ENGINEERING / CONSULTANCY / DESIGN

RESPONSE

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MOVING TOWARDS SUSTAINABILITY

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RESPONSE ISSUE 08

EDITORIAL

ENGINEERING SUSTAINABLE SOLUTIONS

The UN's Sustainable Development Goals (SDGs) are fast becoming an important topic among decision-makers and influencers. But how do we move from ambition and goal-setting to action?

Successful sustainable development is the product of everyday decisions, expertise and ingenuity, great and small. Solutions are already available that can make cities, buildings, mobility, production and consumption more resource- and cost-efficient, longer-lasting and better for society and people. Solutions that will effectively build the world we want while providing a strong business case for companies and authorities alike.

Very often, Ramboll's clients prefer the broader approach to sustainability that is not only about being environmentally but also socially and economically sound. To solve their challenges it is necessary to combine technical expertise with integrated, holistic solutions.

This issue of Response demonstrates just that.

For example, in California groundwater is for the first time being mapped by a helicopter with electromagnetic sensors that scan the top soil layers. This not only prevents salt water from infiltrating ground water in the specific location, but will also contribute to saving the scarce water resources in the state – and other places – in the long term.

In London, some of the building sector is beginning to manufacture components offsite, reuse building materials and use cross-laminated timber – all of which is good for the climate and finite resources but also saves time and money.

And in Dubai, advanced structural engineering is being used to design the world's tallest residential tower as a functional and elegant building - with solar panels and wind turbines - that paves the way for sustainable living.

In other words, Ramboll already has vast experience in helping to fulfil the SDGs while also providing added value to our clients and society.

Enjoy your reading.

Jens-Peter Saul
Group CEO

The SDGs are a universal set of goals, targets and indicators that UN member states will be expected to use to frame their agendas and company policies up to 2030.

Response is Ramboll's magazine covering global agendas and local solutions. Please share your ideas, insights and feedback with us at: response@ramboll.com

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Amager Bakke waste-to-energy plant, Copenhagen.
Photo: Scanpix.

CREATING SOLUTIONS FOR GLOBAL CHALLENGES

Engineering consultancies have a major role to play in solving some of the world's biggest challenges, according to experts.

By Michael Rothenborg

The Sustainable Development Goals (SDGs) are a universal set of goals, targets and indicators that all 193 UN member states agreed upon in 2015, and that all nations will be expected to use to frame their agendas and political policies up to 2030.

The world in 2017 is not exactly short of challenges as far as sustainability is concerned.

The United Nations has defined 17 Sustainable Development Goals (SDGs), all of them critical to building the world we want. But the task can seem impossible.

However, according to recognised sustainability experts, ingenuity, technical excellence and holistic, multidisciplinary solutions may be just what are needed to bring us closer to fulfilling these goals.

"Engineering consultancies have a major role to play here since they can contribute both vast knowledge of prior designs as well as the capability to calculate outcomes and optimise multiple combined approaches," says John D. Macomber, Senior Lecturer in the Finance Unit at Harvard Business School.

Professor William Powrie from the Faculty of Engineering and the Environment at the University of Southampton agrees:

"Overall I'd advocate a systems approach that reduces consumption of energy and resources – and hence CO2 emissions – but in a way that makes people feel happy and content. Engineering consultancies have a major role to play in making this palatable and acceptable."

Companies must fill the gap

Dr Michail Fragkias from the Department of Economics at Boise State University in Idaho, USA, points out that engineering consultancies that include environmental, social and economic sustainability in their work can play the most important role.

"Especially now, given the recent developments in the international political scene, with major players deciding to reduce their emphasis on sustainability, private actors along with cities need to fill the gap," says Michail Fragkias.

The experts emphasise that society and companies should address sustainability challenges simultaneously in order to take advantage of any complementarities or co-benefits.

"That way it's possible to check for any unintended consequences of one type of intervention in another area," explains Michail Fragkias.

Finding solutions to one of the UN goals also increases the chances of reaching the others, as they are all interrelated.

Delivering sustainable solutions

The projects Ramboll undertakes and the way they are delivered impact the SDGs, and it is important to mitigate the risks of negatively impacting people and nature. According to a comprehensive assessment, 40% of Ramboll's project turnover has a direct positive impact on the 17 SDGs. And almost all the remaining turnover indirectly impacts at least one goal positively.

"The global community has concluded that we all – companies, governments and individuals alike – need to dedicate our efforts to improving health conditions and resource efficiency, mitigating climate change and building inclusive, liveable cities," says Søren Holm Johansen, Ramboll Group Executive Director. "To Ramboll this is a business opportunity but also a part of our corporate responsibility. We have decided on a new sustainability strategy through which we will be known as a market leader in the area."

Four of the 17 SDGs are integrated in almost everything Ramboll does – and have strong multidisciplinary and cross-market synergies. On the following pages we explore how projects, novel insights and technical excellence are bringing the world closer to:

- Industry, innovation and infrastructure (SDG #9).
- Sustainable cities and communities (SDG #11).
- Responsible consumption and production (SDG #12).
- Climate action (SDG #13). ■

> "Engineering consultancies can contribute both vast knowledge of prior designs as well as the capability to calculate outcomes and optimise multiple combined approaches.
>
> **John. D. Macomber,**
> Senior Lecturer, Harvard Business School

SMART CHOICES DRIVE SMART CITIES

To improve mobility in cities without increasing air pollution and CO2 emissions, transport systems need to be holistic and integrated.

By Michael Rothenborg and Andrew Somerville

Movement is the lifeblood of a city. People walk or bike; cars, trucks and buses roll along the roads; and trains try to keep up with their schedule over- or underground.

However, as many of us who live in cities know only too well, that movement can be far from smooth. Road congestion and unreliable public transport are the hallmarks of many cities and can cause damage to health, well-being, productivity and the climate. And according to forecasts from the UN, among others, things are set to get worse. The world's cities are facing an urgent set of challenges when it comes to ensuring that fundamental rite of urban living: getting around.

Businesses, residents and cities all suffer, with the economic costs estimated to be as much as 2-4% of a city's GDP in the form of lost time, wasted fuel and higher costs of doing business.

Decarbonise transport

For William Powrie, Professor of Geotechnical Engineering at the University of Southampton, the key to improving mobility is more sustainable transport. "The most important thing is to decarbonise, depollute and decongest transport in cities," he says. "We should make more space for cycling and walking, both of which have huge health benefits as well as being non-polluting."

He believes that with better long-term planning and design, it is possible to reduce the need for transport – especially transport that cannot be decarbonised. An important part of the answer is smart mobility where technology and a holistic approach can create a better transport flow in cities while reducing climate impact and air pollution.

"We should not fall into the trap of replacing private cars with driverless electric pods – we need to reduce the number of, and dependence on, vehicles," he says. "That would create space for people, make our cities more pleasant spaces to be, clean the air, reduce CO2 emissions and reduce noise."

One of the cities where Ramboll helps improve mobility is Oslo in Norway.

Making mobility truly smarter

As cities and their infrastructure become more connected, the ability to make transport systems more responsive to demand and adaptive to supply is increasing. Combining intelligent transport systems, which involve utilising sensing technologies like cameras, radar and traffic counters, with the use of data from the internet and smartphones is leading to smarter mobility.

This concept of smart mobility is a central focus of Ramboll's approach to making cities more liveable and sustainable. It takes a holistic view of transport, from maximising the use of precious public space to more sustainable infrastructure such as bike paths, smart parking, car sharing and better traffic information. But smart mobility is not just about technology, emphasises Jukka-Pekka Pitkänen, Director for Smart Mobility at Ramboll.

"Technology is, of course, at the core of this. But mobility in cities does not become smarter just because the technology is smart," he says. "There are also plenty of more immediate ways of increasing mobility and making it more sustainable. This can be everything from more efficient traffic flow to better use of existing transport infrastructure and increasing the sharing of modes of transport."

Mobility as a service

A successful example is MaaS, or Mobility as a Service, which aims to optimise existing transport networks. Already launched throughout several cities in Finland, it is a user-friendly platform that integrates different modes of transport, both public and private.

"It is based on consumers' buying the precise mobility services they need instead of the means of mobility," says Jukka-Pekka Pitkänen. "Users can access an app that seamlessly combines transport and payment options. It's a simple but effective idea that combines the use of technology with existing transport and infrastructure so it's easy for cities and, more importantly, the people who live there, to adapt."

Ramboll prepared the business plan for MaaS, and it already plays a key role in Finland's transport policy.

"Ramboll has been a contributor of expert knowledge from the get-go and continues to be a valuable partner in the MaaS ecosystem," says Sampo Hietanen, CEO and founder of MaaS Global. ■

USER-FRIENDLY TRAFFIC LIGHTS

Ramboll is pioneering a traffic project that will shorten travel times, improve accessibility and lessen environmental and climate impact.

