Circular cities
Cities of tomorrow

Second edition
October 2019

Foreword to the new edition

Cities occupy barely 2% of the Earth's land surface, but they are home to over half of the world's population and generate more than 80% of its economic output. They are more than just a simple collection of buildings and activities; they are the anthropic landscape par excellence, the place where human intelligence has made its biggest mark, shaping it to suit its needs. From the Aristotelian polis to contemporary skylines, cities continue to be the most profound expression of our coexistence.

It is therefore not surprising that they will become one of the key players in the challenges that lie ahead, the stage upon which the major global trends are weaved: demographic trends, the growing demand for energy, the effects of climate change and the scarcity of resources. To a large extent, the future of the planet will be determined by the ability to strike a balance between social, economic and environmental factors, particularly within the urban context.

Patrizia Grieco

Enel's Chairman

The pace of change is astounding. Today, the world is experiencing the biggest wave of urbanisation in its history: according to the UN, by 2030 there will be 43 megacities with populations in excess of 10 million, the majority of which will be in the fastest-growing regions. This trend will continue to accelerate until the situation reaches completely unprecedented proportions that are almost impossible to imagine today: according to current forecasts, in 2100 the world's largest city will be Lagos, with a population of 88 million (in the 1960s it was less than 200,000).

The growth of these megacities will present a major challenge: guaranteeing the provision of essential needs – water, energy, homes, healthcare, security, transport – for a population that's constantly growing, while simultaneously ensuring increased social inclusion and reduced emissions. Unless we act quickly, these cities will inevitably become environmental and social failures.

Utilities will play a vital role in the life of these "giants" and in ensuring that their "metabolism" functions correctly. Since cities already consume around 75% of global primary energy, it's so important that the great energy transition revolution starts with them – and indeed, it already has.
Enel believes that the priority should be to define a coherent, long-term vision for current and future cities, a commitment it sets out in its 2019-21 Strategic Plan, with the objective of creating value while simultaneously improving the quality of life for urban communities. Our challenge has already begun: we are in Bogotá, Buenos Aires, Lima, Rio de Janeiro, São Paulo and Santiago, where we are grappling with rapidly evolving problems and opportunities on a daily basis.

But to tackle the complex and interrelated social, economic and environmental issues that arise in such a megacity, it is necessary to encourage innovative governance whereby the ability to actively listen and inclusion play a vital role, and growing marginalisation must be defeated with a new model of development and a new kind of humanism. We should remember that interpersonal relationships are the most fundamental and distinguishing pillars that underpin a city, the place where man decided to create a community.

Cities are being called upon, once again, to be the incubators of a better future. Enel is ready to play its part and accompany them on this journey, holding the guiding "compass" of sustainability and of technological innovation.

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Executive summary

Today's crucial environmental and social challenges require a major reappraisal of the current economic model. This necessity has, in recent years, led to the increased emergence of a new paradigm known as the circular economy, which has become established as a realistic solution to the conundrum of combining, through innovation, competitiveness and environmental sustainability.

The commitment towards this circular transition is spreading to all levels and geographical areas: institutions, associations, citizens, the research world and businesses are already embracing this vision in their activities. The challenge therefore, is not one of creating consensus regarding this vision, but is about fulfilling it quickly, as the urgency of the problems we are confronted with requires.

Implementing a circular economy model means rethinking the way in which we use materials and energy: from planning through to production, from consumption through to the management of so-called "waste." It's a structural change that requires a twofold commitment: on the one hand reconsidering technologies, business models, behaviours, responsibilities and the relationships between fields and sectors; and, on the other, managing the transition of an economic system in which processes, approaches, regulations, assets and expectations based on a linear economic vision have been rooted for decades.
Complete collaboration between all the major players is therefore absolutely vital: this is why Enel considers it important to continue the work that – from an Open Power perspective – we have already set in motion in recent years.

Imagining a new development model for cities means imagining it for the entire planet. Indeed, more and more of the world's population are living in cities, where they are consuming the vast majority of the resources produced and where the environmental issues are becoming increasingly evident.
It's for precisely this reason that, after one year, we've decided to renew the specific focus on circular cities, both to recognise the new ideas and progress that have emerged during these months and to assess, extend and further accelerate the thinking, discussion and collaboration. The purpose of this report is to provide an update on the subject of circular cities in light of the projects, initiatives and discussions that are in progress, both those associated with Enel, as well as with other organisations that share the same commitment.

For this second edition we have asked the institutions, universities and companies who share our awareness of this subject to make a brief contribution related to their areas of expertise. Such contributions do not represent an endorsement, by them, of the entire document, the responsibility for which rests solely with Enel.

