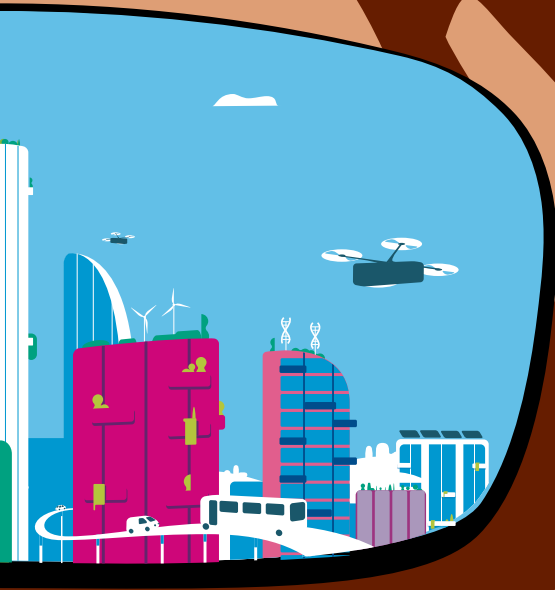



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# INNOVATION FOR A SUSTAINABLE WORLD

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FROM THE "MEDIA"  
RUBRIC ON  
WWW.VINCI.COM

### **About VINCI**

VINCI is a global player in concessions and contracting, employing almost 195,000 people in some 100 countries. We design, finance, build and operate infrastructure and facilities that help improve daily life and mobility for all. Because we believe in all-round performance, above and beyond economic and financial results, we are committed to operating in an environmentally and socially responsible manner. And because our projects are in the public interest, we consider that reaching out to all our stakeholders and engaging in dialogue with them is essential in the conduct of our business activities. VINCI's goal is to build long-term value in this way for its customers, shareholders, employees and partners, and for society at large.

# 1



JUNE 2018

# INNOVATION FOR A SUSTAINABLE WORLD



## **INNOVATION FOR A SUSTAINABLE WORLD**

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# PART 1

# BUILDING MORE SUSTAINABLE CITIES

More buildings are springing up than ever before around the world! Because humankind is converging on cities...

According to United Nations forecasts, the world's urban spaces will triple in size between 2000 and 2030. By then, two in three people will live in cities... The need for housing, business facilities, water supplies, power grids and transport networks is enormous.

The climate emergency is making us think again about everything we thought we knew. Power generation and energy storage mechanisms and the way we use electricity in homes, offices and industry are changing radically. Flows are changing shape and becoming increasingly complex.

The digital revolution has started and the technological shifts it is setting in motion are gradually reshaping every aspect of our daily lives, essentially altering the way we relate to time, the way we work and what we do the rest of the time. This revolution, in turn, is generating huge demand for new infrastructure to harvest, transport, store and process information, to give people more control over the changes unfolding around them.

And all these challenges are concentrating in cities. So the only option for cities is to be more sustainable, in every way: they need to be denser, more frugal, smarter and people-friendlier. And the entire mobility landscape needs to undergo deep-reaching transformation.

Sustainable cities are not just a big issue for future generations: they are brimming with fantastic challenges and breathtaking opportunities for VINCI's 195,000 people to innovate today.

## SUSTAINABLE CITIES WILL BE **DENSER**

The challenge, in a nutshell, is to support urban development, contain sprawl and keep cities pleasant. And the answer for all the above is higher density.

So far, the default direction for cities to grow has been up. Electricity and lifts started this trend and it won't be slowing down any time soon.

Still, that hasn't stopped urban areas from becoming increasingly crowded and land becoming extremely scarce.

So it makes sense to ask if up is really the only way to go.

Or, in other words, why can't we use space below ground for more than pipes, wires and subway trains? Why can't we build cities beneath cities instead of just above them? French architect Dominique Perrault makes a compelling case for "groundscapes", which can be brimming with life and buzzing with activity – and anything but places we would associate with "darkness and discomfort."

**60%**

OF THE WORLD  
POPULATION  
WILL PROBABLY  
LIVE IN CITIES  
IN 2030.

*Source: United Nations,  
Commission on Population  
and Development, 2018.*



## SUSTAINABLE CITIES WILL BE MORE FRUGAL

The other big question is how cities can consume less energy and accommodate more people at the same time. Part of the answer involves revamping construction methods and redesigning power networks (to limit losses, mainly). But solving this conundrum will take a paradigm shift, too: roads, buildings and other infrastructure and facilities that consume energy today – or in the best of cases function “passively” – will be able to produce energy. The circular economy, which is gaining traction today and will be growing stronger as time goes by, is about more than reusing and recycling resources: it is ushering in new business, social and cultural models. Miniaturisation and digitalisation are opening the door to new sources of energy and fast-tracking microgrid development in cities. These local grids will balance production and consumption in real time in neighbourhoods, enabling the people in them to manage and share power. And cities could plausibly build self-sufficient energy systems.

## SUSTAINABLE CITIES WILL BE GREENER

Denser cities mean less urban sprawl and therefore less harm to biodiversity skirting urban areas. But there’s a more exciting question we can ask: can cities actively foster biodiversity? Sustainable cities will do more than assess their impacts on biodiversity: they will opt for large-scale development of green roofs and walls, or set aside more space for urban agriculture.

## SUSTAINABLE CITIES WILL NEED TO REINVENT MOBILITY

As cities become denser, more virtuous alternatives to private cars will gradually take over. There are usually plenty of options if you have to travel less than 10 kilometres (cycling or public transport, for instance) or more than 100 kilometres (motorways, intercity expressways, trains and planes). But not for everyday trips between 10 and 100 kilometres, so private cars are still used 80% of the time on these routes. To solve this,

# 41%

OF THE ELECTRICITY  
CITIES CONSUME  
GOES TO PUBLIC  
LIGHTING.

Source: Ademe (the French  
Environment and Energy  
Management Agency).



# 27%

OF FRENCH PEOPLE  
HAVE CARPOOLED  
TO WORK.

Source: VINCI Autoroutes,  
2017.





cities will need to rearrange their public transport services and create new routes. The new Grand Paris Express programme (now under construction) and bus rapid transit (BRT) systems are two of the answers. Carpooling and intermodal travel (using more than one means of transport for one journey) will also make cities more sustainable. And sustainable cities will need to tackle the last-kilometre parcel-delivery transport and logistics challenge to ease congestion.

Lastly, autonomous vehicles are bound to rearrange cities. This entirely new mobility option will mainstream carpooling and owning a private vehicle may well become a thing of the past. But for all that to happen, cities need suitable and smart road infrastructure.

## **SUSTAINABLE CITIES WILL NEED TO HARNESS THE DIGITAL REVOLUTION'S FULL POTENTIAL**

Densifying cities, energy transition, climate transition and mobility are only a few of the challenges that would be impossible to tackle without digital technology and artificial intelligence. Digital technology will therefore be ubiquitous in sustainable cities.

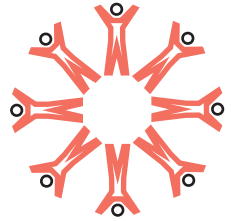
In the construction industry, Building Information Modelling (BIM) will be the new normal. BIM tools create 3D models of facilities and infrastructure on digital platforms, which the people designing, building and maintaining those facilities and infrastructure share. The extensive use of BIM is radically optimising design, construction and maintenance work today, and will be improving products, enhancing services, slashing costs and saving a lot of time going forward.

Artificial intelligence is being used in more and more areas of our daily lives. Automation and big data processing are no doubt the real revolution we will see this century. AI, however, will only support sustainable development if we feed it smart data – meaning relevant data at the right time.

# 72%

OF FRENCH PEOPLE BELIEVE THAT INNOVATIONS IN MOBILITY OVER THE NEXT 15 YEARS WILL IMPROVE THEIR DAILY LIVES.

*Source: An Ipsos/BGC survey for ASFA (the association of French motorway companies), 2017.*



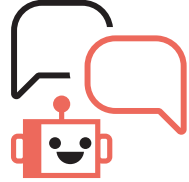
Automation 4.0 and robotics will also become essential. Robots will do more than repetitive tasks and won't necessarily be confined to production plants: they will be moving into businesses and the world of work in general, and into homes to provide a whole new array of services.

And new technologies are also upending customer relationships by opening the door to new services, which are in turn reshaping our lifestyles and ushering in new consumption patterns. Developments in digital technology will turn yesteryear's passive infrastructure into living and communicating systems, and bring about new and ever more valuable experiences for customers and users.

**20 to 25%**

OF GROWTH  
A YEAR IN THE  
SERVICE ROBOTICS  
MARKET  
(\$5.2 BILLION  
IN 2017).

*Source: IFR, 2017.*



**VINCI IS LEVERAGING THE  
BREAKTHROUGHS THAT  
ITS BUSINESS LINES ARE  
DEVELOPING DAY AFTER DAY  
TO TEST SOLUTIONS AND  
SERVICES THAT PROVIDE  
GLIMPSES INTO THE FUTURE.  
BECAUSE WE DESIGN, BUILD,  
OPERATE AND INVEST IN THE  
PUBLIC INTEREST, WE ARE  
RISING TO THE CHALLENGES  
ON THE ROAD TO SUSTAINABLE  
CITIES AND INVENTING THE  
WORLD OF TOMORROW TODAY.**

# PART 2

# VINCI AND INNOVATION: AN ECOSYSTEM IN ACTION

One of VINCI's distinctive features is its very decentralised organisation: we have over 3,000 interconnected business units in five large business lines. Our innovation drive mirrors this pioneering organisation.