By Michael Rothenborg

Almost every motorist has tried it: being stuck in a long queue at a red light while a single car turns on green in the opposite direction.

This is because of the systems used for traditional traffic signals. Usually sensors are buried in the road, and the traffic light changes when so much as a single car drives up to the junction – no matter how many cars are heading the other way.

But Ramboll is doing a pilot project for Aarhus Municipality in Denmark where instead four technically complex radars are installed up in the

traffic signal masts. The radars register all traffic up to 500 metres from the junction, taking into account the number and the type of vehicles heading towards the junction.

Greener, with better capacity

This will not only save time for the individual driver – and thus for the area's business and society as a whole – but also reduce CO2 emissions and other air pollution, as trucks will be prioritised.

"We get better capacity in the road network – which is extremely important, as the increase in traffic clearly exceeds the increase in road capacity – while we also reduce the environmental impact of traffic," project leader from Aarhus Municipality Anders Kruse Christiansen explains.

The radars also make it possible to reduce the 'interims', or intervals between red and green lights, when the junction is empty – without compromising safety.

"That way, we can get an even better traffic flow," says Stig Grønning Søbjærg, Traffic Engineer at Ramboll and manager on this project.

Far less wasted time

Preliminary calculations estimate that the number of stops can be reduced by 9-11%. According to calculations based on a model from the Danish Road Authority, the potential savings are substantial. In a junction with 20,000 vehicles per day, like the one chosen for the pilot project in Aarhus, roughly every third vehicle has to stop and wait at a red light for 10 seconds. That means approximately 50,000 litres of extra fuel consumption per year – equivalent to a value of more than half a million kroner (around EUR 80,000) for road users. For just one such junction, that is. And to this should be added the significantly higher value that road users, companies and society gain from the time drivers do not have to stop for a red light.

A regular motorist might think that this smarter traffic management is widespread, but no, on the contrary. The Nordic countries are front-runners here, and only one other radar system like this is under development in Denmark – at Aalborg University, where Ramboll is providing input.

Aarhus Municipality calls the pilot project system 'The world's most intelligent signalling'. ■

> "We get better capacity in the road network – which is extremely important, as the increase in traffic clearly exceeds the increase in road capacity.
>
> **Anders Kruse Christiansen,**
> Project Leader, Aarhus Municipality

TRAFFIC STOPS PRODUCTION

Increased congestion on Danish roads is harming the productivity of many of the nation's companies, leading to increased discussion about investing in transport infrastructure.

According to a Ramboll survey of over 670 Danish businesses for the Confederation of Danish Industry, one out of every three companies has needed to stop production due to delayed deliveries caused by road congestion and other transport problems.

Copenhagen and Prague inspire Australia when it comes to climate-friendly and cost-effective mobility incentives.

By Charlotte Ankerstjerne and Michael Rothenborg

GET ON YOUR BIKE, MATE!

With the right incentives, big cities can inspire citizens to choose greener modes of transport.

This is the conclusion from Canberra's Minister for Planning and Land Management, Mick Gentleman, after a recent visit to Prague and Copenhagen. The minister is looking for ways to break the habits of the 80% of Canberra citizens who prefer driving to other modes of transport, and one of his field visits with Ramboll entailed a trip to Nordhavnen, a new quarter in Copenhagen laid out to optimise bicycle transport.

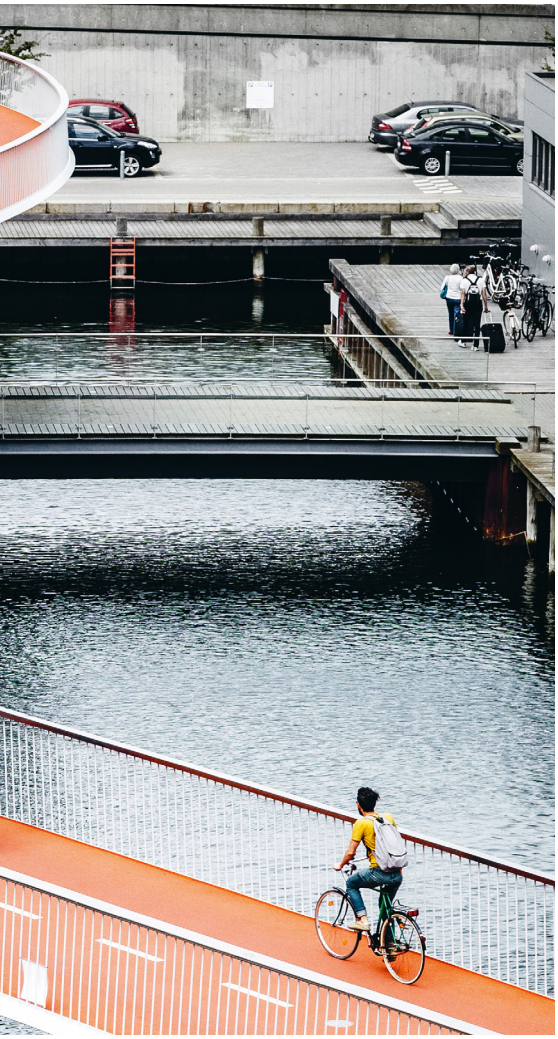
"These visits give us amazing knowledge that we didn't have before," says Mick Gentleman.

His visit was part of a new EU World Cities project that aims to enhance sustainability and urban liveability by facilitating the exchange of information between some of the global metropolises. Ramboll is a partner in the project, which has paired Canberra, Australia, and the European capitals of Prague and Copenhagen.

The goal of the three-year project is to strengthen market opportunities and job creation while also promoting the sustainable economic development of the cities involved.

The Canberra government has set greenhouse gas targets to reduce its emissions by 40% from 1990 levels by 2020, by 80% by 2050, and to have no net emissions by 2060.

"We have similar challenges in our city, but some aspects are strikingly different," Mick Gentleman explains. "For example, here in Copenhagen, more than 50% commute to work on bicycles. And it is very similar in Prague – most use bicycles or public transport. Canberra is the opposite. We have 80% who use cars to get to work, and a very limited number use bicycles and public transport. So, what we learn from both Copenhagen and Prague is that if we give people the right incentive



and the ability, they will change their mode of transport."

Reduced health costs

Some of the incentives Copenhagen has provided have been developed by Ramboll – which has collaborated with the City on bicycle lanes since the 1980s. Current projects include better safety at dangerous intersections, increased accessibility for two-wheelers on one-way car streets and intelligent transport systems solutions like a 'green wave' of traffic lights for cyclists on bicycle lanes.

A flagship project is The Bicycle Snake (pictured above), a bicycle and walking bridge to the island of Amager that opened in 2014. According to the City of Copenhagen, the snake reduces bicycle travel time by 380 hours per day, thus making fewer people take a longer car route. Calculations show that society saves around 1 Danish krone for each kilometre cycled, because the physical activity reduces health treatment costs and increases productivity. There are also climate gains and other advantages. ■

UPGRADING TRAIN COMMUTES

By Michael Rothenborg

People who commute to work by bus, train or bicycle or on foot are happier than those who drive their cars to work every day, or so shows a study of 18,000 British workers done by a team at the University of East Anglia. However – and not surprisingly – this primarily applies if the commute by public transport actually works.

Thus, more frequent and more reliable trains are a must if the world wants to improve infrastructure and reduce air pollution and CO2 emissions.

Two of the largest infrastructure projects in Scandinavia aim at doing just that.

In Sweden's second-biggest city, Gothenburg, the so-called West Link comprises an eight-km double-track railway, of which six kilometres are a railway tunnel running underneath the city centre and thereby increasing capacity and reducing travel time.

Ramboll took on two key sub-projects on the West Link: the overall design of the railway technical solutions and a detailed design for the line, its connection points and one of the three new underground stations (pictured above).

In the Norwegian capital of Oslo a similar project is underway: the 23-km Follo Line railway will connect Oslo to the commuter town of Ski. Currently the largest transport project in Norway, the Follo Line includes Norway's longest railway tunnel (19 km), a feature that allows much faster and more frequent trains, thus boosting rush-hour capacity by 63%.

Ramboll has been awarded the signalling consultancy contract for the Oslo-Ski link, as the company has gained experience from several key railway signalling upgrades in Europe – most notably an extensive signalling upgrade in Denmark and a railroad project in Trondheim, Norway.

A GOOD LIFE IN A HEALTHY CITY

More and more people are living in cities. This creates both opportunities and challenges – which need to be carefully balanced to maintain sustainable development.

By Michael Rothenborg

"A good city exists for the sake of a good life – not for the sake of life only."

The Greek philosopher and scientist Aristotle spoke these words of wisdom almost 2,500 years ago. But they seem more relevant now than ever.

According to the United Nations Development Programme (UNDP), the share of the world's population living in urban areas increased from 30% (746 million people) in 1950 to 55% (4 billion) in 2015, a figure projected to reach 60% (5.1 billion) by 2030.