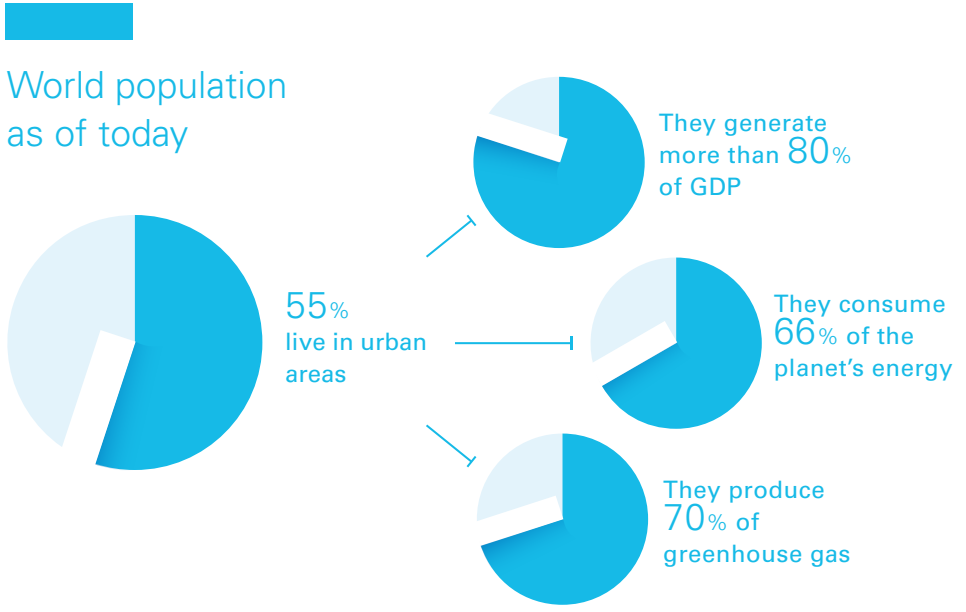
Part A

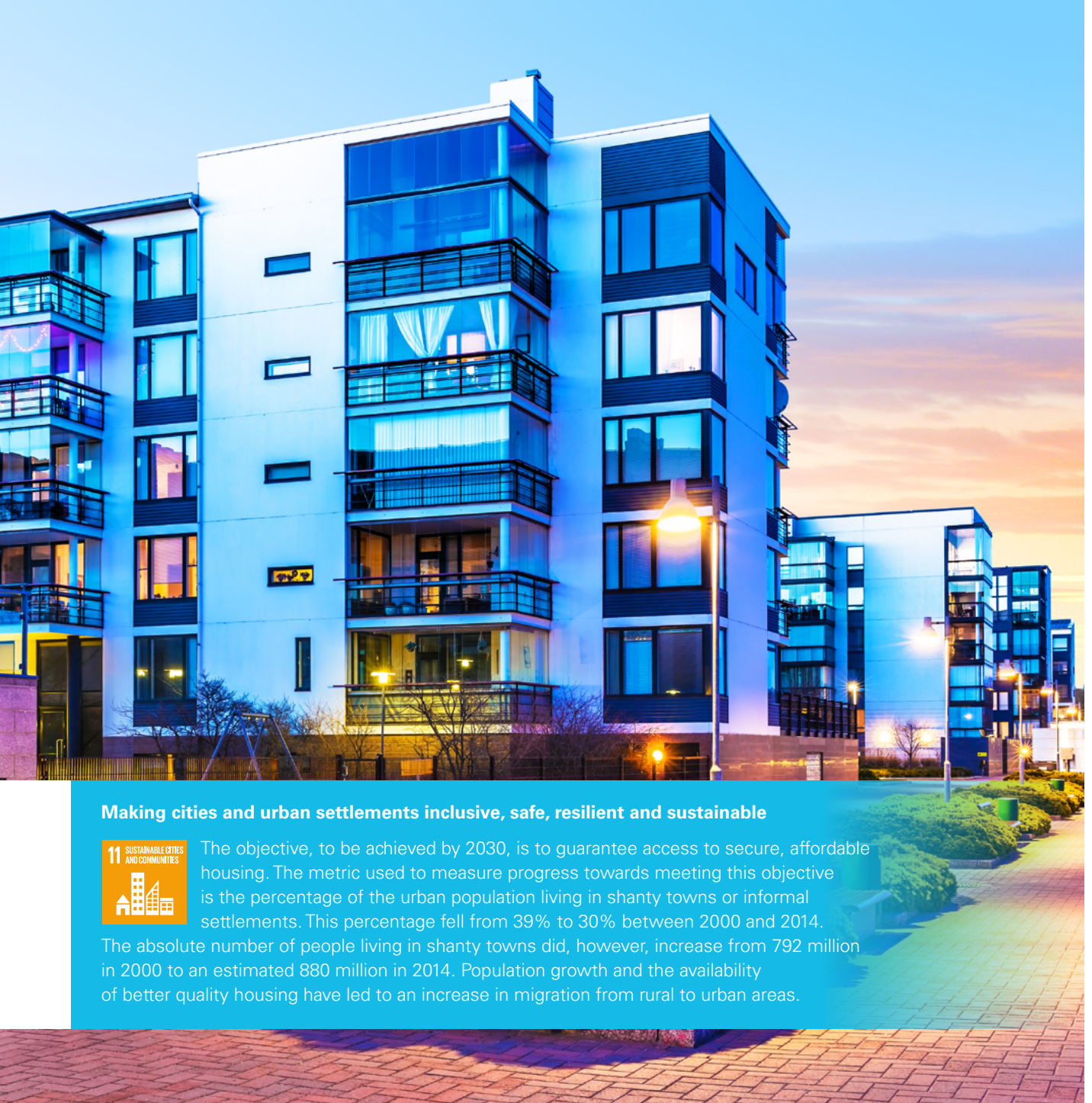
The circular economy and sustainable development

The new global context

1

The further deterioration of environmental problems, the rapid evolution of technology and increasing social issues are undoubtedly among the major transformations we are currently witnessing today.
Currently, 55% of the world's population live in urban areas[1], they generate more than 80% of global GDP[2], consume two thirds of the planet's energy[3] and are responsible for 70% of the world's greenhouse gas emissions[4].
With the world's population constantly growing, the percentage living in cities is due to reach 68% by 2050[5] with average per capita consumption also increasing[6], and, unless there is a radical reversal in these trends, all these indicators are destined to continue rising: for example, the production of waste is expected to increase by 70% over the next 30 years[7].
At the same time, cities are becoming increasingly vulnerable to the effects of climate change: in an environment where there is a high concentration of man-made structures, the impact of extreme weather events can be dramatic[8]. The fight against climate change – which really came to prominence during the 21st session of the COP (Conference of the Parties) to the UNFCCC (United Nations Framework Convention on Climate Change), held in Paris in December 2015 – and environmental pollution demands a rapid process of decarbonisation and a reappraisal of how we use materials and energy. These objectives necessitate a circular model based on the electrification of consumption that increasingly uses renewable energy sources.
The understanding that the boundaries and challenges should be viewed as integrated and interconnected is becoming ever more evident, thanks to approaches like the *planet boundaries*[9], concept, which analyses the planet's nine principal boundaries in quantitative and integrated terms, or the doughnut economics model which integrates the economic model with environmental limits and social needs so as to identify a safe and just space for humanity[10].
The topic of sustainable development falls within this new vision with the UN's Sustainable Development Goals (SDGs). With a completion deadline of 2030, 17 objectives have been established to shape a new economic paradigm that directly





Making cities and urban settlements inclusive, safe, resilient and sustainable

The objective, to be achieved by 2030, is to guarantee access to secure, affordable housing. The metric used to measure progress towards meeting this objective is the percentage of the urban population living in shanty towns or informal settlements. This percentage fell from 39% to 30% between 2000 and 2014. The absolute number of people living in shanty towns did, however, increase from 792 million in 2000 to an estimated 880 million in 2014. Population growth and the availability of better quality housing have led to an increase in migration from rural to urban areas.

concerns urban areas; one objective in particular (SDG 11: "Sustainable Cities and Communities") is exclusively aimed at cities.
Innovation plays a fundamental role: how new technologies can contribute to improving the interaction between humans and nature, and how new business models can combine economic development and social inclusion are questions that are still under discussion. Technology in itself is an enabler, but to meet these challenges a complete rethink is necessary in terms of objectives, governance, approach and culture.

