)

Regenerative energy sources such as solar panels and wind energy are plausible in concept, but the efficiency and space usage pose a problem: ratio between efficiency and input must have an added value to the whole system. Renewable energy has marketing value, but often produces more energy waste than efficiency. Ultimately, the best solution for a building is one that creates a positive energy balance.

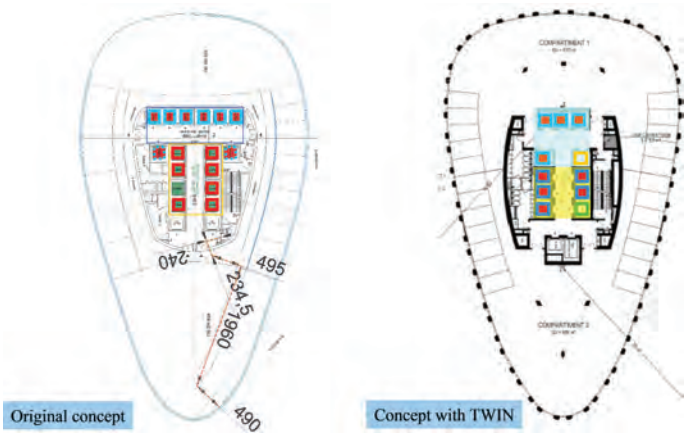

Figure 2. Office Tower – Paris
图-2. 巴黎办公大楼

建筑构造会涉及拥有不同的利益的利害关系人。这些利益并不总跟可持续性发展目标一致。但是其中的两个目标-成本和建筑使用面积——对于所有的利害关系人来说是一致的，这两个目标可以通过蒂森克鲁伯电梯的新技术 ——独一无二的双子电梯系统——来进行最优化。

除成本和使用面积之外，公众对于建筑的感知和认可也是极为重要的。 这点尤其适用于地标式建筑，如上海环球金融中心及世界贸易中心一号楼，二者均采用最前沿的蒂森克鲁伯电梯。与众不同的电梯和扶梯可以从功能上以及外观上推动令人满意的建筑核心。

在一个城镇化不断加剧，人口持续密集化的世界，智能，是超大都市内外新的最终结论。

节约能源,智能系统和成本

具有革新意义的电梯技术，如蒂森克鲁伯双子电梯，与其它电梯技术相比可以节省高达27%的能耗,减少至50%的电量消耗。如图-3所示，双子电梯通过在同一个井道不同楼层之间单独运行两个轿厢来实现这一点。结果是建筑将只需要更简单和便捷的电力供应系统。根据德国工程师协会在2009年发布的电梯能源效率标准(VDI4707)，最有效率的电梯技术配置可以节省高达70%的建筑能耗。 同时双子电梯更加灵活。现代建筑层高的不同可以轻松通过两个独立运行的轿厢来解决。另外，对楼层之间客运量和乘客不同楼层分布的考虑也将提高效率。

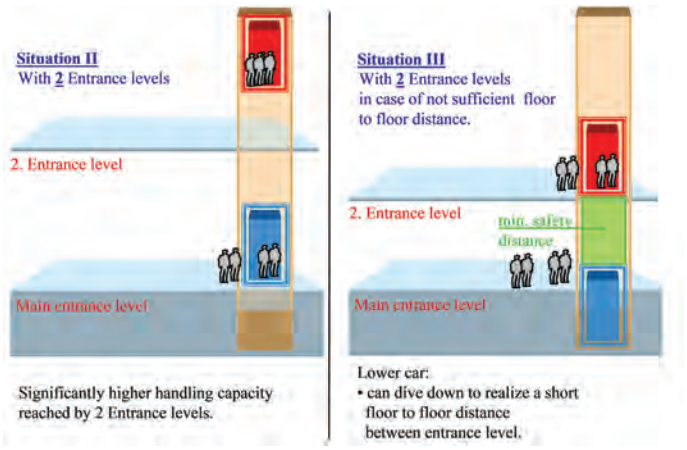

Figure 3. Flexibility of the TWIN-System with 2 cars in one shaft on floor distances
图-3. 双子电梯系统-同一井道内两个轿厢停层的灵活性

An unsolved problem with regard to renewable energy is storage: energy production without usage and energy storage with a without major outflow when used. These questions are being analyzed, but there is not yet an effective solution. To provide more value to customers in promoting environmentally conscious practices, ThyssenKrupp Elevator trains their employees to become LEED Green Associate certified. This is a way to contribute to the efficiency of a building in a reasonable way, without major risks for the customer and providing reliable outcomes with defined scopes.