At VINCI, we have an abundant spring of innovative ideas, and a structure to channel them. We look at people's real needs to spark and steer creativity in each of our entities, and we upgrade our technical solutions and methods based on the customer benefits they can enhance. And we give this bottom-up innovation drive a boost every two years with the VINCI Innovation Awards, a competition every Group employee is welcome to enter.

Sustainable cities are also fascinating because they are generating a practically endless stream of challenges – cutting across energy transition, mobility revolution and biodiversity, to list only three. The conventional solutions to those problems have stopped working. To find new ones, we need to harness all our creative energy Group-wide, enlisting every VINCI business line and our full constellation of startups, research centres and other partners.

That's what we're doing at Leonard: exploring the cities and infrastructure of the future and thinking about how VINCI's fields of expertise need to evolve to cater to them. Leonard, in essence, is pooling intelligence in a variety of fields to fast-track innovation. It is tapping into Group-wide synergies to tackle Group-wide issues. It has also set up foresight working groups to identify growth opportunities and anticipate developments in our markets and fields of expertise over the next five to ten years, i.e. where short and long term overlap (our Contracting companies typically work to quarterly timeframes whereas our Concession contracts can last decades).

Leonard is rounding out an ecosystem that already encompasses the VINCI-ParisTech Chair in Eco-design of building complexes and infrastructure (which we set up with three ParisTech schools), the Fabrique de la Cité (City Factory) think tank, the VINCI Innovation Awards and an array of initiatives within Group companies.

# VINCI AND INNOVATION

## An ecosystem in action

### VINCI Construction

R&D incubator, startup and research partnerships, etc.

### RÊVE DE SCÈNES URBAINES

Testing new approaches to designing and managing cities in real-life situations.



### LEONARD

VINCI's foresight and innovation programme.



### VINCI Autoroutes

The Digital Factory, Cyclope, etc.



### VINCI-PARISTECH CHAIR IN ECO-DESIGN OF BUILDING AND INFRASTRUCTURE COMPLEXES

A scientific research partnership for more sustainable cities.

### **VINCI Immobilier**

Vivacity.



### **THE FABRIQUE DE LA CITÉ**

A think tank shedding light on urban transformation.

### **Eurovia**

Next Move, Eureka!, partnerships, hackathons, etc.



### **VINCI INNOVATION AWARDS**

Encouraging employees' initiatives

### **VINCI Concessions**

Smart infrastructure, open innovation, etc.

### **VINCI Energies**

La Factory; Inerbiz and Energize (managerial and investment funds), etc.

## LEONARD VINCI's foresight and innovation programme

Leonard, the latest addition to VINCI's ecosystem, is a programme channelling foresight and innovation to fuel the Group's development. As its name suggests, it is all about creating, learning and experimenting. Its mandate is simple – to invent the future of the Group's fields of expertise – and it is fulfilling it in three steps.

**First, watching all the emerging trends** in all VINCI's business lines and markets, then sharing its findings on a regular basis with the Group's employees, customers and partners on its website (<https://leonard.vinci.com>) and at a variety of public events.

**Second, bringing the future into focus.** People from all VINCI business lines meet for regular working group meetings to discuss medium-term issues. They zero in on opportunities to boost the Group's expertise and streamline its organisation, and on new growth opportunities five to ten years down the road. The working groups exploring five of the six main issues are chaired by VINCI Executive Committee members:

- Autonomous and connected mobility: what place for infrastructure? (Chair: Pierre Anjolras, VINCI executive committee member, Chairman of Eurovia);
- Climate resilience: designing, building and operating resilient cities and infrastructure (Chair: Jérôme Stubler, VINCI executive committee member, Chairman of VINCI Construction);
- Building Information Modelling, Building Operating Systems: digitalisation of the construction value chain (Chair: Richard Francioli, VINCI executive committee member, Executive Vice-President, VINCI, in charge of Contracting);
- New forms of work: rethinking management (Chair: Franck Mougin, VINCI executive committee member, Vice-President, Human Resources and Sustainable Development, VINCI);
- How the as-a-service shift can reshape our Contracting and Concessions activities (Chair: Nicolas Notebaert, VINCI executive committee member, Chief Executive Officer, VINCI Concessions);



EXPLORING,  
REACHING OUT AND  
ENTREPRENEURSHIP:  
VINCI IS INVENTING  
THE FUTURE OF ITS  
FIELDS OF EXPERTISE  
WITH LEONARD.



- Artificial intelligence: the new value propositions for Contracting and Concessions (Chair: Olivier Genelot, Brand Managing Director, Axians at VINCI Energies).

**And third, the most operational step: developing incubation and acceleration programmes** for innovative projects addressing cross-business challenges, tendered by startups as well as VINCI employees (Leonard also encourages and coaches intrapreneurs in the Group).

Eleven projects entered the incubation phase in the first contingent, five of them moved on to the acceleration phase in March 2018, and three others are receiving tailored support. These projects are exploring a wide variety of topics ranging from climate resilience to additive manufacturing and on to worksite waste recycling, digitalising buildings and construction processes, human resources, communal living and energy transition.

In February 2018, the selection committee reviewed the 91 submissions for the second contingent and chose nine of them. They moved into the incubator in March to receive tailored support and intrapreneurs will spend 20% of their working time over the coming four months turning their ideas into projects.

Leonard:Paris, in the heart of Arc of Innovation (a short walk from Gare de Lyon), is an all-new venue for creativity and networking. It opened in June 2018 and also houses the Fabrique de la Cité, the VINCI-ParisTech Chair in Eco-design of building complexes and infrastructure, and the Fondation d'entreprises VINCI pour la Cité. All VINCI business lines helped build this forum, which is open to everyone.

# THE VINCI-PARISTECH CHAIR IN ECO-DESIGN OF BUILDING COMPLEXES AND INFRASTRUCTURE

## A scientific research partnership for more sustainable cities

This partnership between VINCI and three ParisTech Graduate Schools of Engineering covering a spectrum of complementary disciplines – Mines ParisTech, École des Ponts ParisTech and AgroParisTech – dates back to 2008 and is in a class of its own on several counts.

VINCI companies work with the chair’s researchers and provide them with testing grounds to source a wealth of data.

This chair essentially channels multidisciplinary scientific research findings to all the city’s stakeholders, so they can factor environmental issues into their urban development decisions.

It is focusing on three research areas: assessing the environmental quality of buildings and neighbourhoods, analysing transport infrastructure’s life cycles and impacts, and equipping and regulating buildings and transport infrastructure.

The research into transport infrastructure’s life cycles has led to five projects revolving around public transport, inner-city flows and environmental impacts. The teams looking at equipping buildings and transport infrastructure are focusing on energy management and car park eco-design in urban areas.

**The Chair’s research has produced several novel and very practical tools** used at VINCI, including Biodi(V)strict (to direct decisions on blending biodiversity into urban settings), NovaEquer (to analyse a building’s life cycle by assessing its environmental impacts from design to demolition) and ParkCap (to ease traffic congestion by optimising parking capacity).



VINCI-PARIS TECH’S  
ECO-DESIGN CHAIR  
IS A FORUM FOR  
CONVERSATIONS  
BETWEEN  
RESEARCHERS  
AND STAKEHOLDERS  
IN CITIES.

## THE FABRIQUE DE LA CITÉ

### A forward-looking think tank shedding light on innovation in cities

VINCI set up this think tank in 2010 to provide a forum for interdisciplinary conversations about the future of cities and innovation in France and around the world. It gathers stakeholders – businesses, government agencies, scientific labs and non-profits – to discuss best practices in urban development and present novel ways of building and rebuilding cities. This think tank's five main focus areas are mobility, urban development and buildings, energy, the digital revolution, and evolving lifestyles. The topics it is currently zooming in on include financing infrastructure and urban regeneration, urban resilience, the stations of the future, affordable housing, electric mobility and urban form. In 2018, it is also hosting workshops throughout France to talk about everyday medium-distance travel.

The Fabrique de la Cité's three-day annual seminar will take place in Vienna in 2018. It will provide opportunities for experts and stakeholders in the transitions that are reshaping urban areas today to discuss quality of life in cities.

This think tank has been awarded endowment-fund status, serves the general interest and publishes all its findings on its website, [www.thecityfactory.com](http://www.thecityfactory.com)

## RÊVE DE SCÈNES URBAINES

### A real-life lab

Besides spurring scientific research through the VINCI-ParisTech Chair in Eco-design of building complexes and infrastructure and engaging in in-depth conversations at the Fabrique de la Cité, VINCI has set up a life-size industrial demonstrator for sustainable cities, Rêve de Scènes Urbaines (Dream of urban scenes). This project was our response to a call for proposals by the French ministry of ecology, sustainable development and energy in 2015.

The theme we have chosen for this demonstrator is "the city over the city". We see the project, located in Plaine Commune (an industrial suburb north of Paris), as an opportunity to test brownfield solutions aimed at furthering the transition towards more sustainable cities.

We are working in partnership with other businesses, government agencies and Plaine Commune authorities, and the goal is to pool expertise and devise new approaches to designing and managing cities together.



THE FABRIQUE DE LA CITÉ IS SHARING ITS INSIGHTS TO FUEL DEBATE ABOUT INNOVATION IN CITIES AND SHOWCASING PIONEERING INITIATIVES ON THIS FRONT.