To meet these challenges a complete rethink is necessary in terms of objectives, governance, approach and culture

[1] UN, *World Urbanization Prospects. The 2018 Revision*, 2018.
[2] World Bank, *What a Waste: An Updated Look into the Future of Solid Waste Management*, 2019.
[3] World Economic Forum, *This Is What the Cities of the Future Could Look Like*, 2019.
[4] C40 Cities, *A Global Opportunity for Cities to Lead*, 2019.
[5] UN, *World Urbanization Prospects. The 2018 Revision*, 2018, cit.
[6] UN Environmnent Programme, *Global Material Flows and Resource Productivity: Assessment Report for the UNEP International Resource Panel*, 2016.
[7] World Bank, *What a Waste: An Updated Look into the Future of Solid Waste Management*, cit.
[8] IPCC, *2018 Global warming of 1,5 °C*.
[9] Stockolm Resilience Centre, *The Nine Planetary Boundaries*, 2019.
[10] Kate Raworth, *L'economia della ciambella, Edizioni Ambiente*, Milan 2017.

The circular economy

2

The circular economy might be seen as an "umbrella concept," the definition of which was progressively shaped over the course of the second half of the 20th century with initial considerations regarding the impact man was having on the environment and the related limits to growth[11], it was then consolidated at the beginning of the 21st century with theoretical ideas like "cradle to cradle,"[12], the "performance economy"[13], "upcycling"[14], "Biomimetics"[15] etc. The basic idea is to rethink the economic model, one that's no longer based on extracting resources, on production, and on consumption but rather on exploiting sustainable inputs (renewables and from recycling) and circular design, on maintaining the value of assets and materials as long as possible and on transferring the focus from ownership to use. The last 10 years have seen a significant acceleration in discussion and work on this subject, thanks to **four key factors**.

1

Innovation
An array of new technologies has enabled the implementation of solutions that until just before their invention seemed unimaginable, both through replacing existing applications with more competitive, sustainable solutions (for example, electric mobility and renewable sources) and through completely new fields such as Information Technology or Artificial Intelligence.

2

Environmental awareness
The importance of environmental issues, which are nowadays also of great concern for the public, has slowly but surely become widely understood to the point whereby it is now, almost unanimously, seen as a key consideration in every decision.

3

Institutional commitment
Albeit with varying scopes and timescales, many institutions at all levels are now putting the circular economy at the heart of their strategies, starting with the Circular Economy Package presented by the European Commission in 2015.

4

Collaboration
The circular economy is also an important catalyst in terms of promoting collaboration, both between sectors and within individual sectors; indeed, each of its applications presupposes the crossing of traditional divisions and silos.

There is a large number of areas in which the circular economy can play an important role, the principal examples of which are outlined below:

Competitiveness. To be genuinely considered as a new paradigm, the circular economy must also offer solutions that are competitive from an economic standpoint. The basic rationale is clear, since the reduced consumption of materials and energy, the improved use of resources and end-of-life value recovery are all indicators of improved competitiveness. It is, however, important to bear in mind that legislation, incentives and business models are all still focused on a linear economic model. Furthermore, both the use of resources and the so-called "negative externalities" are not entirely internalised economically: not fully paying for the environmental impacts being caused, means there is no incentive to reduce those impacts. It is only through innovation and collaboration between the various sectors and key players, both public and private, that we'll be able to overcome this difficulty.

The reduced consumption of materials and energy, the improved use of resources and end-of-life value recovery are all indicators of improved competitiveness

Use of resources. The success of the circular economy presupposes a complete reappraisal of every sector in the entire production and supply chain, focusing on the use of renewable materials and energy and on new models of asset sharing and maintenance that maximises their use. Wherever the use of renewable materials proves impossible, the focus should turn towards maximising the end-of-life recycling possibilities of the resources used, as well as looking to extend the useful life of the assets and products.

Environmental impacts. There are many direct environmental benefits that derive from a circular model: reduced emission of pollutants at a local level, such as NO_x, SO_x and dust, thanks to renewable energy, electric mobility and improved efficiency; reduction in waste being sent to landfill through both a reduction in volume as well as an increase in recycling and reuse; reduction of the impact on water and soil thanks to the use of natural and biodegradable materials.

Decarbonisation. The objectives of decarbonisation should not just be related to direct emissions and offsetting measures, but it should involve all aspects of the economic model. Understanding the impact of the circular economy in this sense is very complex, but the initial studies that have been published in recent years indicate that its impact will be significant[16] [17].

[11] From the report I limiti dello sviluppo (The Limits to Growth) commissioned by the Club of Rome in 1972 and written by the scientists Donella and Dennis Meadows and Jørgen Randers. The report was turned into a book that was published the same year by Mondadori: *I limiti dello sviluppo*.

[12] William McDonough e Michael Braungart, *Cradle to Cradle*, North Point Press, New York 2002.

[13] Walter Stahel, *The Performance Economy*, North Point Press, New York 2006.

[14] Michael Braungart and William McDonough, *Upcycle. Oltre la sostenibilità. Progettare per l'abbondanza (The Upcycle: Beyond Sustainability - Designing for Abundance)*, Edizioni Ambiente, Milan 2015.

[15] Janine Benyus, *Biomimicry: Innovation Inspired by Nature*, William Morrow & Co, New York 1997.

