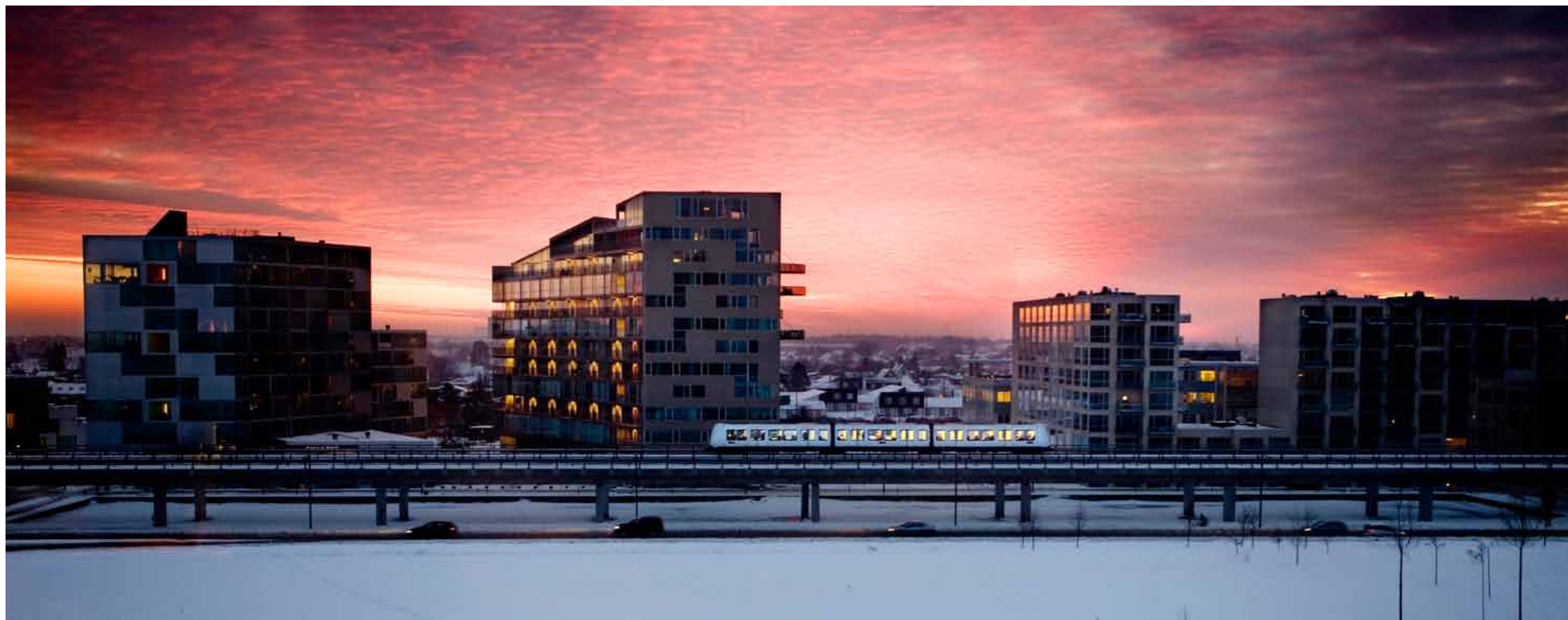




# Metroselskabet/ Metro Copenhagen

PUBLIC TRANSPORT  
TO BE PROUD OF





**Metroselskabet/Metro Copenhagen**

# PUBLIC TRANSPORT **TO BE PROUD OF**

*Metroselskabet holds the distinction of operating and expanding Metro Copenhagen, an ultra-modern, pioneering Metro system that has contributed considerably to the city's growth in recent years*

WORDS BY *Will Daynes* ► RESEARCH BY *David Brogan*



**F**ounded in the 10th Century, Copenhagen became the capital of Denmark in the early 15th Century and is today the country's most populous city, with figures as of October 2013 recording it having an urban population of over 1.23 million and a metropolitan population of 1.97 million. The cultural, economic and governmental centre of Denmark, the city has played host to considerable urban and cultural development in the last several decades which has been facilitated by investment in its institutions and infrastructure.


The investment in Copenhagen's infrastructure has seen its transportation network become a hub within Northern Europe, a network which includes road, rail, an international airport and the Copenhagen Metro.