RÊVE DE SCÈNES URBAINES HAS RALLIED A VARIETY OF STAKEHOLDERS AROUND A COLLABORATIVE INNOVATION DRIVE WITH PUBLIC AUTHORITIES IN PLAINE COMMUNE, AN INDUSTRIAL SUBURB NORTH OF PARIS.

The French government will be working on this project for five years, during which partners will be submitting innovative projects and Plaine Commune will be short-listing about 50 of them each year. The selected projects will be reviewed to fine-tune their business and financial models, and any pending technical or regulatory issues will be resolved. This demonstrator has 20 up-and-running projects today including:

- Cool islands, combining various approaches to shrink urban heat islands (VINCI Immobilier and Eurovia with Veolia, Lafarge and Artelia);

- BIM protocol (Building Information Modelling), to design and test the full series of contracts from construction engineering to building delivery, in real-life conditions, using BIM (GTM Bâtiment with Philia);

- Digital models for infrastructure: the first step to optimise roadworks (GTM Bâtiment, VINCI Construction and VINCI Immobilier);

- Wind-powered noise barriers (Eurovia with Techsafe Industries, Enedis and Fluidyn);

- Micro smart grids: a textbook case for energy optimisation, which involves interlinking buildings with complementary consumption profiles (VINCI Energies with Enedis).

Government representatives from several countries have visited this demonstrator, and local authorities from a dozen French communities have expressed interest in applying its findings in their areas.

## VINCI INNOVATION AWARDS

### Rewarding resourcefulness

At VINCI, we believe that everyone has what it takes to innovate – and has a duty to do so. The Group started rewarding innovation back in 2001 to encourage people everywhere in the hierarchy to come up with new ideas and to put their pioneering initiatives in the spotlight.

The VINCI Innovation Awards competition takes place every two years. About 5,000 employees take part and it has become one of the Group's highlights.

The 2017 campaign attracted 1,874 submissions, with 150 winning regional prizes and moving on to the final stage. Some 15 projects won prizes at the final ceremony. The Grand Prix went to Eurovia for a less volatile, more biodegradable, refuse-derived flux it developed in partnership with Solvay, and all Group business lines won prizes in at least one category.



GROUP EMPLOYEES  
SUBMITTED ALMOST  
2,000 PROJECTS  
AT THE LATEST VINCI  
INNOVATION AWARDS  
COMPETITION.

# STIMULATING INNOVATION IN BUSINESS LINES

Besides working on those Group-level initiatives, all our business lines have plenty of latitude to develop any programmes that will stimulate innovation within their scopes of expertise and meet demand in their markets.

## **Innovation at VINCI Autoroutes is geared to connected mobility**

VINCI Autoroutes set up its Digital Factory in April 2017 to address its increasingly connected customers' evolving habits, wants and needs. Its digital technology specialists and motorway professionals are tapping into expertise and ideas from VINCI Autoroutes teams to create new digital services that will enhance mobility, and their ultimate goal is to connect their 40 million customers.

VINCI Autoroutes is inventing a new generation of smart infrastructure because it believes that autonomous vehicles will only thrive if they can communicate with roads. It proved its point that this cooperation is essential for vehicles to become entirely autonomous with PSA, a carmaker, by designing a system enabling a car to clear a toll plaza with no human intervention, for the first time ever worldwide, in July 2017.

VINCI Autoroutes has also created Cyclope, a subsidiary where specialists in artificial intelligence applied to image analysis are developing new toll systems and fine-tuning algorithms to analyse traffic in real time using the surveillance cameras on the motorway network.



VINCI AUTOROUTES AND CARMAKER PSA ENABLED AN AUTONOMOUS VEHICLE TO CLEAR A TOLL FOR THE FIRST TIME EVER WORLDWIDE.

## **VINCI Concessions: analysing flows, smart infrastructure and customer experience**

Managing infrastructure under concession involves anticipating passenger flows, supervising infrastructure construction, and interacting extensively with end users while operating infrastructure assets. Accordingly, VINCI Concessions is focusing its innovation policy on three main areas: traffic forecasting, construction programme management and customer marketing.

VINCI Concessions subsidiaries – for example VINCI Airports, VINCI Highways and VINCI Railways – are broaching innovation with a test-and-learn attitude and tapping into the amazing opportunities to do both in their large infrastructure portfolios. They are channelling these “tailored” experiments through their open innovation policy and teaming up with startups in a variety of ways (ranging from allowing them to carry out experiments on VINCI-run infrastructure to investing in their equity).

This business line kicked off its open innovation drive in February 2016 when it organised its VINCI Concessions Startup Tour. It is currently testing the ideas it short-listed during that tour on Group infrastructure assets. VINCI Concessions has also been a partner of the Lisbon Web Summit for the past two years and holds competitions for startups on a regular basis.

## **VINCI Energies: driving transformation in the digital and energy realms at La Factory**

VINCI Energies is active in a booming sector and naturally at home at the cutting edge of innovation. It inaugurated La Factory – a new venue working full-time to tackle the evolving challenges in the digital and energy landscapes – in La Défense in March 2017. This open and collaborative organisation is active on three fronts:

- exploration, i.e. unravelling emerging megatrends and preparing experiments based on them;
- co-creation, with a pragmatic approach to innovation, centred around the challenges its customers are facing and tapping into its network of in-house experts;
- acceleration, aimed at spreading innovation throughout VINCI Energies’ 1,600 companies.

La Factory houses VINCI Energies’ brand management teams, service-sector teams, smart-city teams, development and innovation department, and startups in residence. And it plays host to many visitors who want to find out more about this inspiring place.



AT THE LATEST WEB SUMMIT, 10 STARTUPS PRESENTED THEIR PROJECTS TO VINCI AIRPORTS’ INNOVATION CHALLENGE JURY.



LA FACTORY ENCAPSULATES VINCI ENERGIES’ INNOVATION DRIVE.

VINCI Energies recently opened a new Factory, Digitale Schmiede, in Frankfurt, and has plans to set up others in Lille and other cities. It has also set up Inerbiz, a managerial and investment fund that supports startups, and its own acceleration programme, Energize, for intrapreneurs working on pioneering projects.

**Next Move: the projects that are driving Eurovia forward**

Eurovia, a world leader in transport infrastructure construction and urban development, opened its international research centre near Bordeaux in 2004 – it has since grown into one of the most respected labs in its industry. It also has a worldwide network of 650 engineers and technicians creating, testing and approving the products and processes that Eurovia markets. Its teams feed dozens of R&D projects into its pipeline every year – most of them revolve around protecting the environment, maintaining infrastructure and smart cities. Eurovia encourages innovation in every department – in technical and other fields alike – and invariably gears it to its customers’ requirements.

It has about 150 Next Move projects at this point in time and has appointed operation-side project managers to lead them, in addition to performing their other duties.

Eurovia has also on-lined Eureka (an innovation management platform where all its employees are welcome to submit their ideas to tackle issues on the ground) and organised an international Innovation Day in May 2018, which involved its 39,500 employees. It is also active on the open innovation front with four main types of partnerships (with startups, manufacturers, top schools and universities) and in synergy with other VINCI entities.

Eurovia furthermore organises hackathons with students from top schools and innovation forums with its customers, and has teamed up with Impulse Partners, a startup incubator, to create an accelerator specifically for projects revolving around mobility and infrastructure.



EUROVIA'S  
RESEARCH CENTRE  
IN MÉRIGNAC, NEAR  
BORDEAUX, HAS  
FILED MORE THAN  
1,560 PATENTS.

**VINCI Construction: leveraging R&D to sharpen its competitive edge**

VINCI Construction is fast-tracking its R&D at central level and in each of its business units, and has filed over 2,000 patents so far. It is also very active on the open innovation front: it is working with Eco-design Chair researchers developing tools to run energy-related simulations, involved in a range of partnerships exploring new fields, and working on a growing number of partnerships with startups (XTreeE and Sunpartner Technology are the two most recent examples). VINCI Construction is also active in incubators, scouting promising business prospects. Its R&D incubator, meanwhile, is focusing on more forward-looking topics that will weave their way into VINCI Construction's fields of expertise over time.



VINCI CONSTRUCTION IS WORKING WITH XTREEE, A STARTUP, TO DEVELOP CONCRETE 3D PRINTING.

**Vivacity: VINCI Immobilier's innovation programme**

VINCI Immobilier kicked off this initiative in 2017 to encourage its teams to come up with new ideas in three areas: new services, new tools harnessing digital technology, and new sales and marketing methods.