[16] *The Circular Economy. A Powerful Force for Climate Mitigation.*

[17] *The Circular Economy and Benefits for Society.*

The circular economy entails a reappraisal of every part of the production and supply chain

FOCUS

The new combination: resilience e circularity

Enel Foundation

While Europe is sizzling through a new record breaking heatwave and droughts in the Horn of Africa have left millions of people severely food insecure – confirming that humanity has entered the Anthropocene a new normal condition, in which we are called to operate, that is here to stay and it is definitely characterized by increased hazard exposure and vulnerability – is becoming more and more clear that the new wealth of nations relies for the years to come on the binomial resilient and circular. Two essential elements to design our economies, our enterprises, our cities and pretty much every constituency we are part of if we wish to leave a healthier and lasting Planet for the generations to come.

Indeed, realizing we are called to operate in a new normal condition where resilience need to be re-design – making its way out of the scientific realm and supranational organization into government cabinets and boardrooms globally – provides an indispensable compass to shape a sustainable development for all.

On the other hand, circularity is the only way forward to ensure fundamental systems transitions and transformations for our societies to evolve within the planetary boundaries lowering the actual pressure on those while adapting faster and smarter to the new operating conditions.
With this new binomial in mind – resilient and circular – practitioners and scientists, business and civil society should converge in pursuing circularity as an essential way to create sustainable products and services conscious that their contribution will have a major impact on our Planet driving preparation and adaptation to the new normal conditions while consistently reduce pressure on planetary boundaries.

3

The circular economy within Enel's sustainable business model

The scale of the challenges faced by the planet today, in terms of economic growth, environmental sustainability and social inclusion requires the involvement of a variety of players including, in particular, companies. This implies the need for these challenges to be fully integrated into their strategies. In particular, contributing to solving the problems that we will have to face, above all global warming, must be given top priority. It is this awareness that, over the years, has driven Enel's transition towards a sustainable business model, a key cornerstone of which is the focus on the circular economy.

Enel encourages the application of the sustainable business model along the entire length of its value chain via the 17 Sustainable Development Goals (SDGs), aligning its strategy with that which has been laid down by the United Nations, in addition to measuring and managing its direct contribution in terms of the achievement of those goals.

To that end, the Group has established specific objectives that contribute to SDG 9 ("Industry, Innovation and Infrastructure") and SDG 11 ("Sustainable Cities and Communities"): Enel expects to reach around 47 million installed smart meters and 455,000 electric mobility charging points by 2021, and to invest 5.4 billion euro in digitalisation over the 2019-21 three-year period.

Enel's commitment, which is based on a clear understanding of current urbanisation trends, is set out in its 2019-21 Strategic Plan via these main initiatives:

- specific investments in the development of distribution networks (to digitalise them and make them more resilient, flexible and capable of delivering new services) and in the increased production of energy from renewable sources in order to electrify consumption and accelerate decarbonisation;
- specific investments in the development of electric mobility (public transport, recharging infrastructure) that have a positive impact on people's lives through the reduction in emissions and average travelling times;
- development of more products aimed at improving energy efficiency in order to make a positive contribution to the energy efficiency of buildings.

Enel has committed to investing approximately 4.6 billion euros over the three-year period from 2019 to 2021 on activities related to the development of networks and around 700 million euro on the development of new energy services, including electric mobility, confirming an expected increase in revenue to derive from such investments.

Part of the financing for these projects comes from Enel's 3.5 billion euro Green Bonds, which were issued on three separate occasions between 2017 and 2019. The proceeds are being used to finance the development of renewable sources of energy but, above all, projects that relate to the UN's 17 SDGs. Enel's Green Bonds have generated great interest in the market. They have received requests that are between 2 and 3.5 times the amount actually issued, at a price substantially in line with the generic Enel Bond with the same maturity (and in 2019, with a spread that is approximately 10% lower).

Furthermore, in September 2019 Enel launched a "sustainable" bond issue aimed at institutional investors for which the demand was almost three times that of the actual amount issued and with a spread of around 20 basic points (bps) below that of a potential "non-sustainable" bond issue with substantial participation from the so-called Socially Responsible Investors (SRI). The bond is aimed at SDG 7 ("Affordable and Clean Energy)", SDG 9 ("Industry, Innovation and Infrastructure"), SDG 11 ("Sustainable Cities and Communities") and SDG 13 ("Climate Action"). In particular, for SDG 11 the target involves investments in retail and new energy services oriented towards electrification so as to achieve, among other things, a 9.9 GW demand response and 455,000 recharging points for electric mobility by the end of 2021.

Enel's Green Bonds have generated great interest in the market. They have received requests that are between 2 and 3.5 times the amount actually issued

Part B

The circular city

Why the circular city

1

Enel has decided to utilise the concept of the circular city to tackle the cities of tomorrow issue, because the Group believes it's important to take a holistic view of the urban context, considering all its various aspects; to that end the circular economy represents an overall framework within which the lines of action can be defined and integrated. Enel's vision is better expressed via this concept rather than through that of smart cities, which is too closely associated with purely technological aspects.
The best solutions for achieving economic growth that also incorporates quality of life, environmental sustainability and social inclusion cannot be considered in isolation without an overarching framework that draws the basic objectives together into a single, integrated strategy.

An urban redevelopment project in Seoul, South Korea, a pedestrian walkway has taken the place of a motorway that was built over the Cheong Gye Cheon riverbed.

Within this context technology represents an essential enabler that facilitates the transition, the effectiveness of which doesn't just come from the implementation of the technology, but from the degree to which the economic, environmental and social objectives are met.