The origins of Metro Copenhagen date back to the early 1990s when plans for its construction first started to be considered. It was in 1997 that an agreement on an overall master plan was signed, with an international tender process leading to ground being broken that same year. Five years on the first phase was opened to revenue service, with extensions being unveiled in the years that followed. Today the Metro boasts 22 stations situated over 21 kilometres of line, upon which a fleet of 34 vehicles operate.

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***“Today the Metro boasts 22 stations situated over 21 kilometres of line, upon which a fleet of 34 vehicles operate”***

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Henrik Plougmann Olsen,  
Chief Executive Officer  
of Metroselskabet





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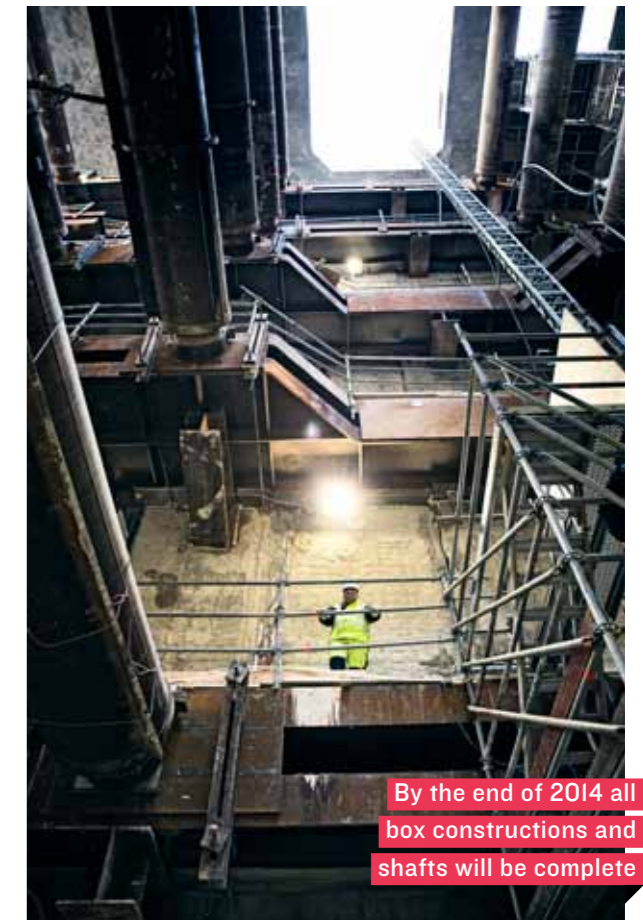
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*“The establishment of Metro Copenhagen bore immediate success and helped usher in a new era of public transportation in the city”*

“The establishment of Metro Copenhagen bore immediate success and helped usher in a new era of public transportation in the city. It has since gone on to contribute towards the growth of Copenhagen, which in turn has resulted in plans to expand the Metro system itself across the city,” states Henrik Plougmann Olsen, Chief Executive Officer of Metroselskabet, the company owned by the Ministry of Transport and Copenhagen and Frederiksberg municipalities, which



By the end of 2014 all box constructions and shafts will be complete

#### DSV AIR & SEA

##### DSV Projects – Carrier of tunnel segments to Copenhagen Metro Project

DSV Projects were in 2012 awarded the Transport Contract covering deliveries of approx. 21,000 concrete rings for the construction of the “Cityringen Metro Project” in Copenhagen.

The concrete rings are produced in Germany and transported to Copenhagen on Roll trailers - 3 rings are loaded on each trailer. For this purpose, DSV provides a Ro-Ro vessel through DFDS who performs 4 sailings every 5 weeks. Each departure will carry approximately 162 rings. Each stack of rings are under ocean voyage lashed and secured with 4 loop lashings, 3 top over lashings and 3 Olympic Lashings. Furthermore, frictions mats are placed under the intermediate wooden beams, which are placed between each segment.

Prior to arrival in Copenhagen, CMT has instructed DSV whether the rings are to be delivered directly to the building site or to be unloaded on a dedicated storage area rented by DSV within the Copenhagen port.

DSV has, for the project, dedicated six trailers to be used for delivery of the rings to the 3 TBM worksites (Nørrebroparken, Tømmergraven & Øster Søgade). For the safe stowage on the vehicles, each trailer has been equipped with two sets of special designed wooden cradles fixed to the deck of each trailer. The 3 Olympic Lashings will remain on each stack until final delivery to the worksite. Each truck is shunting from the port to the TBM worksites every day delivering between 10-12 rings per working day.