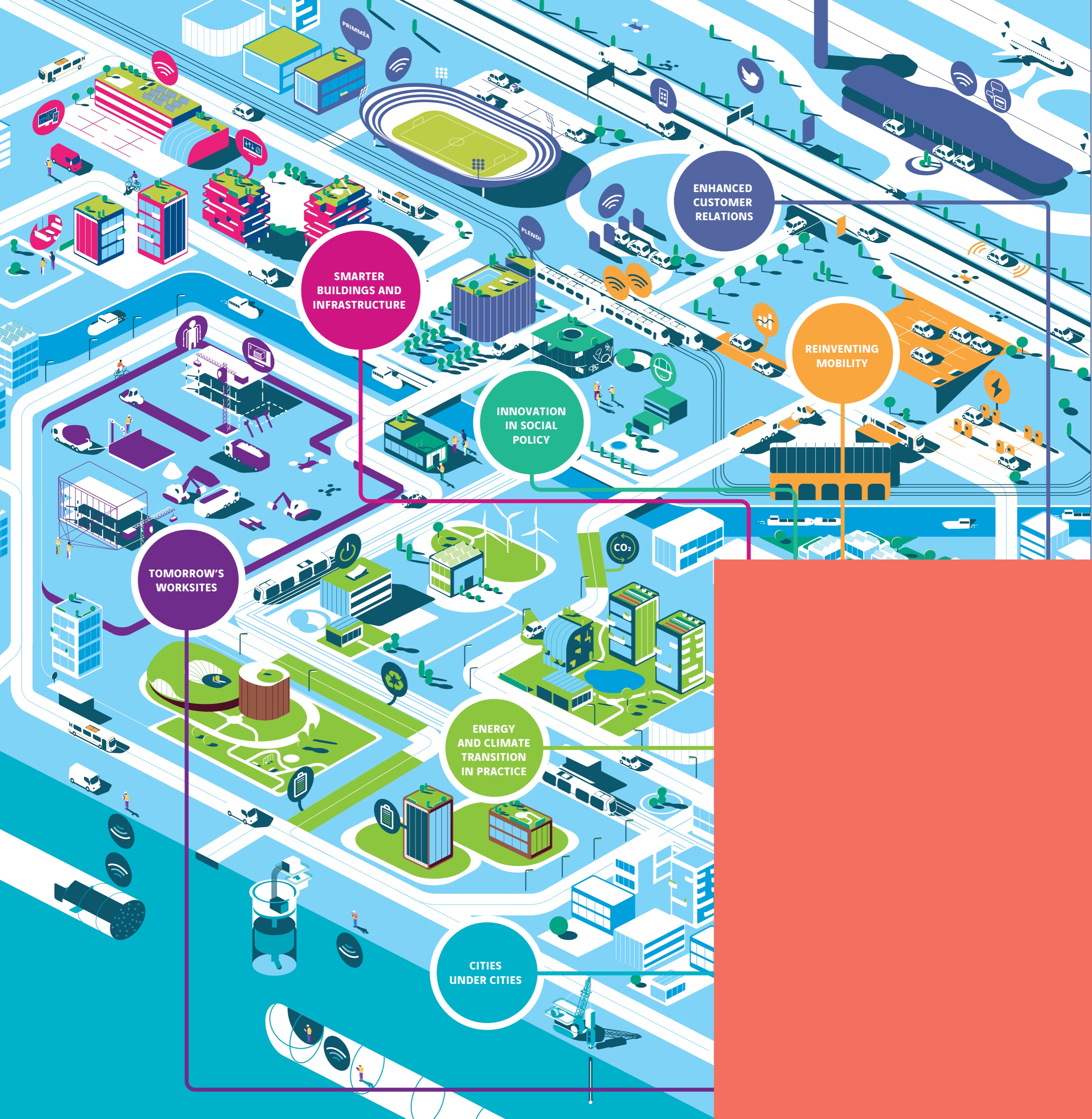
ALMOST TWO IN THREE VINCI IMMOBILIER EMPLOYEES TOOK PART IN THE VIVACITY CALL FOR IDEAS.







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**SMARTER  
BUILDINGS AND  
INFRASTRUCTURE**

**ENHANCED  
CUSTOMER  
RELATIONS**

**REINVENTING  
MOBILITY**

**INNOVATION  
IN SOCIAL  
POLICY**

**TOMORROW'S  
WORKSITES**

**ENERGY AND CLIMATE  
TRANSITION  
IN PRACTICE**

**CITIES  
UNDER CITIES**



# 2



JUNE 2018

# INNOVATION FOR TODAY AND TOMORROW

## **INNOVATION FOR TODAY AND TOMORROW**

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# ENERGY AND CLIMATE TRANSITION IN PRACTICE

Demand for energy and mobility is increasing relentlessly, resources are running out and climate change is becoming palpable. The way forward will necessarily involve smart and decentralised solutions that concurrently reduce CO<sub>2</sub> emissions, save energy and preserve resources.

**UNDERFLOOR AIR  
CONDITIONING**

**ENERGY-PRODUCING  
WINDOWS AND FAÇADES**

**ENERGY-PRODUCING  
ROADS**

**100% RECYCLED ROADS**

**POLLUTION-REDUCING  
SURFACING**

**REFLECTIVE MIXES  
THAT REDUCE LIGHTING  
EXPENDITURE**

**ENERGY-INDEPENDENT  
CITIES**

**OPTIMISING ENERGY  
CONSUMPTION  
IN FACTORIES AND  
COMMUNITIES**

**SMART PUBLIC LIGHTING**

**THE TIMBER  
CONSTRUCTION REVIVAL**

**BLENDING BIODIVERSITY  
INTO URBAN SETTINGS**

**AN EDUTAINING TOOL  
TO RAISE BIODIVERSITY  
AWARENESS**

**RENEWABLE RAW  
MATERIALS**

Three of the factors that are defining the challenges we will need to tackle this century are renewable sources of energy (which are gaining ground in energy mixes), storage and miniaturisation technologies (which are moving through the pipeline) and smart grids (to juggle energy flowing in from a variety of sources in real time and optimise consumption).

VINCI's role in the energy sector principally revolves around optimising infrastructure by adding autonomous and intelligent equipment (smart grids, smart lighting etc.), and developing renewable energy production capacity, transmission systems and distribution grids. The crucial issue in the construction and maintenance sector today is energy efficiency. Today, this sector accounts for 40% of energy consumption. Tomorrow, buildings will be energy hubs that produce their own power (for example using new photovoltaic technologies) and have intelligent systems operating them in local loops. VINCI is also developing new solutions that are using infrastructure to speed up energy transition – including pollution-reducing roads, 100% recycled roads or even energy-producing roads. Innovation, in other words, is happening now.

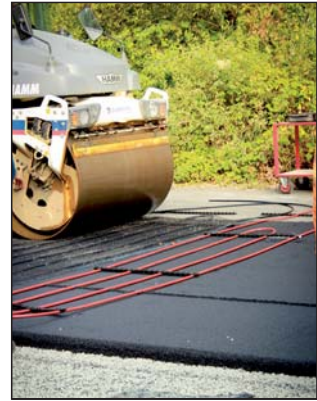
### **Moving forward**

Collective power production and self-consumption are still in the experimental stages (the Smartmagne project is one example). But these systems will progressively power entire neighbourhoods then entire cities. Central power generation will give way to local renewable energy production near the places where it is consumed. New buildings will not only be designed to consume less: they will become energy-positive, i.e. produce more energy than they consume. Stationary electricity and heat storage solutions (in the form of hydrogen for fuel cells or in the form of kinetic energy) are the exception rather than the rule today. But that will change and, when it does, these solutions will bridge the gap between renewable energy supply (which is often intermittent) and demand.



## **UNDERFLOOR AIR CONDITIONING**

VINCI Construction and VINCI Energies developed GreenFloor, a next-generation heating, ventilation and air conditioning system (which won the special jury prize in the Central Activities region in the VINCI 2013 Innovation Awards competition). The air in this system travels through concrete slabs, driven by radiation and convection in ceilings, and keeps the temperature just right for the people in the building. It consumes negligible amounts of energy and saves a lot of space.



## ENERGY-PRODUCING WINDOWS AND FAÇADES

The Horizon product range is a perfect example of what VINCI Construction means when it refers to buildings as “energy hubs”. Façades have at least two advantages: they are huge and near the places where people consume electricity. So just add intelligent connected Horizon windows and Horizon Energy glazed façades, which we developed with Sunpartner Technology (a French specialist driving innovation in solar energy), and buildings start producing power. Horizon smart windows have opacifying electrochromic glass to block the sun’s rays and shave about 30% off air conditioning bills. And they have the latest BIPV (Building Integrated Photovoltaics) transparent or invisible coatings, so they also produce solar energy and feed it into the building. Users can operate the system using their smartphones, remote controls or central building management consoles. Horizon Energy has supersized this concept with glazed façades for building sides.

## ENERGY-PRODUCING ROADS

Eurovia developed Power Road with public- and private-sector partners (IFSTAR, CEATech, Burgeap) and support from Ademe (the French Environment and Energy Management Agency). Power Road blends into local energy systems, captures the heat from the sun in summer, stores it for several months and releases it when needed, for example to heat nearby homes and other buildings, melt snow on the road or even cool down urban heat islands.





## 100% RECYCLED ROADS

This project – which the French government selected for its *Investissements d’Avenir* (investment for the future) programme run by Ademe (the country’s Environment and Energy Management Agency) – involves concurrently re-engineering production methods, processes and tools to remove all the factors limiting the amount of recycled content in asphalt-mix formulas today. Eurovia and Marini-Ermont, a company that builds asphalt production systems, have created the world’s first mobile plant that can manufacture asphalt mix containing only recycled materials. Besides setting an unprecedented standard for recyclability in a mobile plant, this solution consumes significantly (20% to 50%) less energy, and releases commensurately lower amounts of greenhouse gases and volatile organic compounds than previous-generation plants. Eurovia Grand Travaux tested the system for the first time, on the ASF (VINCI Autoroutes) motorway network, in May and June 2018.