A holistic view of the urban context

The most relevant urban sectors

2

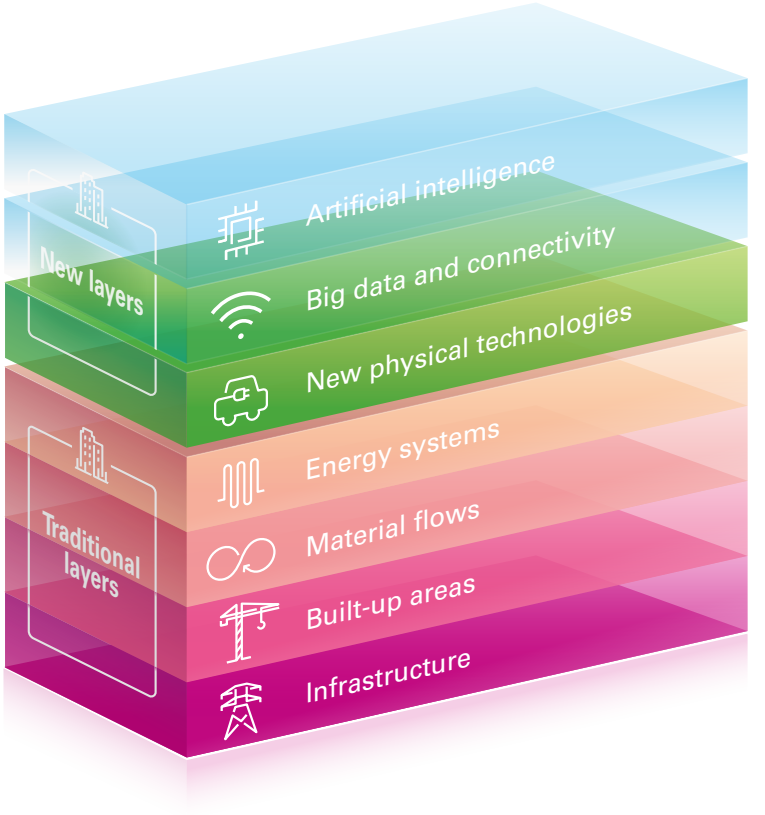
To analyse the challenges and opportunities of the cities of tomorrow it's useful to consider the key elements that constitute the urban metabolism on the one hand, and, on the other, the various technology plans that have been developed in recent years for those elements. A key role will be played by **infrastructure** (electricity grids, street lighting, water, gas, telecommunications and ports). And, the more is digitalised and the more it develops a platform model, the greater the possibilities for enabling other services. The traditional contexts for urban metabolism are:

- **Built-up areas**, both residential and industrial;
- **Material flows:** with a focus on food and the bio-economy, including the issues of food, packaging and waste;
- **Energy systems**, in other words heating/cooling, transport, energy supply.

With respect to the technology plans, which have emerged in recent years and have now assumed a central role, we have considered:

- **New physical technologies**: new tangible technological solutions that substitute existing technologies;
- **Big data and connectivity**: technologies that underpin the management and transmission of huge volumes of data;
- **Artificial intelligence**: applications and solutions that provide services to users.

Even these new city layers need to be reappraised from a circular viewpoint, because the digital technologies themselves are also consumers of energy and rare metals[18].



[18] *European Parliament resolution of 13 November 2018 on digitalisation for development: reducing poverty through technology.*

2.1 Energy systems

Energy systems are absolutely fundamental to the circular city, in particular for industrial and residential energy consumption, transport and heating/cooling systems. Despite the fact they are responsible for the majority of emissions and urban pollution, they are a fundamental element of the drive towards economic growth and improved quality of life. In a circular economy, all these elements must be reassessed with respect to renewable energy, energy efficiency and electrification, so as to develop an entirely renewable paradigm that has zero emissions, both locally and globally. This approach makes it possible to resolve the environmental challenges we face, to encourage innovation and to improve the quality of life.

The technology to do so is already there, it's just not yet as widely available as it needs to be. Here's a brief overview.

Electrification of consumption
Electric technologies (electric cars, heat pumps, etc.) offer incredible efficiency and zero local emissions resulting from combustion. In addition, if they could also be supplied with electricity from renewable sources, they would represent the path to the holy grail.

Use of renewable sources
Renewable energy sources (principally solar power and wind power) have already reached a level of competitiveness that makes them a genuine alternative to fossil fuels, thereby contributing to the stabilisation and reduction of energy prices.

Application of new technologies both to the network and to the digitalisation of processes offering advantages in terms of advanced operations management

Energy efficiency
The possibilities for reducing consumption are significant, from building insulation to the increased efficiency of production systems to the replacement of applications with better performing ones.

Innovative technologies
New solutions are making certain technologies increasingly competitive, for example batteries (optimising the consumption of energy from solar panels), demand-side management (reducing consumption with additional economic benefits), Vehicle-to-Grid, where electric cars can also supply services to the bi-directional network while parked, thus maximising their use.

Network digitalisation and new technologies
Smart meters offer automation and remote control with benefits in terms of improving the quality of service, enabling new services to be made available to the customer, enabling the integration of distributed generation, reducing network leaks and improving operational efficiency. There's also the application of new technologies (the Internet of Things, Industry 4.0, Artificial Intelligence, Augmented Reality, etc.) both to the network and to the digitalisation of processes offering advantages in terms of advanced operations management (predictive maintenance, monitoring, diagnostics, simulations, training, workers' health and safety, etc.), enabling new organisational and management models and keeping the customer at the centre of the ecosystem.

2.2 The Built Environment

ARUP

The circular approach offers a unique opportunity to tackle the complex and multi-dimensional nature of the built environment. Capitalising on this opportunity requires a move towards a systemic approach that can be applied across a variety of dimensions and scales: buildings, infrastructure, districts, cities, regions and even entire economies.
Up until now the built environment has been slow to streamline its processes: many traditional divisions and silos continue to impede the kind of drastic changes that have transformed other sectors. Realising the potential of the circular economy requires a new approach to all aspects of the value chain. These include financing, purchasing, planning, construction, management, maintenance, reuse and recycling.
At Arup we believe that a new approach to design, planning and construction – one that incorporates the principles of the circular economy – would contribute to improving the quality of the built environment, which in turn would have a significant impact on human health, well-being and productivity.
Minimising negative externalities is a key objective of the circular economy and we are analysing case studies to explore every possible avenue for achieving it. Some recent examples include the Circular Building (London, 2016) and the People's Pavilion (Eindhoven, 2017). In the first example the construction components and systems were leased from a number of producers and temporarily installed on the building before being dismantled and reused via an effective reverse logistics process. In the second case the pavilion was built using materials and components recovered from an old building, thus prolonging their useful life through a second use.
These new approaches to creating buildings require a step change and an innovative mindset in terms of the design, technological and economic aspects. Digitalisation helps to stimulate innovation, which is driving the change towards circularity, thus maximising

The People's Pavilion (Eindhoven, 2017)
Built using materials and components recovered from an old building, thus prolonging their useful life through a second use.