The UNDP Global Trends report "Challenges and Opportunities in the Implementation of the Sustainable Development Goals" concludes that this urbanisation "presents both significant opportunities and enormous challenges" – not least because it makes the issue of ensuring city residents a good life more complex.

John D. Macomber, a senior lecturer in the Finance Unit at Harvard Business School, has no doubt that the private sector has to help build sustainable cities:

"The problems created by rampant urbanisation are among the most important challenges of our time. They also represent one of the greatest opportunities – and responsibilities – for the private sector. Business is uniquely positioned to shape the sustainable, economically competitive cities of the future," John D. Macomber emphasises.

Unique set of challenges

Ramboll's Group Director for Sustainability, Neel Strøbæk, agrees. A speaker at this year's UN Climate Week in New York, she emphasises that arguably the most important, integrated and holistic approach is to concentrate on what makes a city healthy.

According to the World Health Organization (WHO), a healthy city "continually creates and improves its physical and social environments and expands the community resources that enable people to mutually support each other in performing all the functions of life and developing to their maximum potential."

"Not all cities are equally healthy, and each city faces its unique set of challenges in very different ways," Neel Strøbæk says.

She recognises that engineering consultancy cannot solve all the challenges a city faces.

"But we can work holistically, complementing traditional engineering solutions with socio-economic analyses and mapping both benefits and co-benefits. In this way we can make sure that cities become healthier," Neel Strøbæk continues.

She adds that investing in making cities healthier brings an infinite number of benefits:

"Benefits include longer life expectancy, lower costs of treating lifestyle diseases, fewer respiratory conditions, better road safety and, last but not least, greater urban resilience to climate change." ■

> "Each city faces its unique set of challenges in very different ways.
>
> **Neel Strøbæk,**
> Group Director for Sustainability, Ramboll

A CITY FULL OF DILEMMAS AND INTERDEPENDENCIES

The opportunities and challenges posed by urbanisation are often interrelated and complex.

MOBILITY AND INFRASTRUCTURE

When cities grow, traffic congestion often increases. But with careful planning, cities can improve traffic flow. Improving infrastructure, promoting sustainable transport and designing with walking and cycling in mind helps reduce the need for transport and makes mobility less dependent on fossil fuels.

LIVEABLE HOMES

Many cities are facing housing shortages. While high-rise buildings can provide housing for a large number of people, as well as lower energy costs and increase energy efficiency, living in densely populated areas presents its own challenges. It puts a strain on the natural environment, decreases air quality, impacts human health and potentially creates social problems. To enhance liveability, cities need to find the right balance between high- and low-density housing.

CLIMATE ADAPTATION

The need to adapt cities to climate changes is increasing. Many cities face the challenge of flooding, particularly those situated in coastal regions. Their built-up environments drive up temperatures and make them more vulnerable to cloudbursts and floods. Adapting cities to these changes can, however, make them more liveable. Well-planned blue-green infrastructure makes a city more climate-resilient while also improving liveability and the mental and physical health of the people living there.

ENERGY EFFICIENCY AND CLIMATE MITIGATION

Cities are often extremely resource-intensive. But by building efficient energy infrastructure and maximising the use of resources, less effort is needed in supplying basic utilities like fresh water and electricity. District heating systems that use energy from waste and wind farms that generate power contribute to making the energy system more effective, sustainable and climate-friendly.

Sources: UNDP, KPMG, Sustainia, McKinsey, IWA, Ramboll et al.

ADVANTAGES OF URBAN NATURE

- Strengthens local, national and global biodiversity and demands less maintenance than traditional parks.
- Holds large amounts of water and creates natural shade that cools areas and thus serves as a buffer against climate change.
- Helps renew air and thereby improves air quality. More plants in the cities can also curb emissions and contribute to cleaner air.
- Has a calming and healing effect with regard to a number of disease symptoms and stress.
- Supports several of the SDGs and thereby helps cities follow a sustainable development strategy.

UNDER PRESSURE – HOW TO MAKE URBAN NATURE FLOURISH

As urbanisation increases, the challenge to keep green areas green gets more complicated. However, it can be done – and with added benefits.

By Michael Rothenborg

As cities all over the world grow and attract more people, the natural environment is increasingly under pressure. It is a global goal for the UN and the EU to stop the decline in biodiversity by 2020 at the latest. The fulfilment of that goal can be helped by a strengthened focus on urban nature.

It is Ramboll's stated mission to make people and nature flourish, and the company has acted on many projects that deliver net positive environmental benefits, enhance wildlife and add to public enjoyment. These include projects that support oases of urban nature as well as greening of the road and rail routes into city centres.

Network Rail's GBP 7-billion Thameslink Programme in Greater London has been testing the potential of biodiversity offsetting since 2012 when it published guidance for developers. One of the most successful examples was part of the project that untangled the tracks approaching London Bridge station – thus ensuring Thameslink rail lines can cross over Kent lines unimpeded and run more efficiently.

Ramboll's prime contribution to the infrastructure challenge for this Bermondsey Dive Under project was engineering design, but when construction started in 2012, the Thameslink Programme also sought to improve the site's low conservation value and limited botanical diversity. This was challenging because the site contained the previous tenant's debris, and the soil was heavily contaminated with asbestos, hydrocarbons and Japanese knotweed.

Overall, 21,900 tonnes of contaminated material were removed and replaced by 765 m2 of green walls and a colourful mix of native wildflowers. Furthermore, the railway embankments now function as green corridors and stepping stones to the wider area (pictured right).

A global trend

London is far from the only place where biodiversity and urban liveability go together.

"There is a large potential to improve biodiversity outside the traditional sites of conservation interest, and the benefits are multiple, since nature, people and society at large need stronger ecological coherence," explains Kristine Kjørup Rasmussen, Chief Consultant on urban nature at Ramboll.

In Offenbach, Germany, an industrial peninsula on the River Main presented an almost equally challenging environment with contaminated soil. Ramboll is now converting the area into a new, sustainable city district based on a holistic climate adaptation concept, developed to create 'soft' city spaces and streetscapes while retaining and cleansing stormwater before releasing it to the river and harbour. Innovative natural water treatment systems such as cleansing biotopes are being integrated into the park spaces, and new, natural habitats are being created for riparian flora and fauna while also giving the city a refreshing green oasis.

In Singapore Ramboll has finished a similar project. As elements of an award-winning climate adaptation and green-area restoration project, added plants and a healthier river in Bishan Ang Mo-Kio Park have improved the city's biodiversity, attracting many different species of birds and insects – which also keep the mosquitos at bay.

In Denmark too, biodiversity projects are often combined with measures to address climate adaptation and expand recreational areas. This is the case in Kagsåparken, northwest of Copenhagen, and in Tommerup on the island of

This is Harrestrup Å – part of a large Greater Copenhagen climate adaptation and restoration project, where an almost 30-km system of streams with mostly paved edges is being returned to a natural state with greener banks, clear water and fish.

RIVER REHABILITATION IN CHINA

By Martin Zoffmann and Michael Rothenborg

China's rivers have been profoundly affected by industrialisation for decades, but in recent years river rehabilitation has gained increasing attention.

Ramboll is part of this work, for example, in a project on the Beijing stretch of the Xiao River, a 346-km manmade waterway that needs restoration due to heavy pollution.

The landscape architect experts at Ramboll Studio Dreiseitl Beijing are responsible for redesigning the river on behalf of Beijing Enterprises Water Group Limited, a stock-listed and highly influential group providing a broad range of environmental-protection and water services in China.

The winning design creates a scientific eco-landscape framework that matches the requirements for developing the riverfront of the rapidly expanding urban district of Tongzhou.

Several other projects are located close to Changchun City, which is the capital and largest city of Jilin Province in northeast China. Here, as in other fast-growing Chinese megacities, river rehabilitation is on the rise, and large investments in urban development are currently being implemented. Ramboll is involved in projects on the Yinma River and the Xinkai River as well as a landscape and eco-water design project on 16 km of the Dongxin River, with the goal being to create a beautiful river park that enhances urban liveability.

→ Funen, where habitats for wild species are planned as part of the new green and blue corridors crossing the town and thus increasing local biodiversity.

Awards for double benefits

In the UK the Bermondsey Dive Under project has been rewarded with three awards in the first half of 2017: the project team from Network Rail, Skanska and Ramboll was presented with the ICE London Civil Engineering Infrastructure Award for the most innovative, creative and sustainable contributions to the physical and social environment in the UK Capital. The project also won the Ground Engineering - Sustainability award, not least because the benefits were achieved with significant innovations, including cost reduction from reduced piling and pile depth, reduced material movement and impact. Finally, having increased biodiversity in the area by 113%, the CEEQUAL Excellent Whole Team Award secured a score of 96.6%, the highest ever granted to a completed project on the Thameslink Programme.