[www.dsv.com](http://www.dsv.com)





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Waterproofing systems below ground structures are faced with more stringent requirements regarding durability, exposure and stress conditions, construction method and sequence, ease of application and total cost management. In addition, sustainable system solutions are becoming more important in order to save natural resources, energy and water, plus reduction of CO<sub>2</sub> etc. As the global leader in providing structural waterproofing solutions, Sika has the most complete and comprehensive range of products and systems that are designed and can be adapted to meet the specific needs and requirements of owners, architects, engineers and contractors on site. Sika with worldwide experience in Waterproofing of important Infrastructure Projects.

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is responsible for building the ambitious Cityringen project that will once again transform the Metro network.

Founded in 2007, Metroselskabet has more than 200 employees and is responsible for the daily operation of the existing metro and for the construction of new lines. "It is very much a dual task that we are performing in Copenhagen," Olsen continues. "Our primary task is to ensure constant high-quality, frequent public transport, a side

*"It is very much a dual task that we are performing in Copenhagen"*



Passengers awaiting the Metro

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SIKA DANMARK A/S delivers flexible Waterproofing Systems to the Metro Cityring in Copenhagen:

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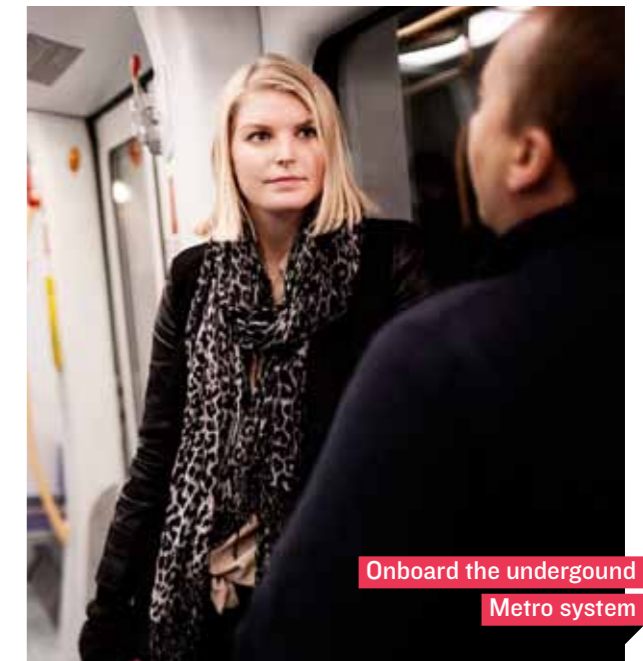
From Cramo you can rent movable, flexible modular units.  
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effect of which is the generating of further growth within the city.”

The existing two-line Metro in the city continues to increase in popularity and usage, and understandably this has resulted in considerable demand for more lines and stations. The answer to this demand was in fact agreed back in 2007 when the Danish Parliament, Folketinget, and the municipalities of Copenhagen and Frederiksberg decided on building a new route that was called Cityringen. The contract for this route was signed in January 2011, with principle construction work commencing that summer.

The project itself comprises a circular underground line within the city, closely modelled on the existing metro with the



Onboard the underground Metro system

*“Our primary task is to ensure constant high-quality, frequent public transport, a side effect of which is the generating of further growth within the city”*

### CRAMO

Cramo is a service company specialising in equipment rental services, as well as rental of modular space. Our equipment rental services comprise machinery and equipment rental as well as rental-related services. As one of the industry’s leading service providers in Europe, Cramo operates under the Cramo brand in Finland, Sweden, Norway, Denmark, Estonia, Latvia, Lithuania, Poland, the Czech Republic, Slovakia and Russia (Kaliningrad). In Germany, Austria and Hungary, operations are under the brand of the fully owned subsidiary Theisen Baumaschinen, and in Russia and Ukraine under the brand of the 50 percent owned joint venture Fortrent. Cramo provides modern rental solutions through the Cramo Concept. Under

the Cramo Concept, construction companies and customers in trade, industry and the public sector, as well as private customers, are provided with machinery, equipment and modular space through different rental solutions and services. By combining the product portfolio with its extensive offering of services, Cramo reduces the capital invested by its customers and can create total rental solutions for every need for both the short and long term. Through a network of close to 360 depots and offices, with the total number of rental items over 200,000, Cramo’s approximately 2,500 employees serve over 150,000 customers in fifteen countries.

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# ALUBAR

## ALUBAR FLOOD GATES AND FLOOD DOORS

Since the Estonia ferry accident in 1994 ALUBAR has protected ferries in international traffic against flooding on their car decks. Due to more extreme weather world wide the flood protection onshore is now the main market.