efficiency, encouraging flexibility and reducing waste. In particular, a new capacity for gathering, archiving and connecting data will be key to shaping a new innovative notion of the built environment, including the concept of the building as a sort of asset bank, where materials, systems and components are only temporarily held before being reused. Such an approach minimises the use of virgin materials and ensures that those already produced maintain their value. Similarly, the use of BIM (Building Information Modelling) will support the design process by creating digital models of construction resources; this will facilitate improved operations, maintenance and future dismantling.
Alongside these aspects, a broad change will also require a reappraisal of how the value chain works, including new business models and financial incentives. Such models will apply to all phases of the construction process, from procurement and the use of assets to production, to transport and right through to the installation and dismantling of materials and components, and will lead to social – specifically, new jobs –, economic and technological benefits.
The physical context within which all these changes will occur will be our cities, environments consisting of systems within systems, with a multitude of overlapping networks that interact at different levels. Cities are dense, highly resource-intensive ecosystems. Arup's aim is to establish a specific framework for the built environment that brings all the existing and emerging principles together with approaches to design. This involves a collaborative and all-encompassing structure, one that's defined by the circular functionality of the entire value chain and not by the delivery of single components. The circular economy offers an alternative approach to the growth of our cities, one that uses less resources, reduces the impact on the environment and makes them more resilient.

2.3 The Bio-economy

NOVAMONT

The bio-economy – which is defined by the European Commission as that economy which uses organic renewable resources or waste as inputs to industrial, food and animal feed and energy production – can be a key component in preventing the pollution of our ecosystems and exploiting waste from a circular economy perspective.
The approach is to ecodesign products conceived to increase the quantity and quality of recycled waste, reduce the amount of organic waste sent to landfill and to protect the water and soil. Protecting these two elements, which are of fundamental importance but are particularly vulnerable to degradation and pollution, is also essential in the urban context, and can be facilitated through the use of products that are specifically designed to safeguard natural resources. One such example is compostable bioplastics which can be disposed of

The bio-economy could be an important tool for preserving ecosystems and enhancing the value of waste from a circular economy perspective

together with organic waste and will break down in composting facilities, thereby offering a solution that simplifies the management of waste, particularly food waste. Indeed, since it would otherwise just end up in landfill, using such materials makes food waste more valuable by transforming it into quality compost. This in turn can, from a circular economy perspective, be used as a kind of fertiliser by returning organic substances back to the soil, thus combating desertification.
Using bags for waste sorting, for example compostable shopping bags and fruit and vegetable bags for organic waste, helps to improve the quality of sorting and sorted waste. Closed systems such as canteens and town festivals are situations in which, due to the large quantities and to hygiene regulations, it can be difficult to use reusable tableware, so the application of compostable tableware makes it possible to optimise waste sorting and to dispose of all the materials with the organic waste.

Another type of bio-economy product that is capable of creating added value in cities is bioherbicides, which can be used in the management of public green areas, and there are also biolubricants, which can be used for the maintenance and operation of vehicles and machinery

that help provide urban services. These offer a viable, sustainable alternative to traditional products, since their natural biodegradation doesn't have a negative impact on the environment and protects the health of citizens.
Biolubricants also generate added value in terms of safety, their flash point is higher than that of traditional lubricants, so there is a reduced fire risk. Finally, the increased use of biodegradable ingredients in cosmetic products helps to avoid the contamination of sewage sludge and the dispersion of microplastics into the oceans and seas, since such products are specifically designed to biodegrade in wastewater treatment facilities. Urban facilities and systems are the key to facilitating circularity and to transforming potential problems into opportunities.
The development of projects which look to make bio-economy products compatible with wastewater treatment and composting facilities is vital in the quest to regenerate resources, because it reduces man's impact on the environment and generates new solutions from scrap products and waste.

A sustainable alternative to traditional products, since their natural biodegradation doesn't have a negative impact on the environment and protects the health of citizens

2.4 Food

University of Gastronomic Sciences
Università degli Studi di Scienze Gastronomiche

Specialisation now prevails over generalisation, productivity prevails over quality of life, and profit prevails over well-being. It's as a result of this linear way of thinking, for example, that it's become clear that the concept of waste and the consequential environmental and social decline were "system design errors"[19]. Just taking a look at the figures on food waste – one of the many problems connected to the unsustainability of our productivity model – we can see that we are contributing to a very real "crisis of reason"[20]. Every year, we throw away 1,300,000,000 tonnes of food (the equivalent of about 8,600 cruise ships), with an overall value of 1,700 billion dollars[21], all while knowing that it would require approximately 267 billion dollars per year to eradicate world famine by 2030, an investment amounting to 0.3% of global GDP[22].
Furthermore, while we continue to send products to landfills that the system can't metabolise, the same thing, less evidently, is happening in our bodies. With 83% of the world's drinking water now contaminated[23], along with our "normal" food every week we are ingesting 5 grams of microplastics[24] together with a considerable number of chemical substances (antibiotics, fungicides, insecticides, herbicides, etc.) that alter our physiological balance.

Every year, we throw away 1,300,000,000 tonnes of food (the equivalent of about 8,600 cruise ships), with an overall value of 1,700 billion dollars

[19] Carlo Petrini, *Un atto politico e culturale (A cultural and political act)*, in Franco Fassio and Nadia Tecco, *Circular Economy for Food. Materia, energia e conoscenza, in circolo (Circular Economy for Food. Matter, energy and knowledge, in circulation)*, Edizioni Ambiente, Milan 2018.

[20] Albert Einstein, *Come io vedo il mondo (The World as I See It)*, Newton Compton, Rome 1975.

[21] FAO, *Global Initiative on Food Loss and Waste Reduction*, 2015.

[22] FAO, IFAD, WFP, *Achieving Zero Hunger: The Critical Role of Investments in Social Protection and Agriculture*, 2015.

[23] Orb Media Report, *The Plastic Inside Us*, Washington, 2017.

[24] Kala Senathirajah e Thava Palanisami, *How Much Microplastics Are We Ingesting? Estimation of the Mass of Microplastics Ingested*, The University of Newcastle, Australia 2019.