"The fantastic score of 96.6% is the result of our collaborative way of working to not only protect but enhance the environment and the community whilst delivering this complex project", says Gerardo Austria, Consents & Sustainability Manager, Network Rail. ■

> "The benefits are multiple, since nature, people and society at large need stronger ecological coherence.
>
> **Kristine Kjørup Rasmussen,**
> Chief Consultant, Ramboll

WHAT IS A LIVEABLE CITY?

Clean air, affordable housing and better prevention against crime, floods and traffic accidents. These are some of the main areas in which local authorities can increase their efforts, says a new survey.

By Michael Rothenborg

We all have a sense of what a liveable city is, but it is not easy to define. In the run-up to the Danish local elections in autumn 2017, Ramboll conducted a survey in which the research institute YouGov interviewed more than 3,200 Danish citizens about what makes a city attractive to them. (The survey was done in the five biggest Danish cities and two typical provincial towns – Copenhagen, Aarhus, Odense, Aalborg, Esbjerg, Vejle and Køge.)

Among the key findings are:

- Clean air is among the most important conditions for liveability – and citizens are not satisfied with the authorities' efforts in the area.
- Safety is vital – both traffic safety and crime prevention – and citizens are also dissatisfied on this count.
- There is also a gap between the demand for affordable housing and its availability.
- Mobility is another definite priority – and a majority find better conditions for pedestrians, bicycles and public transport more important than better conditions for cars.
- Green areas and urban nature are very important, especially in Copenhagen – in fact green areas are the most important aspect of liveability in the capital.
- Citizens see flood resiliency as less of a priority than most of the other factors mentioned above, but still expressed dissatisfaction with what they felt was too low a level of climate protection.

Later this year and in 2018 Ramboll will present the survey findings and recommendations to Danish local authorities. The company has been working to improve liveability in cities for decades – and has helped generate measurable results, not least in Copenhagen. 2014 was, for example, the third year that the influential international magazine Monocle declared the Danish capital the world's most liveable city. And urban planners worldwide are increasingly looking to the Nordics for inspiration on taking a holistic and integrated approach.

"Cities the world over face similar challenges, so cities outside Denmark will also be able to use some of the recommendations from this survey," says Henrik Seiding, Executive Director, Ramboll Management. ■

OBTAINING THE RIGHT RESIDENTIAL MIX

It is possible to develop and renovate housing projects so that they are socially, environmentally and economically sustainable. We examine two such cases in Denmark and California.

By Michael Rothenborg and Andrew Somerville

At Ellebo in Ballerup, north of Copenhagen in Denmark, Ramboll and head architect Adam Kahn are helping to bring economic, environmental and social benefits to the 276-apartment estate in a major renovation project.

One of the main features is what is known as winter gardens. A well-known concept in the UK, the winter gardens consist of rooms facing the inner courtyards. They are perfect to grow plants or relax in, and more importantly they provide an isolated buffer between the apartments and the external part of the balconies and therefore minimise the large heat loss typical of this type of 1960s construction.

Along with a major improvement in wall and roof insulation, the winter gardens also significantly reduce residents' energy bills.

"But you have to consider the indoor climate too," explains Christian Bodekær Thomsen, Project Leader and Design Engineer, Ramboll. "Otherwise there will be problems with mould or humidity. When we use class A energy windows for example, we have to optimise the ventilation at the same time."

More diversity

All the new balconies will face the green communal area in the middle of the estate – a good way of bringing the residents closer together. This green area will also have new climate adaptation measures to collect rainwater and minimise the risk of sewerage leaking into the basements.

On top of the four blocks of buildings, Ramboll and partners are also building new penthouses with a higher rent. This is part of a plan to attract a diverse mix of people to Ellebo.

A recent scientific study from the Danish Kraks Fond, Institute for Urban Economic Research, has documented that efforts to raise living standards and the reputation of social housing actually work, thus helping to reduce unemployment rates, among other things.

Sustainable redevelopment

On the outskirts of San Francisco, Ramboll is involved in another redevelopment that is not just environmentally but also socially and economically sound. The project is at Hunters Point, once home to a thriving shipyard and the iconic Candlestick Park baseball stadium (where the Beatles played their final concert), but for decades the area was virtually neglected.

However, for the last eight years Ramboll has been part of a project that aims to modernise without compromising the unique heritage.

The goal is to develop a mixed-use planned community including homes, commercial and retail premises, educational institutions and recreational facilities.

"Historically, this is an area for people on low incomes and minority groups – that is, a part of the city that has been chronically under-served," says Michael Keinath, Principal at Ramboll in the USA. "It is a huge reinvestment in this part of the city where we need housing. 12,000 new units and houses, 4 million square feet of research development areas, as well as huge shopping areas in a part of town where there is no retail."

Community involvement is crucial

A project of this size is not without challenges, not least because some of the land is contaminated.

"How do you structure a 30-year construction period with tonnes of equipment on a site with radiological material and in close proximity to people who are already living there?" asks Michael Keinath.

The answer has been to undertake detailed modelling and risk assessments of the site to determine how 30 years of heavy construction will affect people and more importantly, how to put in safeguards to protect them.

"The key to a successful re-urbanisation project like Hunters Point is public engagement on all levels," says Michael Keinath.

"Ultimately it is people, not buildings, that make a neighbourhood." ■

> "Ultimately it is people, not buildings, that make a neighbourhood.
>
> **Michael Keinath,**
> Principal, Ramboll

ADEQUATE HOUSING

The UNDP points out that in many cities around the world, housing has not kept up with the pace of urbanisation. The problem is of course most evident in the developing world. But it is also prevalent in countries such as Denmark and the USA, according to the UN and others, including McKinsey in their 2016 report 'A blueprint for addressing the global affordable housing challenge'.

FIT FOR THE FUTURE?

Air pollution and other health problems in growing cities are huge challenges that require different solutions, depending on local conditions. But an integrated Nordic approach can be used globally.

By Michael Rothenborg

Across the world, many cities are struggling to offer a healthy environment for their booming populations.

According to the United Nations, around 1 billion people worldwide live in slum conditions such as inadequate sanitation or water, poor access to healthcare and an increased risk of infectious disease. Even in richer countries, city lifestyles can bring serious health problems like obesity, diabetes and debilitating stress.

Then there is the mounting problem of air pollution, which the World Health Organisation says has now become the world's greatest environmental health risk, linked to one in eight of total global deaths.

These major city problems are closely related to the world's health challenges, but engineering can solve some of the issues.

Health effects of active travel

In the developed world, smog levels are typically so relatively low that the benefits of active travel in cities exceed the disadvantages. But how can those benefits be qualified?

A Ramboll team has modelled the positive effects of constructing new pathways that would increase walking and cycling in cities in western Sweden. The team developed a mathematical model that shows how various route scenarios would impact the incidence of diseases like heart disease, dementia and diabetes in the population and thus engender health and economic benefits. The model also calculates the reduction in air pollution that would result from these initiatives as well as from the relocation of existing roadways and other infrastructure changes and improvements.

The outcomes projected by this analysis are helping municipalities in West Sweden guide public policy. The project team has been awarded a research grant from the Nordic Knowledge and Innovation Fund for a project to further explore the development of health aspect information in environmental impact assessments, with the potential to expand this work to other locations globally.

A Nordic approach in India

The Nordic approaches to more sustainable and healthy cities are not so Nordic that they cannot be used elsewhere in the world. This was the conclusion of a delegation of city planners from India who visited several Ramboll projects in September 2017.

"The basic challenges of urbanisation are in many ways the same," says Prathima Manohar, founder of the Mumbai-based liveable cities think tank The Urban Vision and one of the visiting delegates.

Prathima Manohar and her Indian urban planning colleagues are one of the many delegations that have visited Ramboll projects in Ørestaden. The tour almost always includes the Mountain residences (pictured) and the 8 House, both of which Ramboll has worked on in collaboration with the architectural firm Bjarke Ingels Group (BIG).

"How do you build sustainable and liveable buildings and infrastructure when cities are growing so rapidly? We have all learned at school and university that it is necessary to be people-centric, but we tend to forget it in practice. Copenhagen is proof that enhancing sustainability and liveability with, for example, trees, parks and small rivers or canals often does not cost more than just building in a grey concrete style that is not people-centric," says Prathima Manohar.

Ramboll already operates in India. India's government recently launched a plan to transform 98 of its cities into smart cities – an undertaking that includes just about every urban challenge from housing and traffic management to public health, water use and education.