## POLLUTION-REDUCING SURFACING

The NOxer® process actively neutralises nitrogen oxide from vehicle exhausts (which causes acid rain and summer smog, and is harmful to health in several other ways). This system developed by Eurovia works on road surfaces as well as noise barriers, and the principle underlying it is natural: when the sun’s light strikes the titanium dioxide in the NOxer® mix, it acts as a catalyst triggering a chemical reaction that turns NOx into stable, innocuous molecules without releasing any polluting by-products and without using any energy other than the sun’s.



## REFLECTIVE MIXES THAT REDUCE LIGHTING EXPENDITURE

Eurovia and Citeos (VINCI Energies) developed Lumi+ light-reflective surfacing using beige, white or grey aggregate, and hydro-stripping treatments. With the right lighting system, roads reflect light, look more appealing and lower towns' and cities' public lighting costs by 30% to 40%.



## ENERGY-INDEPENDENT CITIES

VINCI Energies and the Syndicat Départemental d'Énergie in Cher (central France) are working together in Marmagne, a rural town, on France's first collective production and self-consumption project, Smartmagne. The ultimate goal is simple: to supply Marmagne with electricity produced locally from renewable sources. They are using photovoltaic panels on the roofs of municipal buildings to produce the power and have a combination of algorithms that process weather forecasts and consumption profiles to determine whether to route energy towards self-consumption, storage (up to 100 kW) or the public grid. Self-production is expected to cover 69% of the town's requirements. This project kicked off in November 2017 and should be up and running in 2018. It has earned official recognition as an industrial demonstrator for sustainable cities.



## OPTIMISING ENERGY CONSUMPTION IN FACTORIES AND COMMUNITIES

Smart Grid Energy, a startup that has become a wholly-owned VINCI Energies subsidiary, develops pioneering solutions in its areas of expertise, which include peak shaving for industrial customers, aggregating decentralised production capacity and advising customers on their energy procurement. In practice, Smart Grid Energy uses peak-shaving strategies to regulate production plants' energy consumption: if the grid is under stress, plants agree to momentarily lower or interrupt their electricity consumption in exchange for financial compensation.



## SMART PUBLIC LIGHTING

Citeos, VINCI Energies' lighting and urban equipment brand, has developed systems that adjust lighting to the number of people in an area, instead of leaving lights on at full power when nobody needs them. The system uses magnetic sensors to detect pedestrians, cyclists and motor vehicles, and can be used in various ways – for example to lower the power supply reaching LEDs to 15% of the standard level after 11pm (as it is doing in Aubinges and Aix les Bains today). Chartres is using a number of additional features we have developed with SysPlug, a startup, including a series of lamp post mounted units that communicate with sensors to forward information about available parking spaces, carry Wi-Fi signals, monitor electric vehicle charging stations and optimise waste collection rounds by monitoring bin fill rates.



## THE TIMBER CONSTRUCTION REVIVAL

Wood is the only building material that has a positive carbon footprint (using 1 sq. metre of timber is tantamount to storing 1 tonne of carbon dioxide instead of releasing it into the atmosphere). And it's staging a comeback. About 80% of timber constructions are prefabricated in production plants so they're very quick and simple to assemble when they reach worksites (meaning less inconvenience for nearby residents).

Arbonis, a VINCI Construction subsidiary, is developing new solutions to tackle more complex challenges and bolder projects – for example a stadium in Nice, a cathedral in Créteil and the 28-metre-tall Aqualagon (photo) in Normandy.

Industry is also using wood in more and more projects. Arbonis is building France's largest logistics platform in Eure et Loir, including a timber structure for the tower and a combination of wood and concrete for the flooring. The Cité du Vin in Bordeaux and the Pôle Culturel in Cornebarrieu, two projects by Arbonis, have won national-level prizes for cutting-edge timber construction affording verifiable energy efficiency gains and using local species.



## BLENDING BIODIVERSITY INTO URBAN SETTINGS

Biodi(V)strict, one of the outcomes of our Eco-design Chair and partnership with AgroParisTech, is an assessment tool that helps steer planners' decisions and encourages them to factor biodiversity into any urban or suburban project from the start. Biodi(V)strict assessments use maps, geographic information systems and five key variables – natural-habitat diversity,

soil permeability, vegetation-stratum variety, intra-site connectivity and the proportion of green spaces in an area – to suggest ways of fostering biodiversity (for example rooftop gardens, green walls, urban farms and possibly ponds). The ultimate goal is to recreate the corridors that wildlife species need to travel.

We used this approach at the Condorcet Campus worksite in Aubervilliers, and recently set up Urbalia, a startup, in a joint venture around Biodi(V)strict.

## AN EDUTAINING TOOL TO RAISE AWARENESS OF BIODIVERSITY

New District, another outcome from our VINCI-ParisTech Chair in Eco-design of building complexes and infrastructure, is an online role-play game to help planners understand biodiversity and the point of including it in the earliest stages of project design. Six to fifteen participants play roles as key urban development stakeholders and can see the ways in which their decisions impact biodiversity.



## RENEWABLE RAW MATERIALS

Eurovia, which produces aggregates for the roads it builds, set up a programme to save natural resources by reusing or recycling 100% of the resources going into its building and civil engineering projects, several years ago. In 2011, it introduced Granulat+, a circular-economy initiative including a range of services to upcycle inert worksite spoil into ready-to-use aggregate.

# ENHANCED CUSTOMER RELATIONS

VINCI's legacy building, civil engineering and concession operations principally involved working with businesses and governments. Our more recent moves to develop our motorway, airport and stadium concessions, along with our facilities management services, have put us in direct contact with the people using the facilities. At the same time, the boom in digital technology and the wealth of new services that this revolution is bringing about are opening up a plethora of opportunities for Group subsidiaries to reinvent their relations with customers and to upgrade them across the board.

**ELECTRONIC TOLL  
COLLECTION**

**ROBOTS ASSISTING  
PASSENGERS**

**A DIGITAL TRAVEL  
COMPANION**

**ROBOTS WELCOMING  
GUESTS**

**DRONES HELPING  
DRIVERS**

**PRIMMÉA AND PLENDI:  
THE CONSTRUCTION  
SECTOR'S CUSTOMER-  
CENTRIC SHIFT IS  
RESHAPING SOLUTIONS**

**FANS' EXPERIENCES IN  
CONNECTED STADIUMS**

**PASSENGER-FRIENDLIER  
AIRPORTS**

New technologies are doing more than ushering in new services: they are also enabling users to gather in communities and enabling us to offer these communities new services. Digital technology is reshaping the concessions business too, turning the infrastructure operators of yesteryear into forward-looking service providers.

### **Moving forward**

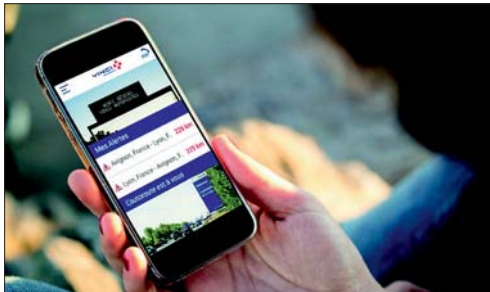
Before setting out on a journey, drivers will be able to sign up for a deal entitling them to use the motorway, top up their electric car's battery and have a meal for example. Or why not hire a long-distance driver, sit back and watch a film or sleep. Airline customers will glide through new-generation airports. They will be able to complete most of the formalities – from checking in to dropping off luggage – before leaving the city (but will still need to leave cities to board planes for the foreseeable future!). Facial-recognition software and molecular-level scanners will fully automate security checks, so we won't need to remove our electronics or liquids from our bags anymore. And airports will be places where people have fun and relax instead of standing in queues.



## **ELECTRONIC TOLL COLLECTION**

VINCI Autoroutes' overarching goal is to treat drivers to smoother travel experiences, which involves easing any friction that unnecessarily slows them down on motorways. Electronic toll collection is one of the main steps in this direction and we are working on two fronts:

- digital toll tags, to enable more and more people to use the system, for example by providing subscriptions and a convenient smartphone app. This large-scale experiment on VINCI Autoroutes' network began in September 2017 and this new service will be available on all our motorways in the coming months;
- at the same time, replacing barriers with free-flow technology: Cofroute is familiar with this technology (it rolled it out in the United States in 1994) and will be able to introduce it on VINCI Autoroutes' France-wide network as soon as the regulatory and legal framework allows this.



## A DIGITAL TRAVEL COMPANION

VINCI Autoroutes introduced a new free-of-charge travel companion app this July to offer customers comprehensive mobility services before, during and after their journeys. This companion is enhancing every aspect of their journeys with customised features, and has been live since the beginning of the 2018 summer holidays. It includes:

- a simplified interface enabling communication between VINCI Autoroutes – via a digital customer relations unit – and its two million daily customers;
- a reward programme: frequent VINCI Autoroutes network users will be able to use this app to earn loyalty points that will allow them to benefit from free coffee when they stop at motorway rest areas;
- geolocated dynamic information about upcoming rest areas (restaurants, shops, etc.) in real time, with one click;
- the app will also tell drivers about attractions around the motorways and, over time, include a wealth of digital mobility services (for example enabling users to purchase goods before reaching rest areas, book carpooling arrangements or pay online to use electric vehicle recharging stations).



## DRONES HELPING DRIVERS

VINCI Autoroutes is using drones to watch over strategic points in the network and forward footage to users. It is already using drones over the busiest sections of the A7, A8, A9, A10 and A50 to feed live multiplex footage through VINCI Autoroutes' communication channel during the school-holiday seasons. The artificial intelligence programme developed by VINCI Autoroutes will soon enable these drones to watch over motorways in self-reliant autopilot mode.