Even if we just look at our economic system from this perspective, it's clear that we are more concerned with furthering economic goals rather than responding to humanity's real basic needs[25]. So the need to change paradigm is now urgent, to improve our ability to understand and see the interconnections, to listen to feedback[26] and to apply this model to food so as to generate real change.
After all, it shouldn't be that difficult to understand, especially since "circularity" is a characteristic of man and the environment in which he lives. Man is an open system containing an array of circular dynamics[27], like that which begins when we eat something. Food is the means by which the human body starts to metabolise matter which is then transformed into energy for life[28]: we are what we eat[29].
So, this is not exclusively about reducing waste by finding a new use for by-products or waste: developed from just this perspective, there would be a risk of the new economic paradigm becoming a model that promotes a manipulative approach to waste, an approach that could, ironically, lead to the acceleration of planned obsolescence. Instead, using food to develop a change of paradigm in a circular sense means turning the attention back towards the community, to the quality of relationships and to the nature of behaviours[30]. This means not jeopardising the relationships with the best suppliers of raw materials known to man[31], it means moving away from a linear economy that creates the appearance of abundance but serves it up on a very fragile plate, to one that's circular, regenerative and designed to

Using food to develop a change of paradigm in a circular sense means turning the attention back towards the community, to the quality of relationships and to the nature of behaviours

[25] Abraham H. Maslow, *Motivation and Personality*, Harper & Row, New York 1955.

[26] Donella Meadows, *Pensare per sistemi (Thinking in Systems)*, Guerini, Milan 2019.

[27] Ludwig von Bertalanffy, *General Systems Theory*, George Braziller, New York 1968.

[28] Humberto Maturana and Francosco Varela, *Autopoiesi e cognizione. La realizzazione del vivente (Autopoiesis and Cognition: the Realization of the Living)*, Feltrinelli, Milan 1980.

[29] Ludwig Feuerbach, *Die Naturwissenschaft und die Revolution (Natural science and the revolution)*, Akademie Verlag, Berlin 1871.

[30] Carlo Petrini, *Un atto politico e culturale (A cultural and political act)*, in Franco Fassio and Nadia Tecco, *Circular Economy for Food. Materia, energia e conoscenza, in circolo (Circular Economy for Food. Matter, energy and knowledge, in circulation)*, Edizioni Ambiente, Milan 2018.

[31] Amory Lovins, Hunter Lovins and Paul Hawken, *Capitalismo naturale (Natural Capitalism)*, Edizioni Ambiente, Milan 2011.

be at one with nature[32]. The current geopolitical "food system" challenge is about revolutionising the production model, starting with the correct management of natural capital[33] to which cultural capital is also associated[34], by respecting the planet's limitations[35] while simultaneously allowing reasonable space for civil society[36].
The priority in this regard, particularly in the urban context, is to treat food as being part of the infrastructure that's interconnected with the surrounding environment[37], an infrastructure that must be designed around the circular model. This is in synergy with the flows of materials, energy and knowledge that characterise this type of model[38].
Circular cities, since they are social and urban ecosystems, must become the symbol of man's coexistence with natural ecosystems, and the involvement of the people that live there is vital for the achievement of this objective. The main objective for the Circular Economy for Food Hub in Pollenzo[39] is to encapsulate, without trivialising[40], this complex vision of the "food system": spreading the word on the three pillars which should drive the evolution of a new food paradigm, the so-called three Cs, as described by the Circular Economy for Food.
The first C is the most important, the basis of all reasoning, it stands for natural Capital, to which cultural capital is also linked: without biodiversity it's impossible to maintain a new economic model that's stable and resilient. The second C stands for Cyclicality, in other words the necessity to operate within a regenerative flow of resources and energy, using sustainable inputs, extending the useful life of all products, promoting the selling of services rather than products, incentivising sharing platforms and planning every product's end of life so that it can always be used for a new purpose. The final C is for Coevolution, in other words the system cannot evolve in a way that creates social inequality, and the human race cannot continue to live on this planet over the long term if it doesn't allow nature to evolve at its own pace.

The so-called three Cs, as described by the Circular Economy for Food:
C for natural Capital
C for Cyclicality
C for Coevolution

[32] Franco Fassio and Nadia Tecco, *Circular Economy for Food. Materia, energia e conoscenza, in circolo (Circular Economy for Food. Matter, energy and knowledge, in circulation)*, Edizioni Ambiente, Milan 2018.

[33] Amory Lovins, Hunter Lovins e Paul Hawken, *Capitalismo naturale (Natural Capitalism)*, Edizioni Ambiente, Milan 2011.

[34] Pierre Bourdieu, *Actes de la recherche en sciences sociales*, vol. 31, January 1980; *Le capital social (Social Capital)*.

[35] Johan Rockström et al., *Planetary Boundaries: Exploring the Safe Operating Space for Humanity*, in "Ecology and Society", 14, 2, 32, 2009.

[36] Kate Raworth, *L'economia della ciambella (Doughnut Economics)*, Edizioni Ambiente, Milan 2017.

[37] Andrea Calori and Andrea Magarini, *Food and the cities: politiche del cibo per città sostenibili (Food and The Cities: Food Policies for Sustainable Cities)*, Edizioni Ambiente, Milan 2015.

[38] Franco Fassio and Nadia Tecco, *Circular Economy for Food. Materia, energia e conoscenza, in circolo (Circular Economy for Food. Matter, energy and knowledge, in circulation)*, Edizioni Ambiente, Milan 2018.

[39] Alice Calaprice, *The Ultimate Quotable Einstein*, Princeton University Press, Princeton 2013.

[40] In 2018 the University of Gastronomic Sciences in Pollenzo, in collaboration with Regione Piemonte (the Piedmont Regional Council), created the Circular Economy for Food Hub (CEFF HUB), a forum involving major companies and researchers from across the world for discussing the evolution of the circular economy with respect to food and communicating it to the public in a way that's accessible and understandable: so that the information can be circulated in order to become a catalyst for positive action.

2.5 Infrastructure and energy networks

Circular solutions cannot become properly established if they are not supported by adequate infrastructure. The term infrastructure encompasses a broad range of aspects: particularly worth mentioning are those related to transport (railways, roads and motorways, airports, ports), the digital infrastructure and energy networks. These are areas in which the circular economy can play a fundamental role in the conception, implementation, maintenance and possible decommissioning. Let's just look at energy networks and consider **some of the important aspects**:

Smart grid
To realise the possibility of a system based on renewable sources and electric technologies, the installation and management of numerous new delivery and/or withdrawal points (electric cars, heat pumps, residential solar panels, etc.) are necessary. Customers who become prosumers (producers and consumers) are looking for the electricity grid to be constantly adapted and upgraded through smart meters, automation, remote control and new technologies (sensors, drones, robots, Augmented Reality, Artificial Intelligence, etc.). This enables the full use and evolution of the network, it becomes a neutral enabler for the supply of new services to customers while guaranteeing its own stability, quality and efficiency.