In 2016, 20 cities were chosen for the upgrade, including Udaipur in the Rajasthan province. To ensure a "smart" transformation Ramboll has worked with the National University of Singapore to create a comprehensive water, traffic and biodiversity plan. ■

IMPROVING AFRICAN AIR

Africa is also increasing its focus on sustainability. As part of the African Development Bank's 10-year strategy to facilitate the continent's gradual transition to green growth, the bank has awarded Ramboll a contract to map transport emissions and monitor air pollution, as well as to build capacity in five cities in Cameroon, Ivory Coast, Morocco, Tanzania and Zambia. The ambition is to implement the project results throughout Africa.

ENHANCING RESOURCE EFFICIENCY

Production and consumption must be much more sustainable – and at the same time more cost-efficient.

By Michael Rothenborg

12 RESPONSIBLE CONSUMPTION AND PRODUCTION

The textile industry is the world's second most polluting industry after oil, the second biggest water consumer after farming, and it uses around 25% of the world's chemicals.

These figures from the UN, Huffington Post and other sources indicate that if the world is to achieve both economic growth and sustainable development, we have to reduce our ecological footprint by changing the way we produce and consume goods and resources.

According to the UN, important milestones for reaching this goal are more efficient natural resource management, better disposal of pollutants and a reduction in the use of chemicals. Industries, businesses and consumers can also be encouraged to recycle and reduce waste as well as to generate energy from it.

Design for sustainability

Global Director of Sustainability Services at Ramboll Environment & Health Lisa Grice emphasises that cost-efficient sustainability is possible.

"The cost of resource inefficiency is often in collateral rather than direct resource costs," she points out. "Water, for example, often has a low direct cost to users. However, factor in the associated costs of wastewater discharge, discharge permits, water treatment chemicals, labour and the energy used to convey, treat, heat or cool water, and the costs of conserving this precious resource quickly become material.

GREENER CHEMICALS

By Michael Rothenborg and Andrew Somerville

Ramboll is involved in several projects aimed at making chemicals greener.

One of them is supporting the global corporate sustainability program for the leading life science and high-technology materials company Sigma-Aldrich. Ramboll helped the company translate the twelve principles of green chemistry, developed by Paul Anastas and John Warner from Oxford University.

According to Sigma-Aldrich's Director of Global Citizenship, Jeffrey Whitford, these represent "an actionable, meaningful approach to evaluate products and share unique product information with customers – and to ensure results are both scientifically accurate and increase the value proposition for our customers."

Ramboll is also involved in the Chemical Leasing initiative that the United Nations Industrial Development Organization (UNIDO) introduced in 2005. Instead of selling chemicals by volume (such as litres or tonnes), suppliers provide a value-added service to users, who then pay only for the service rendered – for example, the number of parts painted or the amount of water treated. In this way, both parties have a commercial and economic interest to do the job using the fewest chemicals possible.

According to a UNIDO study, in the industrial cleaning sector alone, companies that consume more than 2.6 million tonnes of chemicals per year could save up to 1.2 million tonnes of solvents and cleaning agents by using chemical leasing.

The study also suggests that companies of this size could potentially see a reduction of waste and emissions by more than 100,000 tonnes per year, as well as energy savings of at least 300,000 tonnes of CO2 equivalents. There are also significant health benefits for workers due to reduced exposure. These economic benefits, the study argues, could total over $160m annually.

> "The cost of resource inefficiency is often in collateral rather than direct resource costs.

Lisa Grice,
Global Director Sustainability Services, Ramboll

And this is even before the benefits to local communities and natural ecosystems are considered."

She adds that Ramboll now has clients who are working to 'design for sustainability', which includes designing products whose input materials originate from previously used products and which, at the end of their lives, can become part of new products.

"Thus, the product and its components become resources in a cradle-to-cradle way of thinking," Lisa Grice says.

Greening the textile industry

Ramboll has done a study for the Nordic Council of Ministers to examine what happens to used textiles collected for recycling. The study involved the first-ever mapping of used Nordic textiles, and investigated the effects of textile exports on the environment, waste management, employment and other aspects of the local economy in recipient countries.

Together with the International Solid Waste Association (ISWA), Ramboll has also helped the global clothing brand G-Star RAW to become more sustainable. In the project G-Star manufacturers and designers agreed to five future commitments, and waste managers supported these with five recommendations for manufacturers looking to join the circular economy. ■

BUILDING FOR THE FUTURE

Offsite construction, material reuse and alternative sources can help optimise and green the building industry.

By Michael Rothenborg

Productivity in the construction industry is lower than in the global economy as a whole – and the gap has widened since the financial crisis, according to The Economist and the McKinsey Global Institute.

However, it is possible to build more efficiently – and more sustainably. In London, for example, Ramboll uses components manufactured in a controlled, offsite environment to increase efficiency. The method has a number of advantages.

It significantly decreases construction times by enabling construction and engineering challenges to be addressed before construction starts. On some projects, this has shortened a 12-month construction programme by 2.5 months. Offsite manufacturing also reduces the number of workers at a construction site, because fewer activities are done onsite – which also reduces noise and minimises the impact of construction on the local area.

Another sustainability approach is to use materials like cross-laminated timber (CLT). At Dalston Works in Hackney, London, Ramboll has helped design the world's tallest and largest CLT building by volume. The lighter construction weight of CLT enables smaller foundations, a critical factor at the Dalston Works site, which has High Speed 1 and Crossrail tracks passing beneath it. Building with CLT has saved 2,400 tonnes of carbon – approximately 50% – compared to an equivalent residential block with a concrete frame.

Stabilising soft soil

Yet another approach is to reuse building materials. Ramboll has done this with success in several projects – at Katrinedalskolen (pictured), for example, a school on the outskirts of Copenhagen, where the reuse of bricks has lowered costs and reduced CO2 emissions by 70 tonnes.

Materials that cannot be reused in buildings might be used to prepare soil for their construction. A new technology (called UUMA2), developed by Ramboll in collaboration with Aalto University in Finland, is benefiting both the environment and the economy in Vietnam's capital, Hanoi, among other places. Soft ground has made some of the city's central areas uninhabitable, but using cement or ash instead of, say, natural rock resources as a binder can stabilise the soil and make it fit for development.

The full extent to which these approaches can improve efficiency and reduce consumption is impossible to quantify, but, according to the McKinsey report "A blueprint for addressing the global affordable housing challenge", reducing construction costs and unlocking land supply are the most efficient ways of narrowing the housing affordability gap. ■

WASTE: AN ESSENTIAL PART OF THE CIRCULAR ECONOMY

The Amager Bakke waste-to-energy plant in Copenhagen produces energy from waste, with extreme efficiency and a recreational touch.

By Michael Rothenborg

We are closing the loop of design, production, consumption, and waste management, thereby creating a green, circular and competitive Europe."

First Vice-President of the European Commission Frans Timmermans, who is responsible for sustainable development, made this statement earlier this year when the EC published its new guidance on the production of energy from waste as part of the EU Action Plan for the Circular Economy.

The EU guidance emphasises that "generating energy from waste that cannot be recycled or reused can contribute to a circular economy and energy diversification, thereby reducing greenhouse gas emissions from the waste sector".

The OECD estimates that about one-fifth of global material extraction becomes waste, and, according to the International Solid Waste Association (ISWA), 70% of global waste is still disposed of in landfills.

World-class energy efficiency

Ramboll works with clients to reduce waste generation, increase high-quality recycling and use residual waste for efficient and clean energy generation – and Ramboll's Energy from Waste division has projects in the UK, Switzerland and Singapore, among many other places.

Amager Bakke, right in the middle of Copenhagen, offers a good example of how waste incineration can deliver world-class energy efficiency. The plant can treat up to 560,000 tonnes of waste a year, thus supplying low-carbon electricity to 550,000 people and district heating to 140,000 households.

The plant, which is being built in collaboration with world-renowned architects BIG, has climbing walls and ski slopes. But its interior is equally innovative.

Amager Bakke cost-efficiently combines a high energy efficiency boiler with flue gas condensation technology. Consequently, the plant will recover practically all energy stored in the waste, and the net energy efficiency will probably be the world's highest for a waste-to-energy facility.

"It was important for us to have the best of the best with the know-how to control and construct a plant and a project of this size," explains CEO Dan Fredskov from the Amager Bakke ARC. "That's where Ramboll came into the picture." ■

HOW TO SAVE AN ENDANGERED FISH

Until a few years ago the production at a lot of Danish fish farms was damaging the populations of wild fish in the creeks. A large-scale, EU-financed rescue plan has improved the conditions – but there are still complex challenges to solve.

By Michael Rothenborg

The calculation was unusual and quite difficult too: hydraulic experts had to find the optimal meandering for the creek – but with a minimum amount of soil.

"Soil is very expensive to move, so we basically had to use what was already here," explains Ebbe Høy, the project manager from Vejen Municipality.

Vejen is one of the Danish municipalities obliged to protect the houting, a small, red-listed salmonid. The houting is the rarest freshwater fish in Denmark and, in fact, among the rarest in Northern Europe. The fish once thrived in most of southern Jutland and northern Germany, but fish farms and other industries put weirs and dams in the creeks as part of optimising their production.