We tested this system for the first time, with French civil aviation authority approval, on a 10-km motorway stretch in July 2018.





## ENRICHING FANS' EXPERIENCES IN CONNECTED STADIUMS

New digital tools are opening up opportunities to smooth customers' paths and enhance their experiences. The Stade de France introduced in July 2017 Click & Eat, an app fans can use to order on-the-spot snack services instead of wasting time in queues. Meanwhile, fans at the Allianz Riviera in Nice can also watch slow-motion replays of match highlights on their smartphones using the Live & Replay feature on the stadium's app.



## PASSENGER-FRIENDLIER AIRPORTS

VINCI Airports is constantly liaising with its customers to optimise passengers' experiences. It introduced free unlimited Wi-Fi in all its airports in 2015 and has not stopped blazing new trails since then. At Lyon-Saint Exupéry, for example, it is testing various services including a chatbot that provides instant replies to inquiries that reach it via the airport's website, Messenger account or app. Business travellers can use a service by Eelway, a startup, which picks up their luggage in their hotel or office and returns it to them at the airport in the evening. We will soon be trying out an in-city luggage check-in service in partnership with Lyon-Saint Exupéry Airport and Rhônexpress, the city's airport shuttle train. The passengers most pressed for time will be able to test virtual queuing, starting with a test on the Paraphe automated passport control system, courtesy of Lineberty, a startup. Porto and Lisbon airports have teamed up with Business in the Air, another startup, to put passengers in touch with each other via LinkedIn, and we're planning to extend this system to the rest of the VINCI Airports network soon.



## ROBOTS ASSISTING PASSENGERS

Airports are already using robots to make travellers' lives easier. Stan, a robot valet that Lyon-Saint Exupéry Airport introduced in September 2017, takes over cars when they reach the airport, sparing passengers the hassle of finding a parking space and manoeuvring their car into it – and saving them valuable time. When passengers return, their car is waiting for them where they agreed earlier to retrieve it. And this robot developed in partnership with Stanley Robotics fits 50% more vehicles in the car park where the test is being carried out.



## ROBOTS ASSISTING GUESTS

VINCI Energies is also using robots to welcome visitors. It developed Heasy with Hease Robotics, a startup, and has been using it at La Factory since February 2018. Heasy welcomes them as soon as they reach the reception hall and escorts them to their destination, answers their questions, and can read barcodes and send information to mobile phones. It uses facial recognition software and a Slam (simultaneous localization and mapping) algorithm.



## **PRIMMÉA AND PLENDI: THE CONSTRUCTION SECTOR'S CUSTOMER-CENTRIC SHIFT IS RESHAPING SOLUTIONS**

The construction sector is booming – and adopting marketing segmentation methods that business-to-consumer companies would typically use. Adim, a VINCI Construction France subsidiary, for example, has set up Primméa, an unprecedented partnership-based programme to build quality homes that cost buyers 25% to 30% less than average market prices. We are working on this programme with Constructa (which is handling property sales), Crédit Foncier (mortgages), Dassault Systèmes (digital construction) and local authorities (land) to streamline construction processes. Digital construction is one step beyond BIM, lowers costs and shortens construction timeframes. We kicked off Primméa in 2014 with three residences in France (in Avignon, Le Petit Quevilly and Laneuveville Devant Nancy). This programme is especially suited to first-time homebuyers and is proving to be a suitable response to demand for new homes.

Plendi is VINCI Construction's brand for upscale hotels, investors, decorators and homeowners that want to design, build or refurbish luxury homes and establishments in France and around the world.

This division pools talent from top engineering, visual-arts and interior-design schools, works with a network of world-class artisans, and can count on a world-class construction specialist for backup. It has, *inter alia*, extended the Shangri La and Mandarin Oriental hotels in Paris and London, the Peninsula and Plaza Athénée hotels in central Paris, Four Seasons hotels in Prague and Budapest, a 5-star Hilton in Vietnam and Louis Vuitton's flagship store on the Champs Élysées.



# REINVENTING MOBILITY

The transport sector releases more greenhouse gases than any other – and is under all the more pressure to do its part to stem climate change. Air pollution, road congestion and difficulties multi-purposing public space are a few signs showing that the model has stopped working and that transport networks are ready for an overhaul.

**SMART ELECTRIC VEHICLE  
RECHARGING**

**FINE-TUNING FORECASTS  
OF WORLDWIDE FLOWS**

**OPTIMISING TRANSPORT  
INFRASTRUCTURE**

**MORE CONNECTED  
INFRASTRUCTURE**

**MOTORWAYS CATERING  
TO NEW FORMS OF  
MOBILITY**

VINCI is naturally playing its part in this transformation.

VINCI Autoroutes is fostering carpooling and encouraging bus rapid transit systems in order to lower greenhouse gas emissions on the infrastructure it operates. Eurovia is also extremely active devising tomorrow's recycled, connected, pollution-reducing and power-producing roads today. And VINCI Energies is engineering smart recharging systems for electric vehicles.

### **Moving forward**

Autonomous vehicles will progressively take over roads and become the norm. Most vehicles can only handle a few aspects of driving today (level 1) but they will soon require less driver intervention (level 2). Then they will only need human assistance during certain phases (level 3), become fully autonomous unless the driver decides to take over (level 4) and ultimately be fully self-driving (level 5). They will need bespoke infrastructure to get there and, when they do, autonomous vehicles will completely change our perspective on private vehicles. Carpooling will optimise the use of vehicle fleets, we will transition from owning vehicles to using mobility services, and we will transfigure cities as we know them in the process.



## **SMART ELECTRIC VEHICLE RECHARGING**

The law on clean buses due to take effect in France in 2020 is already prompting plans for all-electric bus fleets. However, operators need to deal with new issues before they can bring these fleets into service (right-sizing the equipment in depots, sourcing electricity, and factoring recharging time and other vehicle downtime into schedules). VINCI Energies has developed CWay to address all these complex issues. This turnkey solution also takes several other factors into account – including the weather, traffic conditions, service timetables, detours and the line's topography – to help operators optimise infrastructure management, lower costs and avoid any consumption peaks. CWay, which won a VINCI Innovation Award in 2017, has an intuitive, user-friendly interface, and runs on tablets and smartphones.



## OPTIMISING TRANSPORT INFRASTRUCTURE

Smartvia (short for self-monitoring analysis and reporting technology) is Eurovia's response to fifth-generation roads and the technological shifts bringing those roads into existence. The company purpose-engineered this system in 2014 to assess road strain in real time by embedding sensors to measure temperature, pressure, dampness and distortion in the various layers of the surfacing. These sensors are connected to a central data logger and monitoring tools to schedule maintenance work.

Smartvia Cryo measures temperature throughout a road's surfacing to optimise winter maintenance. Smartvia.track is the same as Smartvia but tailored for railways. The instruments are embedded in the sleepers, measure pressure, bending, temperature and water content, and include optical fibre lines to measure vibration along rails. All this information is analysed to optimise rail infrastructure maintenance.



## MOTORWAYS CATERING TO NEW FORMS OF MOBILITY

New intercity and peri-urban modes of transport are more connected, cleaner, more intermodal and more communal. VINCI Autoroutes is active on all these fronts, creating pioneering mobility services that are helping to bring about new ways of travelling.

• **Electric mobility:** VINCI Autoroutes is building fast electric vehicle charging systems in its motorway rest areas to enable medium- and long-distance travel. It has already set up over 100 charging stations on the main arteries in its network under the Corri-Door programme, which is jointly financed by the European Union.

• **Carpooling:** it is also introducing a carpooling deal (which has already attracted 150,000 users) with BlaBlaCar

and building free parking areas for carpooling (2,500 available spaces).

• **Intermodal connections:** and it is encouraging coach services on motorways by building stops connecting with car parks, bus stops and train stations on the outskirts of large cities (for example in Briis sous Forge, about 40 km southwest of Paris on the A10).



## FINE-TUNING FORECASTS OF WORLDWIDE FLOWS

As VINCI Concessions' business model relies to a large extent on traffic levels, it is innovating in two areas – data and capacity – for example to predict how many passengers will be travelling through each of its airports and how many vehicles will be using its motorways outside France next year, in 10 years' time and in 30 years' time, or how many trains will be using the SEA high-speed line between Tours and Bordeaux when it opens up to competition.

VINCI Concessions' teams are developing exclusive methods to harvest reliable data, which will determine each project's entire life cycle.

Forecasting worldwide flows to predict traffic levels on each infrastructure asset is also helping VINCI Concessions to adjust capacity in new ways. Redesigning infrastructure around flows, in particular using BIM technology, is one way of broaching this complex equation. And, when enlarging infrastructure isn't one of the options to increase capacity, VINCI Concessions tackles the issue with an out-of-the-box approach. It has partnered HAL 24 K, a startup that specialises in big data (and in which VINCI Energies has invested) to furnish Greek drivers with technology to plan their journeys around rush hours. This system is ultimately helping traffic move more smoothly even though more vehicles are using the motorways. Harnessing information systems to increase capacity is one very practical step towards the smart transport systems of the future.