In Metro stations or tunnels the ALUBAR flood gates are designed for high pressure or large openings. The protection system include sensors in the tunnels. The sensors will alert about potential water and ensure automatic closing of the flood gates and doors. The flood gates will be able to withstand a water pressure of 25 metres.

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### ALUBAR

More wet and windy extreme weather worldwide increase the need to secure property and public facilities against flooding. The New Cityring Metro in Copenhagen, which will be in full operation by 2018, needs to flood protect 4 of its 17 stations. The Norwegian Halvorsen Group company Alubar A/S has won the contract and will use the experience from their well-known door solutions to develop and design the flood protection system together with their sister company, Engineering Research Center.  
[www.alubar.com](http://www.alubar.com)

same high-frequency service and short trains. The contract covers 15.5 kilometres of twin bored tunnels and last year the first Tunnel Boring Machine (TBM) started the tunnelling from one of the three shafts 40 meters underground at the work site of Nørrebroparken. By 2018 the completion of the Cityringen line and its 17 new stations will almost double the number of metro stations in the Danish capital and will result in a scenario whereby 85 percent of all residents of Copenhagen will have a station within 500 metres of their homes or places of work.

The development of Metro Copenhagen

*“The completion of the Cityringen line and its 17 new stations will almost double the number of metro stations”*

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Travelers going from Copenhagen city centre to the airport





Since October 2012 I.CO.P. Denmark Aps has been executing secant piles and diaphragm walls by trench cutter, which will build the main boxes, technical rooms and ventilation shafts of some new stations of the 16-kilometer-long ring to connect the central areas of Copenhagen with the existing metro line. On the whole, 21 stations are under construction.

[www.icop.it](http://www.icop.it)

*“Two significant and impressive characteristics of the Metro, have been the adoption of both a 24 hour service and the use of driverless vehicle technology”*

in recent years has resulted in several landmark moments that have made the city's network a pioneering model compared to others throughout the world. Arguably the two most significant and impressive characteristics of the Metro, ones that have captured the attention of other providers hoping to replicate their fortunes, has been the adoption of both a 24 hour service and the use of driverless vehicle technology.

Initially, 24 hour operations were limited to weekend travel only, however this has since been extended to cover the



The Metro, bus and train services have a fully integrated ticket system

#### I.C.O.P. SPA

I.C.O.P. has executed entirely cased secant piles with diameter of 1,000mm and interaxis of 800mm up to a depth of 36m from the working surface, for a total length of 23,800m.

The works also include the execution of diaphragm walls with thickness of 1,200mm and depth up to 32m. I.CO.P. has been employing for the execution of the above mentioned works three drilling rigs (BG30, BG39, BG40) equipped with kelly bar and rotary drive with diameter of 1,000mm. A drilling rig type BG28 and the cutter BC32 are being used, instead, for the execution of diaphragm walls.

Soil stratigraphy mainly consists in Upper CPH

clay limestone and Mid CPH Clay limestone under ground water level. Due to the presence of numerous granite blocks, the use of rock drilling equipment (i.e. core barrel and bucket) proved to be necessary during the whole excavation process since the very first meters.

Particular attention is paid to the installation of reinforcing cages. Indeed, as per technical specifications strict tolerances are to be observed, in particular with regard to pile length (+15/-5cm), rotational motion (<5°) and vertical deviation (<1/100).

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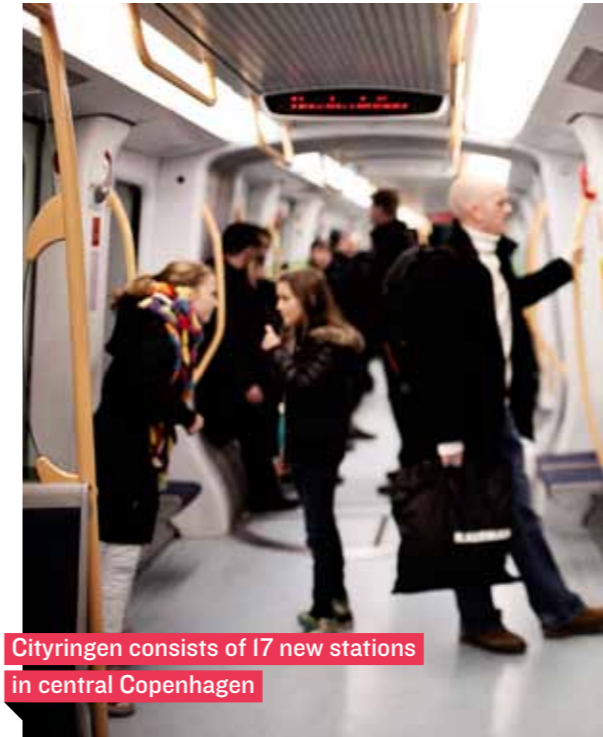
Tunnelling of one of the new lines