This practice was far from environmentally responsible – and did particular harm to the houting, which does not swim as well as salmon or trout.

"The houting had no chance of ascending the creek and spawning on a stretch like this," says Ebbe Høy, pointing to the small creek, part of the Sneum River system in Glejbjerg, a village west of the town of Vejen.

The local fish farmer had changed the once meandering creek into a straight canal and, even more importantly, installed a weir that was impassable for fish and other aquatic fauna. As a result, houting and other salmonid species could not reach their spawning grounds upstream from the weir.

Precise calculations

The fish farm here in Glejbjerg is now closed, as are the vast majority of fish farms in this and other creeks in southern Jutland. In 1980 there were 29 in the Sneum River system; now there are only three. This is chiefly due to a large-scale rescue plan for the houting, a plan running for almost 20 years and financed in great part by the EU,

Ebbe Høy from Vejen Municipality is collaborating with Ramboll to improve the conditions for the endangered houting, a salmonid fish in the Sneum River system in Jutland, Denmark.

because the houting is a high-priority species.

The plan has been a success. Houting have been breeding further downstream for a couple of years, and this spring anglers have already reported seeing salmon and trout spawns upstream from Glejbjerg.

However, living conditions are not yet good enough for the houting, which is why Vejen Municipality needed experts to optimise the meandering of the creek.

"Ramboll did the calculations and determined that we could manage the meandering with the soil we already have here," Ebbe Høy says, pointing to the muddy banks of the creek. "This way the meandering makes both environmental and economic sense."

Water from pumps

The challenges in the Sneum River system are not over, though. Another tributary at Holsted still has an active fish farm, and Vejen Municipality and Ramboll are working on a solution that allows the fish farm to continue production – although with due consideration for the natural environment. The fish farm requires a large amount of water, but the stream must also be more stable and houting-friendly. One of the solutions being considered is the use of groundwater pumps.

Ramboll is also in the process of removing obstacles in Ansager, a side creek of the Varde River system and the northernmost habitat of the houting.

"There are still essential projects that have to be completed before the houting can enjoy good living conditions again in all of its habitats," says Peter Bønløkke, Market Manager at Ramboll. ■

A SCARCE RESOURCE IN SUNNY CALIFORNIA

An almost six-year drought has made California even more dependent on groundwater. Ramboll is using know-how and technology to help the California authorities map and manage this vital resource.

By Martin Zoffmann

California currently produces more than 80% of the world's almonds, and each little nut takes almost four litres of water to grow. All in all, the state uses more than four trillion litres annually for almond farming – that is one-fifth more than Californian families use at home.

The agro industry's production and consumption methods are in other words not exactly sustainable - especially when you consider that longer and more permanent droughts are forecast in the future.

In dry years the groundwater part of the state's total water supply increases from approximately 38% to 46% or more. Some communities rely entirely on groundwater for their drinking water, and it is a critical resource for many farmers in the Central Valley and Central Coast regions. California authorities are thus investigating ways of better mapping and utilising groundwater resources.

Ramboll has been engaged to help authorities reduce the risk of salty seawater's infiltrating fresh groundwater in a large area near Monterey Bay (pictured).

"The so-called saltwater intrusion occurs when underground aquifers have been overdrafted, and the pressure gradient pushes seawater inland and underground," says Max Halkjær, a Ramboll market manager and groundwater specialist.

Never had the technology

Ramboll is using its experience from mapping groundwater in places like Denmark to get a clearer picture of when and where to find the

fresh groundwater before it gets intermixed with saltwater.

Ramboll is collecting the data by using SkyTEM technology, which involves flying over an area with a helicopter carrying electromagnetic sensors that can scan the geological layers. Santa Cruz County Water Resources Planner Sierra Ryan describes this effort as a "key piece of the puzzle" in the ongoing work of charting the impact of water overuse in the area.

"Nobody's ever done this in California before. We've never had the technology," Sierra Ryan told the local news site the Santa Cruz Sentinel. "It has to be able to penetrate through the ocean. What we've done similar to this is that we drill wells, but we're not drilling monitoring wells offshore."

Ramboll is also part of a team helping the San Luis Obispo County Flood Control and Water Conservation District to characterise the hydrogeology and develop conceptual models of groundwater flow in five fringe areas within the Santa Maria Valley Groundwater Basin in Western California, between Los Angeles and San Francisco. The company is also talking to several other potential clients in California about securing a more sustainable water supply.

Collaboration on water technology

In September this year Ramboll's Max Halkjær was invited to California Governor Jerry Brown's office to give an inspirational presentation on "Integrated Data Management for Regional Groundwater Planning". Danish Minister for the Environment and Agriculture Esben Lunde Larsen was also present and signed a deal with Governor Brown on water collaboration. A range of companies and utilities in Denmark and the USA, including Ramboll, have formed the Water Technology Alliance (WTA) forum, whose main purpose is to share knowledge and develop new solutions to the water-related problems caused or worsened by climate change. ■

> "The so-called saltwater intrusion occurs when underground aquifers have been overdrafted.
>
> **Max Halkjær,**
> Market Manager, Ramboll

SCARCITY IN SWEDEN

Access to sufficient and safe drinking water can also be a challenge in countries like Sweden. In 2011 the microscopic parasite Cryptosporidium contaminated the water in Skellefteå, a town in northern Sweden, so for seven months its inhabitants had to boil their drinking water.

The municipality decided to replace the old, dilapidated waterworks with a new treatment plant – a project that is the largest of its kind in Sweden. The new setup, for which Ramboll is the lead consultant, includes artificial groundwater recharge followed by the three steps of oxidation, filtration and disinfection.

CLIMATE PROJECTS WITH ADDITIONAL BENEFITS

The cost of investing in climate projects is much less than doing nothing. But investments must be made through integrated masterplanning and cross-sector innovation.

By Michael Rothenborg

It is hard to find a list of global challenges from recognised organisations, intergovernmental bodies or think tanks where climate change is not in one of the top spots.

As a matter of fact, it is often at the very top. It certainly came first on the World Economic Forum's Global Shapers Survey from August 2017, which surveyed more than 25,000 millennials from 181 countries to gauge the priorities, concerns, and attitudes of young people around the world. 2017 was the third consecutive year that climate change was voted the most serious global issue.

The survey suggests that millennials are concerned not only about climate change in itself but also about the cost of climate mitigation and adaptation.

And their concern is justified, according to experts.

In 2015 the insurance market Lloyd's reported that the share of national GDP at risk from climate change-related incidents exceeds $1.5 trillion in the 301 major cities around the world. The OECD, the Stern Review from the London School of Economics and several other experts have concluded that investing in climate mitigation and adaptation is far cheaper than not investing at all.

Create more value

Executive Director of Ramboll Management Consulting Henrik Seiding agrees. But the investments must be done right:

"Cities, for example, are responsible for 70-75% of global CO2 emissions, and air pollution kills seven million people every year. But climate change and air pollution are not solved separately through silo initiatives. They are solved through urban leadership, integrated masterplanning and cross-sector innovation," Henrik Seiding emphasises.

He adds that, when it comes to both climate mitigation and adaptation, one needs expertise in a variety of disciplines to be able to see and paint the whole picture – and to deliver a 360-degree solution:

"When we invest in making our cities resilient to climate change, we must create additional value by, for example, making the local environment more attractive for citizens. Investments in city infrastructure can become value drivers rather than cost drivers if we take a holistic approach and base investment decisions on thorough analyses of the social and economic impacts," Henrik Seiding says. ■

STRONG FOUNDATION INITIATIVE

Ramboll has been invited to participate in a collaboration with R20 – Regions of Climate Action. The invitation came because Ramboll is a member of the German Renewable Energy Cluster Hamburg. The R20 initiative, founded by Arnold Schwarzenegger in 2010, is one of the side events at the COP23 in Bonn in November 2017. Ramboll is also participating in other business community events at the UN Climate Change Conference, where governments will convene to discuss the next steps after the 2015 Paris Agreement.

REDUCING CO2 FROM FOSSIL FUELS

Ramboll has several projects that reduce the carbon footprint from the extraction of fossil fuels. One such example is an assessment for the Norwegian authorities on decreasing CO2 emissions from the Gjøa Semi platform in the Norwegian Continental Shelf (NCS). This includes identifying the technical feasibility for recovering gas from the LP flare and atmospheric vent system on Gjøa Semi.

Since 2010, Gjøa Semi has worked with modern technology to recover gas from the on-board processing facilities, such as the so-called 'closed flare', which recovers larger volumes of gas, as well as an LP flare/closed drain system and cold ventilation that release smaller volumes of CO2 from low pressure systems.

The project is part of Norway's initiative to reduce emissions corresponding to 2.5 million tonnes of CO2 per annum by 2030.