Intelligent control systems like destination selection control, or DCS, can also contribute to the efficiency of systems within a building. Intelligent, smart algorithms make more effective transportation and elevator dispatching. Learning algorithms provide for an even more efficient solution in the future.

Pure improvements to an already established solution add their value as well. Smarter components need less energy, less material, less recycling, and less space compared to other systems. This all has a direct impact to costs, space and the energy balance of elevator products. The life cycle assessment, or LCA, is increasingly important in the future of mega-cities. LCA is defined by the US Environmental Protection Agency as "a technique to assess the environmental aspects and potential impacts associated with a product, process, or service." With regard to the vertical transportation industry, there are issues that will need to be resolved in the near future: what will be elevator of choice when Europe starts to renew their legacy systems? What elevators will be used in China as the country tries to become more energy efficient green-conscious? LCA, currently an amenity in the elevator industry, will become standard as it already is transforming the automobile industry.

Smart component usage is only one answer for energy-efficient problems. The ultimate solution is the intelligent combination of different systems as described for instance in Figure 4. A TWIN Elevator System as the single product for elevators is not a viable or attainable solution. The combination of already established systems like TWIN, Doubledecker, standard elevators, escalators with an amalgamation of an intelligent control system, equipped with sustainable components, sensor technology, and a reliable energy source is the path forward.

Intelligent integration of commuting systems is another opportunity in providing energy-efficient solutions for high-rise buildings in cities and beyond. The ThyssenKrupp iwalk helps complete the entire "path of travel" from the starting point or the end destination, integrated in a smart grid of people movement. Flexibility and versatility are key features of iwalk due to the horizontal version's modular structure and the easy installation. The pitless horizontal iwalk can be installed without costly civil work and modified by adding or removing sections for faster, easier refurbishment or relocation. ThyssenKrupp iwalk helps to intelligently integrate systems to move people not only vertically, but also horizontally between buildings.

Intra-System communication within a building is the future of "path of travel" of tenants and energy efficiency. High peaks of one system can be communicated to subsequent systems, immediately increasing transport efficiency ability. Sensors such as radar can identify when a customer is heading to an escalator. The step beyond this could be an elevator that can determine that users are close to the elevator and open the doors. The elevators could read the near field communication, or NFC, chip of the parking billet knowing where to go, for example, at an airport. The above mentioned systems are already available and implemented in other applications and industries

除此之外，节省建筑耗能可以通过效率更高的马达或者能量回收来实。小的创新可以带来大的效果。例如，电梯的待机模式允许关灯并将控制器转为低耗能状态。这样类型的创新已经尝试应用于其它行业， 而在垂直运输中的运用将持续改善产品本身和它们的运行效率。

可再生能源如太阳能板，风能是看似合理，然而效率和空间利用产生一个问题:在效率和投入之间的比率应该对于整个系统有附加值。可再生能源有市场价值，但是通常在生产过程中浪费的能量多于产生的效率。 最终，对于建筑的最佳方案是创建一个正的能量平衡。

一个对于可再生资源没有解决的问题是能量存储，表现在两点:能量生产了而不用和能量储存后在使用时没有主流出量。这些问题已经在分析，目前还没有有效的解决方案。在促进增强环境意识的实践中，为给客户提供更多价值，蒂森克鲁伯电梯公司培训其员工拿到LEED绿色认证。这是提高建筑能效的合理途径，并且在已知范围内为客户提供可靠结果，客户也无需冒太大风险。