*“The result is a Metro system providing a virtually continuous service for Copenhageners with an ‘always on’ concept”*

entire week following a period of public consultation. The result is a Metro system providing a virtually continuous service for Copenhageners with an “always on” concept, where the presumption by users is they can just turn up, day or night and expect a reasonably short wait for the next train without needing to consider timetables or schedules, and have a consistently short journey time.

Meanwhile, the adoption of driverless technology was unquestionably a daring





Cityringen consists of 17 new stations in central Copenhagen

decision, one which represents a major departure from the traditional forms of rail transport that were already operating in Denmark, and indeed throughout the world.

“Metro Copenhagen was one of, if not the first Metro in the world to introduce a driverless system,” Olsen explains. “While it was a bold decision to take it has been extremely successful in that the decoupling of staff from trains has resulted in a flexible demand driven service, as opposed to a resource driven one. It has also allowed us to provide a greater degree of exposure to customers for a particular number of staff, thus offsetting the dehumanising effects of employing technology to operate the Metro.”

Turning our attention back to the Cityringen project we today find Metroselskabet in the midst of a considerable

*“Metro Copenhagen was one of, if not the first Metro in the world to introduce a driverless system”*

# renesco®



### RENESCO

#### Three years in the Copenhagen underground

Twenty more Renesco specialists are at work on building the new City Ring for Metro Copenhagen from 2013 to 2016. What's often lovingly called the “mini-metro” has been running on its first nine kilometres of track under Denmark's capital since October 19, 2003. In the northern metropolis' underground, everything is a bit smaller than is usual for subways: the cars, the trains and even the diameter of the tunnel. But then the fully automatic mini-metro is truly a new development. Each of the driverless trains consists of only three cars, is 39 meters long, 2.65 meters wide and carries up to 300 passengers at a maximum speed of 80 km/h.

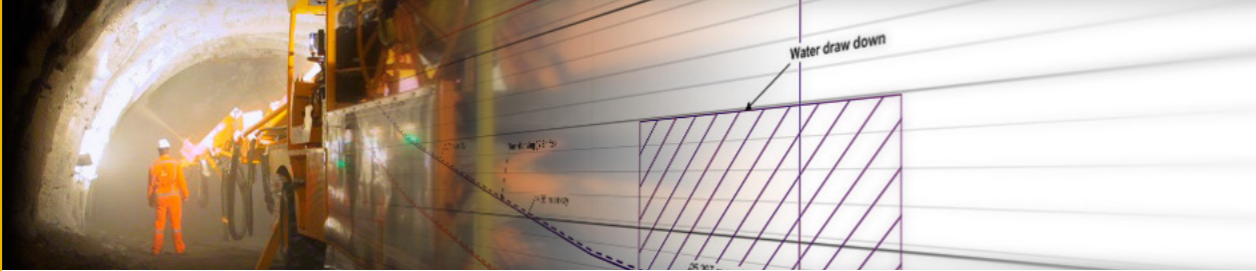
Renesco has to seal 21 metro stations, which on average extend down vertically 30 meters, against water pressure to 3 bar. It will take three years to line – watertight – a total surface of 150,000 m<sup>2</sup> with 600,000 kilograms of material. Installing the sealing in Copenhagen presented some exceptional challenges – above as well as below ground. Per König: “Sometimes we work at six installation sites at a time. That isn't that easy logistically, for the city hardly permits any construction areas for traffic reasons – not even for its own subway.”

[www.renesco.sk](http://www.renesco.sk)  
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*Renesco's specialists can today be found providing expert services towards the building of the new City Ring for Metro Copenhagen*

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Linear project  **TILOS**



Workers celebrate during the tunnelling of the new line

**Did you know?**

**130 million**  
Number of passengers Metro Copenhagen is expected to carry per year.

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**15.5 km**  
Approximate length of the Cityringen underground railway.

program of work. "Right now we have two TBMs driving the first stage of the tunnelling of the new line, with the first now some 800 metres advanced," Olsen says. "By the end of 2014 we intend to have all box constructions and shafts complete, before commencing with the finishing works across all 17 new stations. In addition to these works we have almost completed the construction of the control centre and are now beginning with the installation of technical components along the line."