## MORE CONNECTED INFRASTRUCTURE

Mobility infrastructure assets may have been ungainly and inactive in the past but digital technology is turning them into an array of agile, lively hubs that interact with consumers and operations teams. Machine-to-machine technology, the Internet of Things and artificial intelligence are a few of the interactive solutions we're building into more and more VINCI Concessions infrastructure to provide consistently high-quality systems, improve safety and step up predictive maintenance. Synerail, for example, has rolled out GSM technology throughout France's rail network to ease communication between tracks, trains and operation teams.

In Greece, the Smart Tunnels programme on Olympia Odos is equipping all in-tunnel systems (lights, signs, etc.) with sensors connected directly to the operation control room. With machine-to-machine technology, the devices will track their own degree of obsolescence and report it, boosting maintenance agility and efficiency. In airports, VINCI Concessions is working with Nanomade, a startup, to test nanosensors that respond to touch and pressure on any surface, opening up a variety of exciting prospects in car parks and restaurant or snack outlets.

# WORKSITES OF THE FUTURE

Building and civil engineering sites are also stepping into the future – and away from the traditional image this activity may conjure up in people’s minds. Digital and other up-and-coming technologies are shaking up builders’ jobs – for example easing physical strain, shortening job timeframes, freeing up creativity and boosting productivity.

**CONCRETE 3D PRINTING**

**NEXT-GENERATION  
MODELLING**

**DRONES ON DUTY**

**HIGH-SPEED WASTE  
SCREENING**

**FIBREGLASS TIE-RODS**

**IMMERSION IN  
AUGMENTED REALITY**

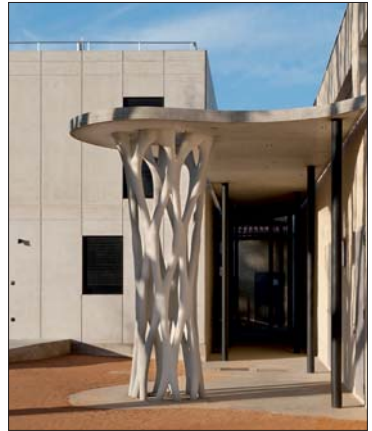
**EXOSKELETONS TO EASE  
STRAIN**

**MOBILE APPS DEVELOPED  
FOR WORKSITES**

BIM (Building Information Modelling) is becoming the new standard for construction project design and management. These 3D models are replacing paper blueprints, taking teamwork to the next level, shortening timeframes more than ever before and slashing construction costs by around 20%. VINCI Construction is one of the companies pioneering this technology, which is kick-starting a revolution in the building sector. Additive manufacturing is another step-change technology that is attracting a lot of interest among construction companies. VINCI Construction is also blazing new trails on this front, for example by developing concrete 3D printers with startups – and in doing so exploring promising new building methods that will enhance smart cities in the future.

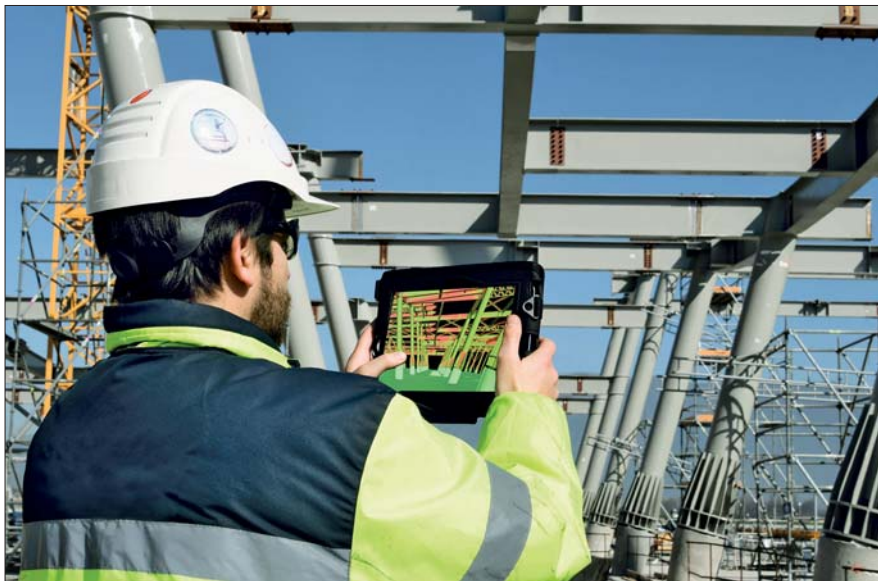
### **Moving forward**

We will be seeing more and more additive manufacturing at building sites as time goes by. Today's 3D printers only need one or two operators to build walls and are already saving very significant amounts of time and money. They are also opening the door to more complex building shapes, unleashing architects' creativity, and using local materials or novel ones (for example "breathing" structures providing natural air conditioning). Worksite crews will have augmented-reality glasses or head-up displays to provide them with real-time additional information.



## **CONCRETE 3D PRINTING AT WORKSITES**

VINCI Construction France and XTreeE, a startup we have invested in, are developing technology that may revolutionise our industry: concrete 3D printing. The tool developed by XTreeE uses additive manufacturing to make complex parts, opening up myriad new possibilities for buildings. Besides producing parts that are extremely difficult to carve out using conventional methods, this technology is boosting productivity gains by optimising the amount of materials we use, and opening the door to using local resources and possibly even reusing worksite waste (clay, sludge from aggregate washing, etc.).



## NEXT-GENERATION MODELLING

BIM (Building Information Modelling) is setting a revolution in motion in the construction sector. It involves creating a digital model as soon as the project kicks off, for everyone working on the project to use throughout the process. BIM platforms connect to databases, so team members can retrieve the project-related information they need on their desktop, laptop or mobile devices. These models reduce risks (during design, construction and even operation), streamline schedules and reduce costs. And, at the end of the day, they increase service quality. Some 250 VINCI employees working around the globe completed the design phase of the Santiago de Chile airport project in six months – instead of a year and a half using conventional methods. We have already used BIM on projects ranging

from a metro line in Doha (Red Line South) to a railway system in London (Crossrail) and on to the Atlantic Bridge in Panama, and will be using it to build a Grand Paris Express railway station in La Défense. And BIM works just as well for large-scale urban infrastructure and development projects as it does for single buildings (for example the Louis Vuitton Foundation near Paris, Phnom Penh and Siem Reap airport terminals in Cambodia, and the Santiago de Chile terminal).



## DRONES ON DUTY

Eurovia is using drones to check aggregate stock levels rapidly and inexpensively, and VINCI Construction is using them to inspect several of its worksites and infrastructure assets.

## HIGH-SPEED WASTE SCREENING

Eurovia and Soletanche Bachy have invented a faster method to screen excavation materials, especially in underground worksites (where above-ground space is usually limited and storage capacity at tunnel entrances and exits is often tight). This method, Carasol, determines the nature of the spoils twice as fast as conventional screening systems (which take four to five days), meaning waste reaches the right processing channel sooner.

## FIBREGLASS TIE-RODS

Freyssinet (VINCI Construction) has developed fibreglass tie-rods to replace metal ones. They are equally effective during temporary works but fibreglass rods can be easily destroyed when the construction work is finished.



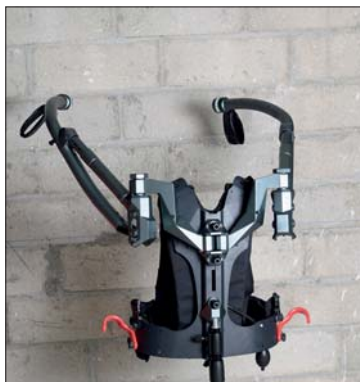
## MOBILE APPS DEVELOPED FOR WORKSITES

At VINCI Construction's request, VINCI Energies has developed mobile apps to enhance collaboration at worksites



## **IMMERSION IN AUGMENTED REALITY**

Touring a live construction site may be awkward and visualising a finished building while staring into a hole in the ground can be difficult. Virtual reality is helping in both those areas, and can also be used to track progress on projects under way. VINCI Construction and Eurovia use it on a regular basis, for all the above reasons and to show people living near their worksites what their new neighbourhood will look like. And VINCI Immobilier uses it to show prospective customers what their home will look like, using a VR headset.



## **EXOSKELETONS TO EASE STRAIN**

These devices are often used in military applications but they also help building crews who have to carry out repetitive and tiring tasks. VINCI Construction is testing exoskeletons it developed with Exhaus, and has for example found that a pneumatic drill operator can work four times faster with one of these systems.



**KALEÏ, AN EXAMPLE  
OF A SMART HOME**

**REVERSIBLE  
CONSTRUCTION**

**THE SMART CITY  
MANAGEMENT  
PLATFORM**

**3D CONFIGURATORS,  
360° VISION  
AND HOLOGRAMS**

**INDUSTRY 4.0**

# **SMARTER BUILDINGS AND INFRASTRUCTURE**

Buildings and cities need to be connected and smart. This means more than outfitting them with intercommunicating components: it means they have to react to changes in the environment around them to enhance user comfort and support operations.



VINCI Energies' brand VINCI Facilities has transferred BIM technology into its field of expertise, facilities management, (and dubbed it BIM FM). It is using Building Information Modelling tools and feeding them with information that helps its teams optimise building management. Smart buildings are also at the core of the energy equation in smart cities. And the Group is ready to blend state-of-the-art solutions from VINCI Construction and VINCI Energies into the smart buildings of the future.