智能控制系统如选层控制也可以为建筑内系统能效做贡献。智能算法可以实现更有效的运输和电梯群调度。算法的研究可以在未来提供更有效率的解决方案。

对于已经建立的解决方案进行单纯的改善也是有价值的。智能部件和其它系统相比需要较少的能量，材料，回收利用以及空间。这些对于电梯产品的成本，占用面积和能耗之间的平衡都有直接的影响。 生命周期评估，即LCA，对于未来的超大城市将越来越重要。美国环境保护署定义LCA为"一种对环境因素和与产品、流程和服务相关的潜在影响进行评估的方法对于垂直运输行业来说，不远的将来需要解答如下问题::当欧洲开始更新它的法律系统时什么会首选电梯?当中国城市尝试转向更加节能、环保时，什么样的电梯将会被选用? 目前，电梯行业中，LAC只是一种便利方法，目前已经在改变整个汽车行业的它将会成为行业标准。

智能部件的应用只是解决能量效率问题的一个方案。这个独特的方案是对于不同系统的智能组合，如图4所示。 双子电梯系统作为独立的电梯产品并不能切实可行地解决问题。更进一步应该将既有的系统，如双子电梯系统、双桥厢电梯、标准电梯和扶梯与配有可持续部件、感应技术和可靠能源的智能控制系统结合起来。

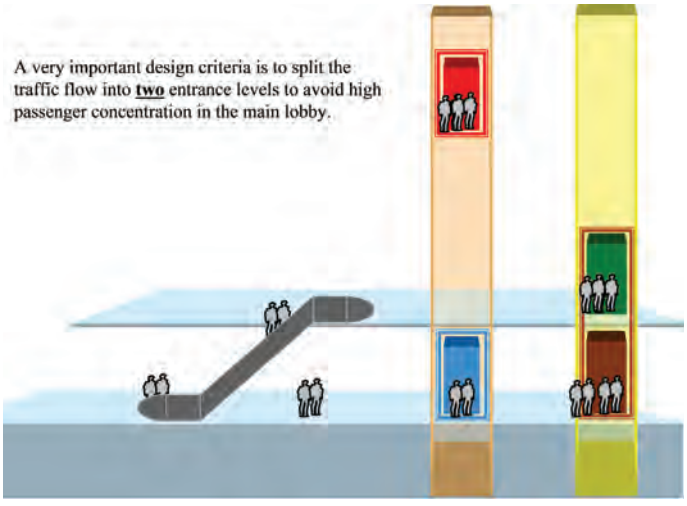

Figure 4. Concepts with TWIN and Double-Decker
图-4. 双子电梯和双轿厢电梯的概念

– just another opportunity to apply existing technology in the vertical and horizontal transportation space.

Building owners and operators also manage central heating and cooling of their property. Current HVAC systems use sensors to identify if a person in present within a room. These types of system brings added value for energy efficiency and cost reduction. Having smart technology to know how building population at each hour of the day, with also knowing their usual path of travel, could increase vertical transportation efficiencies by shutting down unused elevators that would otherwise wait for their own sleep mode.

Increased Floor Space

Depending on building size, the elevator-escalator footprint occupies between 25% and 50% of the building's floor space, resulting in a major detraction from usable areas and rent revenues. Highly compact designs, which occupy a minimum of shaft space, can reduce the floor space previously occupied by elevators by up to 30%. ThyssenKrupp TWIN elevators increase the efficiency of moving people through the building and reducing the overall number of elevators and shaft space required. The building owner is able to decide to reduce the space of the façades and, therefore, the cost of construction. This extra space can be used for more tenant space, retail space, and, ultimately, incoming cash flow.

Enhancing efficiency and sustainability without keeping safety as the top priority means nothing. Each new invention, innovations and technology improvements have to be implemented in one way – in a safe way for customers, users and technicians. As one example, SIL3, the Safety Integrity Level 3, becomes more important for the elevator industry – a topic that ThyssenKrupp with TWIN in the past has already integrated and achieved for central components as the first in the industry and we are still trying to achieve this level of security in critical components.