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*“We plan to have the line opened and in operation by late 2018”*

Further afield in Italy the contractor tasked with building the first trains to operate along the Cityringen are working on train number 15. The progress being made across the project bodes extremely well for the completion of the works ahead of the line opening. “We plan to have the line opened and in operation by late 2018. In preparation for that we will aim to have all tunnelling, construction and installations complete by 2016, giving us a good lead in time to carry out test driving in preparation for the day Cityringen commences operations.”



Employees at Metroselskabet

### COMPLY SERVE

Comply Serve specialises in cloud-based collaborative progressive assurance and risk management solutions for large infrastructure projects. Its ComplyPro® system has been deployed across the DKK 21.3 billion Cityringen project, which sees the construction of a new circular line in the centre of Copenhagen. Targeted for completion by 2018, the new underground Metro system presents added project complexity due to the city being situated at sea level, while the Cityringen network is sited 30m below ground level. ComplyPro is the risk management solution, spanning the entire project and used by all partners, including the on and offshore Copenhagen Metro Team (CMT). CMT is a joint venture between Salini Construction, Technimont ICB (TICB), part of the Maire Tecnimont Group, and S.E.L.I. SpA. ComplyPro provides a global 'live' Project Wide Hazard Record (PWHR) that

details hazards and resulting consequences, as well as potential accidents, during the risk analysis of the project design – plus the actions taken to control these risks. Silvestro Ferrara, risk manager at CMT, said: “This software tool functions as a single point of entry for risks and risk assessment throughout the project lifecycle, one that would help to avoid the continuous exchange of documents and be a live interface between all those involved in risk identification ... a tool that allows for transparency, traceability, fast communication and reporting.”

“Managing all the elements of risk in one place, with one prioritised dashboard, is of key importance to CMT,” commented Steve Tosh, managing director, Comply Serve.

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Operating now for over a decade, Metro Copenhagen may still be a young system compared to others, but it continues to have a sizeable influence both within the capital itself and on the international stage where it is seen as a model for other cities planning to develop modern transit systems. There is of course also a continued focus on ways to improve the system and deliver a better service to passengers. As a matter of fact, since the contracts for the Cityringen project were signed in 2011, a new extension to the Nordhavnen area of the city has been agreed that will see the addition of new stations in a new development area of Copenhagen.

“One of our other responsibilities is to develop suggestions for new metro lines

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MobyDick is the worldwide known brand name for high quality Wheelwashing Systems with the goal to keep the public roads clean. For the CMT Copenhagen project, 27 units of the model ConLine have been operating during the construction period. ConLine is a range of models specially designed for the needs of the construction industry and based on decades of proven technology. All systems are mobile and ready in very short time. They contributed to the intention of CMT to keep the impact on the environment, due to heavy construction, as less as possible.

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*“We currently have plans being considered for a line which will branch off from the Cityringen into the north of the city and a second that will branch off into southern areas”*

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*“This hugely important project will see our company being responsible for building the first light railway system in Copenhagen and indeed the first in Denmark for many years”*



Henrik Plougmann Olsen,  
Chief Executive Officer  
of Metroselskabet

**Did you know?**

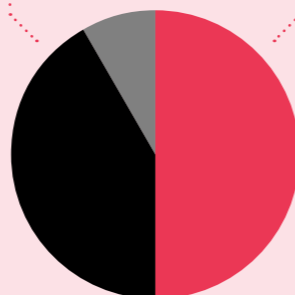
Metroselskabet was founded on 26 October 2007.

Metroselskabet is a partnership, owned jointly by:

The City of Copenhagen  
**50%**

The Danish Government  
**41.7%**

The City of Frederiksberg  
**8.3 %**



View down to  
station level

in conjunction with our owners and we currently have plans being considered from a line which will branch off from the Cityringen into the north of the city and a second that will branch off into southern areas, so the Metro will certainly be expanding in the coming months and years” Olsen enthuses.

As if that wasn't enough, Metroselskabet has also been assigned the considerable task of constructing a 27 kilometre light railway system that will operate around the outskirts of Copenhagen. “This hugely important project will see our company being responsible for building the first light railway system in Copenhagen and indeed

the first in Denmark for many years,” Olsen concludes. “Obviously this is very much in its infancy as a project, however it is without question an exciting, long-term commitment that we are proud to be a part of.” **BE**

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