### **Moving forward**

Tomorrow's buildings will produce more energy than they use, and will be connected. Central building management systems running on smartphones are not very common today but will become the norm in the future. When they do, we will be able to interact with a building's equipment, for example to close a window that was left open or to adjust the indoor temperature, on-site or off-site and at any time. Connected floors will detect heavy or otherwise unusual impacts, so they will be able to contact emergency services if someone falls down, for instance. This will make life easier for elderly people who choose to stay in their own homes.



## **KALEÏ, AN EXAMPLE OF A SMART HOME**

This residence in southern Paris is one of several examples of smart homes. Since the structure rests on a limited number of struts, is surrounded by railway lines and built on a pre-existing slab, a great deal of very sophisticated engineering was required – and involved using BIM. All the information to track operation of the residence (water and power consumption, lift operation, mechanical ventilation and so forth) is gathered centrally in the cloud, so as to optimise maintenance and costs remotely.



## THE SMART CITY MANAGEMENT PLATFORM

Citeos (a VINCI Energies company) has devised City App to help local authorities rise to the challenges awaiting them. This powerful software application keeps urban facilities running optimally, regulates their energy consumption and supervises them using up-to-the-minute data and communication technologies. City App, in other words, enables real-time central infrastructure management – and was one of the final prizewinners in the VINCI 2017 Innovation Awards competition.

## REVERSIBLE CONSTRUCTION

Buildings designed for a specific function are often repurposed at some point in their life cycle – at a very high cost. VINCI Construction has tackled this issue with Conjugo, a system to build offices that can be turned into housing units or vice-versa. The design caters for both purposes and complies with the standards that apply to each one. Conjugo is one of the solutions in Blue Fabric, VINCI Construction's range of responsible building products and services.



## 3D CONFIGURATORS, 360° VISION AND HOLOGRAMS

New technology is helping the people building tomorrow's cities to paint more accurate pictures of the benefits that the solutions they are tendering will generate. VINCI Immobilier, for example, has introduced a 3D configurator that prospective buyers can use to visualise the home they will live in, including a choice of atmospheres and closer looks at a few of the highlights such as the electric roller blinds and videophones. VINCI Immobilier also uses gigantic holograms to present projects – for instance its plan to revamp the building formerly housing the Galeries Lafayette department store in Lille. VINCI Energies has developed Vision 360, a tool to present its most remarkable success stories in a variety of regions and to showcase the extensive choice of solutions it has used in them.



## INDUSTRY 4.0

Actemium, a VINCI Energies company, is very involved in efforts to create the factory of the future. Industry is embarking on its fourth revolution, digitalisation (after steam, electricity and automation). Industry 4.0 will basically involve entirely reorganising production methods using existing tools and moving networks closer to the epicentre of operations. Actemium specialises in industrial processes and has developed myriad solutions that optimise production, maintenance and energy efficiency in production plants, and make industrial processes safer. For example, it is working with Axians (VINCI Energies' ICT brand) and Sentyro (a startup) to help customers deal with industrial cybersecurity issues.

**AN ULTRA-HIGH-  
EFFICIENCY GRIPPER**

**NEW SHAFT SINKING  
TECHNOLOGY**

**MORE ACCURATE  
TUNNEL BORING**

**COMMUNICATION  
IN SECLUDED  
ENVIRONMENTS**



# **CITIES UNDER CITIES: THE NEXT HORIZON**

Cities can no longer expand horizontally to accommodate their growing populations without impinging on farming areas and biodiversity. So the only option for tomorrow's cities is to become denser.

Cities have traditionally grown upwards (especially since electricity and lifts appeared) but the space under cities is also brimming with exciting opportunities – especially as land is becoming an increasingly rare commodity. VINCI Construction companies have extensive experience with major underground works – in particular for transport infrastructure – and are innovating non-stop to push back the borders of these unconventional projects.

### **Moving forward**

The space under cities has been used for little other than subway trains, powerlines and water pipes until now. But that will change: this space will be put to better use and spring to life, seamlessly extending above-ground buildings. Groundscapes, the underground equivalent of landscapes, will start taking shape. They won't be an assortment of unrelated subsurface facilities: they will add up to consistent networks – and pleasant places. Tunnels for delivery vehicles, for example, could ease the congestion that all large cities are facing today. Another advantage in some cities is that underground areas are more earthquake-resistant.



## **AN ULTRA-HIGH-EFFICIENCY GRIPPER**

Soletanche Bachy, VINCI Construction's foundation and ground technology specialist subsidiary, developed its HFG 120T Hydrofraise® gripper to boost drilling operation efficiency. In a nutshell, this system digs deeper (down to 70 metres) in harder soil. It is also faster, more accurate, causes less vibration and makes less noise – which make it especially useful in inner-city worksites with tight schedules and strict noise-related constraints. This system was one of the final prizewinners in the VINCI 2017 Innovation Awards competition.

## **NEW SHAFT SINKING TECHNOLOGY**

VINCI Construction France is among the first companies to use VSMs (Vertical Shaft Sinking Machines) in the country. This new technology is roughly the vertical equivalent of a tunnel-boring machine (it digs the hole and positions the shaft wall at the same time). One of the advantages of this VSM technology is that its footprint is comparatively small – which is handy in cramped areas. We are using this technology on the Grand Paris programme, to build section T3C of the future Line 15.



## **MORE ACCURATE TUNNEL BORING**

The CAP software that VINCI Construction developed in-house helps operators to fine-tune tunnel-boring machine operation and to deal with issues that preliminary geotechnical surveys often miss. This software system is a data centre that monitors all the parameters (sometimes hundreds) that tunnel diggers have to accommodate. This data enhances efficiency and supports underground construction work in sensitive areas. A 3D variant of this software application, CAP3D, is now also available.

## **COMMUNICATION IN SECLUDED ENVIRONMENTS**

VINCI Construction has developed and patented telecommunications systems specifically for crews working in tunnels to talk to each other and to workers outside without using mobile phones (which usually have limited or no network coverage underground).





# INNOVATION IN THE GROUP'S SOCIAL POLICY

At VINCI, we're aware that technology is a powerful driver of progress, but we also know that engineering is only one facet of innovation, and only one of the dimensions that will enhance the cities of the future and the world we will live in tomorrow.

**A NEW ANGLE ON  
WORKSITES**

**QATAR: A NEW PHASE**

**WORKSITES WITH  
AN ARTISTIC TWIST**

**A PROACTIVE  
INTEGRATION  
PROGRAMME**



The fact that VINCI employs 195,000 people worldwide is only one example of the prominent role that the human dimension plays in everything we do. We have a proactive employment policy geared to attracting and retaining top talent. Employee training, mechanisms to share the benefits of performance and initiatives to encourage integration and diversity all rank high on the Group's list of priorities.

VINCI is also fostering new connections in the areas that its projects are transforming: we engage with our host communities and leave them more than new buildings and facilities when we complete our construction projects. That is another aspect of our vision for sustainable development.

### **Moving forward**

The Group's hands-on efforts to foster integration, which it channels through its company ViE (VINCI insertion Emploi), have afforded it widely respected expertise, which could apply to jobs and skills management on a regional scale in future. Employability is set to become a crucial issue as time goes by. More and more employees will be switching paths during their careers, and the focus will therefore shift to skills (over and above experience and training). ViE is VINCI's way of preparing this transition and the projects it is working on in northern and southern France are already yielding promising results.



## **A NEW ANGLE ON WORKSITES**

VINCI recently set up a ground-breaking corporate sponsorship fund for projects within the Grand Paris programme, as part of its commitment to the host communities. This fund – Chantiers et territoires solidaires – works with non-profits and startups near worksites to create business ties and social bonds with a view to generating economic benefits and creating value once construction work is finished.

This fund's main areas of focus are local jobs and social interaction in host geographies. In practice, Chantiers et territoires solidaires will for instance support people on their path to employment and create novel training modules for them. It will do so by providing financial assistance and by enlisting Group employees' skills on sponsorship programmes.



## **QATAR: A NEW PHASE**

VINCI and its company QDVC recently reached a milestone agreement with Building and Wood Workers' International (BWI) on workers' human rights in Qatar. This agreement, which we signed at the International Labour Organisation (ILO) head office, is a first in the country.



## **WORKSITES WITH AN ARTISTIC TWIST**

VINCI Construction also works with artists to foster interaction between its construction sites and the people around them. It is for example teaming up with Bellastock, a group of young architects who are blazing new trails in the circular economy in general and building materials reuse in particular. Our experience with them on the Marly le Roy viaduct (where nearby residents were welcome to decorate the fences around the building site, for example) showed that artistic expression effectively creates connections with people living in an area. We also organise training sessions with artists to bring them up to speed on safety rules to ensure this approach is fully effective.



## A PROACTIVE INTEGRATION PROGRAMME

More and more authorities are asking contractors to hire people on the fringes of the employment market for a given number of hours during construction projects. The standard requirement is 5% of the total number of hours worked but VINCI is intent on doing more than fulfilling its contractual commitments. ViE (VINCI insertion Emploi) has been helping Group companies and its partners to roll out their integration and employment policy by creating sustainable jobs since 2017. ViE is in close contact with central and local authorities and with private-sector operators, and provides a bridge between

business circles and social and inclusive economy circles while liaising with the organisations that help people on their path to work. This tightly knit network naturally caters to worksite staffing requirements as well, and is in a class of its own in France: it handles about 3 million hours of work on integration contracts, i.e. the equivalent of about 1,500 full-time jobs, every year.



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