STRONG TAILWIND FOR RENEWABLES

Even countries that have access to an abundance of fossil fuels are turning to the cheaper wind energy. China and Norway are two of the most notable examples.

By Michael Rothenborg

The renewable energy industry is experiencing an unprecedented tailwind. As the Financial Times put it in an analysis earlier in 2017: "After years of hype and false starts, the shift to clean power has begun to accelerate at a pace that has taken the most experienced experts by surprise."

The shift has come as innovation in the private sector and increased government efforts to curb climate change and smog have driven down costs and spurred technical advances.

One of the strongest single factors in this transition is that wind and solar parks are being built at unprecedented rates – also in countries that were previously very much into fossil fuels.

Offshore export to China

The global leader of this trend is the world's biggest polluter, China, whose wind power market is growing fast. According to the Global Wind Energy Council, last year China had a market share of 43% of new-installed wind capacity, and the expansive growth is now happening at sea too.

China plans to install 10 gigawatts of offshore wind energy before the end of 2020, and in 2016 Ramboll became the first non-Chinese advisor to design a large part of an offshore wind farm - namely the 100 turbines SPIC Binhai North Phase 2 Offshore Wind Farm in the Jiangsu province. This year the collaboration continues with the foundations for the SPIC Binhai South H3 offshore wind farm in the Yellow Sea north of Shanghai.

An important reason for this is that Ramboll has a market share of more than 65% of offshore wind foundations installed worldwide. The so-called suction bucket foundation, in particular, has a bearing capacity capable of supporting turbines even in weak seabed soils – as is the case for Binhai North, which will be located 22 km off the coast in an area prone to earthquakes and very soft soil conditions. The suction buckets enable the structures to resist external loads such as strong currents, collisions and harsh weather.

Largest onshore farm in Europe

Norway is another country with access to an abundance of fossil fuels. Here, too, you can feel the wind of change.

On the Fosen peninsula about 50 km north of Trondheim in Norway, Fosen Vind is the largest onshore wind project in Europe and is highly competitive in terms of energy costs.

Including the central grid connection, the total investment will be in the range of NOK 20 billion, making it one of the largest investments ever made in land-based sectors of Norway. When finished, the wind turbines in the Fosen Vind project will generate enough electricity to power 170,000 households.

Ramboll's scope of responsibility includes hundreds of kilometres of electric cables, 62 kilometres of roads, geotechnical engineering as well as landscape and environmental issues in the highly complex terrain.

"The project involves complicated access roads to get the turbines up on the mountains – and 80 hard stands and concrete foundations. Rough climate conditions throughout the year represent an added challenge," states Per Halvor Bekkelund, Lead Consultant, Ramboll.

In August 2016, Ramboll acquired two German advisory companies in onshore wind energy, and became one of the leading wind advisors globally.

These foundations, developed by Ramboll for its Oil & Gas division, have made Ramboll a market leader in offshore wind foundations.

GREENING TRANSPORT

By Michael Rothenborg

One of the toughest challenges of climate mitigation is greening energy for transport. The big revolution in this field is electrification, which will enable all transport to be fully powered by renewables instead of oil. However, this is unlikely to happen in all countries and sectors anytime soon, and two studies now provide guidance on greening transport in areas where electrification is a less feasible option.

Ramboll is carrying out a study for Norsk Gassforum – a collaboration between 12 regional authorities aimed at promoting the use of natural gas, biogas and hydrogen in Norway – to investigate the feasibility of using biogas on the railroad systems that still run on diesel. This is, for example, the case with Norway's longest railroad, the 700-km Nordlandsbanen.

Converting these railroads to electricity would require massive investments and take a long time. Biogas, on the other hand, can be gradually introduced in a relatively short time and is also able to deliver large CO2 reductions.

Biofuel for airplanes offers another promising example. In a report Ramboll estimates that, by 2030, up to 30% of all aviation fuel loaded at Avinor's airports can be sustainable – if public incentives are put in place.

Avinor operates most of the civil airports in Norway, and its CEO, Dag Falk-Petersen, was positive about the project when the results were presented. He noted that investments in sustainable biofuels would also create new businesses and jobs.

Biofuel

A biofuel is a fuel that is produced through contemporary biological processes, such as agriculture and anaerobic digestion.

Biogas is a type of biofuel – a gas produced by the anaerobic digestion or fermentation of organic matter.

WATER WILL FIND ITS WAY

Technical excellence + blue-green infrastructure = cost-efficient climate adaptation.

By Michael Rothenborg and Martin Zoffmann

Climate change is bringing stronger cloudbursts, storms and hurricanes throughout the world, and effective adaptation is rarely cheap. But climate projects can be more cost-efficient – especially if they combine technical excellence with so-called blue-green infrastructure (BGI), a network that provides the 'ingredients' for solving urban and climatic challenges by building with nature. Ramboll has used this formula on many projects around the world – from Copenhagen and other Nordic capitals to megacities like Singapore and New York.

And projects are also well underway in two other American cities.

In Washington, DC, the Department of Energy and Environment is assessing the potential effect of flooding from the Potomac River in the face of rising sea levels and storm surges, as well as the impact of extreme rainfall.

Ramboll used advanced hydraulic modelling to illustrate how the level of resiliency planned for storm surges and a rise in sea level will only reduce future flooding to a limited extent.

"We are now conducting a cost-benefit analysis of the protection level currently proposed and the higher protection level recommended, to show the value of increasing the present resilience, not only in terms of lower risks but also in terms of added value," says Ramboll Project Manager Trine Munk.

The riverine protection measures proposed are a mix of grey infrastructure and BGI. The added value includes an extension of the existing Riverwalk Trail, additional green space, a living shoreline concept and better access (pictured).

Approval from external experts

The BGI approach includes using streets to convey stormwater and thus direct runoff to areas like parks and plazas, where the water can be

INSUFFICIENT INSURANCE

In the wake of the hurricanes that struck the USA this autumn, it became apparent that many Americans are inadequately insured against extreme weather – not least because the incentives are insufficient.

Insurance and damage prevention in the EU are also far from optimal, shows a new study that Ramboll and the Institute for Environmental Studies at Vrije Universiteit, Amsterdam, have developed for the European Commission.

Some of the main problems are that EU countries perform poorly when it comes to providing incentives for signalling or reducing risk, and households either fail to fully acknowledge the benefits of extreme weather insurance or are unwilling to pay the current premium rates.

Source: Insurance of weather and climate-related disaster risk. Ramboll et al. July 2017.

detained or retained. BGI is effective in improving water quality during everyday rain events and helps control the flooding of carefully selected detention areas during extreme rain events, including potential flooding caused by hurricanes.

In 2016 BGI received approval from independent experts at the National University of Singapore, Zeppelin University in Germany, Harvard University's Graduate School of Design and the Massachusetts Institute of Technology (MIT). The experts delivered input to a study spearheaded by Ramboll's Liveable Cities Lab, which revealed the multiple, interrelated benefits that often make BGI cost-efficient.

Pethmano Phannavong, a flood risk manager from Washington, DC, values the input that Ramboll and the City of Copenhagen have given on the Potomac River project:

"It is this kind of collaboration that is needed to make our cities more resilient," says Pethmano Phannavong.

Stormwater in Miami

Miami-Dade County is also looking for cost-effective approaches to stormwater management. In a challenge for ideas Ramboll's Liveable Cities Lab successfully proposed combining BGI with partner FocalPoint's biofiltration technology, which utilises physical, chemical and biological mechanisms of soil, plant and microbe complex to remove pollutants typically found in urban stormwater runoff.