The customer needs have to follow the safety standard of installations methods and maintenance activities. Elevators that continue to increase speed have to deliver a first-class safety level for all parties involved. Technology has to guarantee the safety and security. Training and continuing education of elevator technicians, is already, and will continue to be a top priority for all elevator companies, especially in fast growing markets and emerging economies like China and India. To ensure a basic level of safety is a topic to face before satisfying the desire for speed and other amenities of the customer.

Conclusion

Energy has become a substantial cost factor for every building, and the possibility of introducing new mobility technologies not only in new buildings but also in existing structures significantly improves total energy savings and cost effectiveness. Buildings continue to grow taller, now exceeding 500 meters in height. Elevators, escalators, and moving walkways play an important part in creating sustainable and self-sufficient constructions. A key factor in their contribution to sustainability is that new solutions must be environmentally friendly, while economical and safe, appealing to all stakeholders in the urbanization process.

交通系统的智能结合将解决城市内外高层建筑的能效问题。由于产品的水平模块结构和简便安装,灵活和变通性成为IWALK的主要特征。无需底坑的IWALK可以在没有附加土建费用的前提下通过增加或者减少模块来快速及简便地重组或者重置。蒂森克鲁伯的IWALK能智能整合不同系统不仅在同一栋建筑内能垂直方向也能水平方向运输乘客。

建筑的内通信系统是承租人和节能高效的未来框架。系统在高峰期时可以和后续系统交互,立即提高运输效率。如雷达传感器可以辩识乘客是否面对扶梯走来。更进一步是，电梯可以辩识乘客正在靠近，然后打开层门和轿厢门。比如说在机场，电梯可以通过读取近场无线通信(NFC)的信息或停车来获得哪里停层的信息。以上所述的系统已经在其他行业中得到应用——也为在垂直和水平运输空间运用该技术提供了另一个机会。

建筑的所有者和经营者需要对楼宇进行中央制冷或供暖。目前的HVCA系统采用传感器来辨别是否房间里有人。这类系统为提高能效和降低成本带来附加值。利用智能系统来统计建筑内每小时的人数，并且记录他们通常的路径，然后通过关闭不用的电梯取代等待休眠状态来提升垂直运输的效率。

提高楼层使用面积

根据建筑大小的不同，电梯-扶梯的面积占楼层的25%至50%，同时影响到可使用空间和租赁额。紧凑的建筑设计，只占用最小的井道面积，能减少30%之前电梯的占用面积。蒂森克鲁伯的双子电梯通过减少电梯的数量和总井道面积来提高建筑内运输乘客的能力。建筑所有者能够决定减少井道从而减少建筑成本。这个节省下来的空间可以作租赁或者零售空间，最终增加的现金流。

为了提高能效和可持续性而放弃安全性的优先权没有任何意义。每一个发明，创新和技术革新必须是一个对于客户，用户和技术人员都安全的方式。例如SIL3，3级安全整合，对于电梯行业越来越重要——蒂森克鲁伯在过去已整合到双子电梯系统中，并作为行业中第一个中心部件达到该标准。

客户需求必须满足安装方法和维修事项的安全准则。持续提速的电梯也必须提供各个参与方头等安全水平。技术必须保证安全和可靠。电梯技术人员的培训和持续教育，已经并且继续作为所有电梯公司的最优先权，尤其如中国和印度一般快速发展的市场和新兴市场。确一定先于满足客户对速度和其他方面的要求。

结论

能源成为每一个建筑物成本组成的重要部分，新的移动技术不仅可以用于新的建筑而且也可以用于已经存在的构架中以明显提高能量节省和成本效率。建筑物持续增高，目前已经超过500米。电梯，扶梯和自动人行道上演着在创建可持续和可自给建筑的重要部分。一个它们对于可持续性贡献的关键因素在于，新的方案必须是环保的，同时是经济的和安全的，这样可以吸引所有在城市化进程中的利害关系人。