Jim Murley, Chief Resilience Officer at Miami-Dade's Regulatory and Economic Resources Department, says:

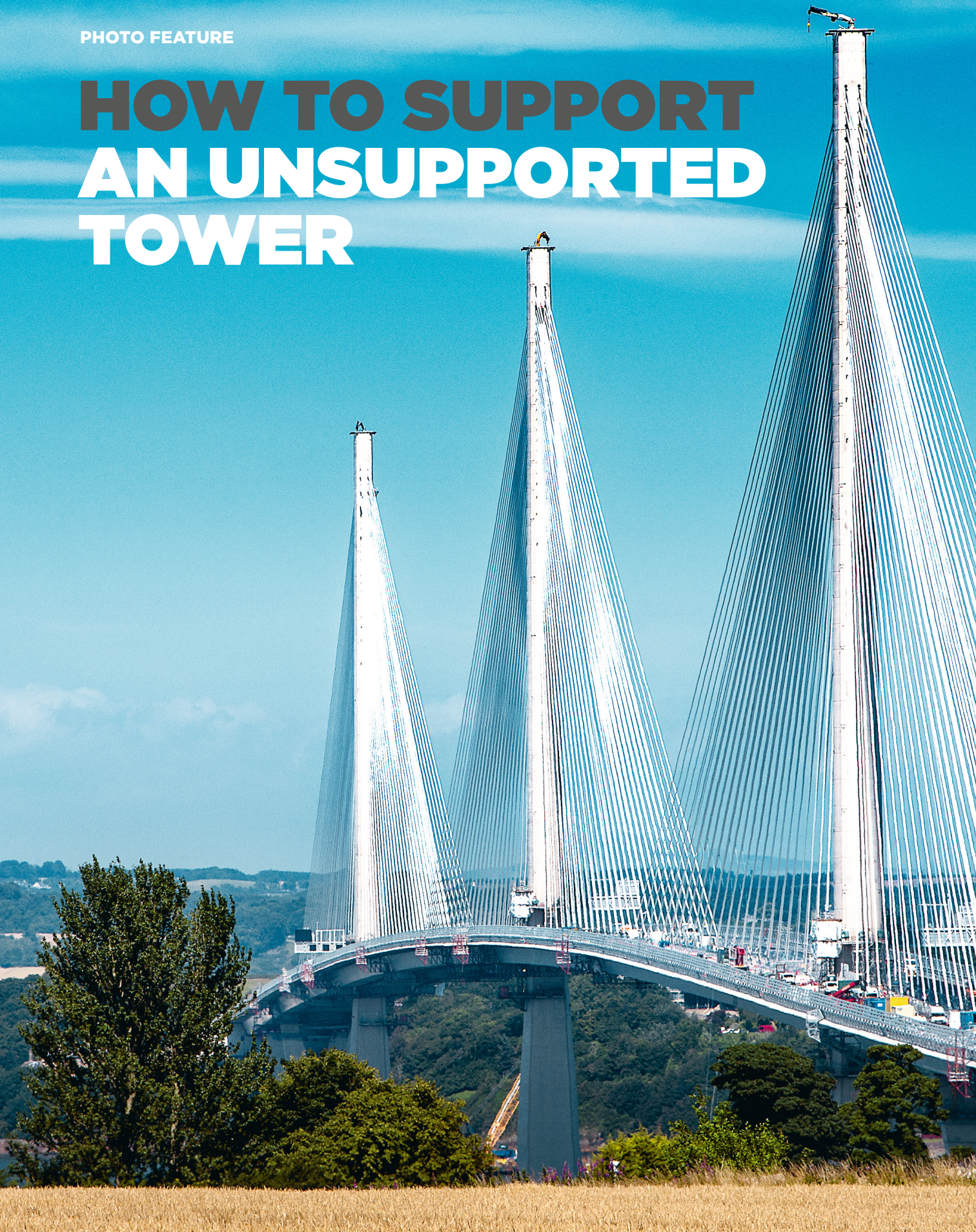
"We were particularly impressed with the proposal's emphasis on innovative ways to manage stormwater with blue-green infrastructure."

"Similarly, we appreciate the emphasis on cost-effectiveness, as this is an essential component of any approach." ■

> "It is this kind of collaboration that is needed to make our cities more resilient.
>
> **Pethmano Phannavong,**
> Flood Risk Manager, Washington, DC

PHOTO FEATURE

HOW TO SUPPORT AN UNSUPPORTED TOWER



How do you make the world's longest three-tower cable-stayed bridge elegant and sturdy? By designing an innovative, world-class cable solution.

By Andrew Somerville

The spectacular Queensferry Crossing in Scotland represents the pinnacle of bridge design and technical expertise.

At its centre is a unique cable design that allows the bridge deck to be lighter and its three supporting towers to be more slender and needle-like. The northern and southern towers of the bridge are supported by cables that reach back to the bridge's approach viaducts. However, the central tower stands unsupported, so a major challenge for engineers was to ensure its stability.

The solution was a clever system of ten overlapping cables that provide extra support for the deck sections on either side of the central tower.

By stiffening these segments with extra cables, the entire deck is stiffened sufficiently to stabilise the central tower. This also allows the deck to be lighter and the three supporting towers to have the same slender profile, significantly enhancing the bridge's visual impact.

One aspect which will not cause much of an impact is maintenance – closure and delays as a result of ongoing repairs are usually the bane of bridge users.

"The Queensferry Crossing has a unique solution to that too," explains Design Joint Venture Project Director Peter Curran from Ramboll UK. "The cables can be replaced strand by strand so that the bridge remains operational during any replacement process – a vital feature for such a major transport artery."

Speaking at the opening of the bridge, Scottish Council for Development and Industry Chief Executive, Mark Bevan said that "everyone involved in the opening of this majestic addition to the bridges over the Forth should be proud of their achievement." ■

CABLES TO STAY THE DISTANCE

- Length of the bridge: 2,638 metres
- Length of cable-stay section: 2,090 metres
- Two main deck spans: 650 metres
- Number of cable stays: 288 – ranging in length from 94 to 420 metres
- Amount of cabling: 37,000 kilometres of cabling – nearly enough to span the circumference of the Earth

EXPERT COLUMN

EXPERIENCE A BUILDING BEFORE YOU BUILD IT

The pace of digitalisation is transforming our industry but not necessarily in ways you would imagine.

By Bo Grave, Director of Digital Innovation and
Hussain Parsianfar, Senior Consultant, Knowledge & Innovation

Ramboll has not been slow to embrace digitalisation. BIM (Building Information Modelling), 3D scanning, and VDC (Virtual Design and Construction) and other advanced computer-aided design techniques are already widely used on countless projects.

But digitalisation is also changing the way we work and the service we offer our clients.

It is increasing productivity and efficiency, allowing us to streamline our working processes and help save time and costs. This makes it easier to adjust or alter details during the project, or even be more experimental in the design phase.

We are also able to rethink the services that we provide our clients. For example, BIM not only allows us to visualise a building but also means that we can help the client experience how it will appear in reality – from the interior design to the placement of internal elements. Such precision allows us to be much better at learning exactly what clients expect and what we can deliver, thus minimising the potential for misunderstandings and reducing the number of costly alterations. With client feedback, we can continually refine the design in a much more agile and flexible way.

And it allows us to redesign our services. New business opportunities are arising out of digitalisation, and it is important that we are prepared. An example of this could be the use of mobile phone data to improve traffic flow; by learning how people move around a city, we can control transport infrastructure such as traffic lights more effectively.

An agile and collaborative process

One particular project where we are utilising the latest digital technology is in Norway, where together with Sweco, we are helping to build 75 kilometres of double rail track north of Oslo for Bane NOR, a state-owned company responsible for the Norwegian national railway infrastructure.

The IC Dovrebanen project involves not just the innovative use of BIM and 3D scanning, but also an extensive agile project management system. Instead of the usual sequential process where a project moves forward a step at a time, this project adapts the so-called scrum method. This is an agile software framework for managing projects made up of a self-organising team that can quickly adapt to any changes that arise and is better placed to respond to any unpredictability. Put simply, the scrum method is perfect for reacting to the needs of clients if and when they change their minds during the project.

Transparency is also a central element of the project, with all data available to all stakeholders – including the client, contractor, architects, engineers and project managers. This improves dialogue, and streamlines the work flow while dividing such a complex project into more manageable pieces – a vital component, as the project involves professionals from over 50 different disciplines. ■

WE CRACKED IT!

Building the world's tallest residential tower throws up a number of serious challenges – particularity when the building's façade needs to be functional, elegant and able to withstand extreme winds.

By Andrew Somerville

The SRG tower in Dubai takes residential high-rises to the next level – the 94th floor to be precise.

Ramboll has been closely involved in the design of the unique façade of the tower, using extensive engineering analysis and wind and structural studies, and drawing on both structural engineering and façade design.

According to Abdulmajid Karanouh, Director and Head of Innovation Design, Facades & Sustainability at Ramboll, the main challenge in designing the façade was to accommodate the exceptionally small site of the building.

"The building has a very tight square footprint of 32 by 32 metres," he says. "Yet it is 440 metres tall – which makes it very challenging to design an efficient structure and façade that can cope with very high wind speeds and building movements without ending up with oversized elements that eat up large chunks of the built-up floor area."

To cope with this, the superstructure of the building is an elongated diagonal grid that is angled in such a way as to translate building loads to the ground while countering wind forces and potential seismic movements. "The geometry of the building," says Abdulmajid, "had to be sculptured in a way to allow it to breathe where air can infiltrate it at certain intervals – therefore open sky-gardens the height of two floors were introduced every ninety metres exactly above where every mechanical floor is located."

No detail has been spared in the quest for efficient and functional design, even at the very top of the tower. "Two wind turbines within the building's crown generate renewable energy, which is in return fed back into the building grid," says Abdulmajid. "The crown was also designed to enable air infiltration to ease the wind pressure and to create a wind corridor to spin the wind turbines effectively."

Another key sustainable feature is a system of photovoltaics (PV or solar cells) incorporated into the façade.

The SRG tower is expected to be completed by 2022. ■