Data transmission networks (optical fibre and wireless)
The technological innovation that has enabled the development of many circular economy applications requires the transmission of far larger volumes of data with increasingly reduced latencies. The current telecommunications systems in Europe, which are often based on copper networks, do not allow for the qualitative leap necessary for the development of new business models for the future of cities (e-government, e-health, e-learning, etc.) and for the development of services required by the cities of the future, such as Fibre-To-The-Home (FTTH).

Smart street lighting
Street lighting networks, in addition to becoming increasingly more efficient, thanks to new LED technologies and advanced remote control systems, are becoming a form of infrastructure that is capable of delivering new services related to security, environmental/local monitoring and connectivity.

2.6 The role of technology in enabling circular cities

accenture

In a circular city the role of technology is crucial. The aim of having increased circularity is not something that can just be written into policies, it's something that needs to become real by establishing the different city layers it's composed of, i.e. the plethora of technological solutions that characterise each level. To do so requires implementing a rigorous process for managing innovation, one that's not just capable of exploiting and connecting existing technologies but which is also, and above all, capable of putting in place the conditions for scaling and integrating them, including through open integration, with emerging and more innovative technologies. Let's consider, for example, the advanced systems on which Artificial Intelligence and the Internet of Things are based. They are capable of laying

In a circular city the role of technology is crucial

the foundations for enabling solutions, opportunities and new business models to better use resources and reduce negative externalities.
In this context the boundaries between the physical and digital worlds become blurred, as do the boundaries between the physical and technological components that integrate and complete each other even better. This process makes it possible to optimise the use and functioning of the various categories of assets and systems and the functions they provide. Indeed, thanks to technology, it will be possible to develop new and ever more efficient solutions for circularity based on the continuous exchange of information regarding the status, inputs and outputs, and supply and demand. This exchange between users, machines, infrastructure, and administration and management systems will simplify and optimise the user-infrastructure-controller interactions in all their forms.
Such interactions will create technology ecosystems that might be viewed as being hybrid, since they are composed of both physical and digital elements. These will act as a glue between the physical world, with its wide network of sensors, and the digital world of data analysis and processing. This then enables the administration and control, including in real time, of the physical assets (roads, railway lines, water mains, electricity grids) and the flows that run along them (cars, trains, water, energy, materials, waste). Similarly, it is also possible to monitor their condition and operation, flagging up issues and ensuring they don't pose a safety risk.
This process of evolution must also be combined with significant data gathering and integration, by using data that is already available to cities in large quantities. This is data generated by information systems that support the urban processes managed by the municipality, by municipally owned companies responsible for running urban services and by third parties, in other words open data that's shared between various parties and is readily available for anyone who needs to use it. This vast quantity of information needs a "Big Data approach" and should be managed appropriately, both for the development of advanced solutions to analyse and exploit information flows, as well as for preparing to manage the expected exponential increase in data generated by sensor-generated data.
In the latter case we are referring to data that's generated automatically, in real time, by interconnected networks, systems, solutions and infrastructure, which would give rise to interactions and applications that are still, even today, totally unimaginable.
Everything described above will only be possible if the future design and development of urban technologies is guided by the logic of integrated planning, safety, sustainability during the building phase, use and decommissioning (circularity), and the capacity to be interconnected and resilient; in a few words, the capacity for being open and smart.
Until now it has been possible to hypothesise the integration and dialogue between these technologies and materials, assets and components,

This process makes it possible to optimise the use and functioning of the various categories of assets

which themselves can be equipped with digital solutions for identification, positioning and traceability. In so doing, the principles of the circular economy can be effectively applied to urban ecosystems, accelerating its adoption through technological solutions. An example is Amsterdam's Urban Data platform, which is supported by the Amsterdam Institute for Advanced Metropolitan Solutions, which is developing a Circular Data platform project to collate data on the flows of materials and waste; the objective is to create a database that allows the planning and optimisation of such flows. Another example is the Shenzhen case, which began the full conversion of the entire urban transport system to electric by putting more than 16,000 e-buses into circulation and installing thousands of charging stations.
We can therefore confirm that the technological transformation journey required to make our cities circular, more efficient and sustainable in their use of resources has now commenced, but clearly we've only just begun.

The citizen's central role becomes the driving force behind the development of a completely new way of living and of perceiving the urban community

2.7 Open Governance: governance of the ecosystem for the circular economy

With the circular economy, the citizen's central role becomes the driving force behind the development of a completely new way of living and of perceiving the urban community. People don't just "live" in the city, but the city is designed around them so as to tackle the complex challenges of sustainable urbanisation. The circular city is an ecosystem, and as such it requires a contribution from all its players in order to function. First and foremost, by people we are referring to both citizens and associations. We've spoken about the importance of the urban centre for establishing circularity, but without the responsible engagement of people every model, no matter how

innovative, would just remain purely theoretical, and any city is fragile when civil society doesn't feel it belongs.
And then there are the companies, startups and the world of research. In rediscovering the importance of creating shared value, these are the essential driving force behind the circular model. Without their contribution in terms of innovation, resources and technology, the new paradigm simply cannot work.
And finally there's local government, the key player in the development of the circular city from at least three different perspectives. The first is the vision and strategic planning: overhauling a city in terms of its flows, not just its spaces, is vital in order to garner the resources necessary for implementing projects for energy self-sufficiency, sustainable procurement, electric mobility and the digitalisation of infrastructure.
Secondly, it is up to local government to educate the people on the importance of a participative approach to the city in order to create value together and to develop the culture of innovation that forms the foundation of the circular model. Spreading the open government idea in itself facilitates public-private interaction, promotes administrative transparency and underpins more mature and responsible community participation. The new recommendation from the OSCE (Organization for Security and Cooperation in Europe) regarding open government, approved in 2017, encourages this kind of approach. At the same time Italy's membership of the Open Government Partnership, which has 75 member countries, also encourages the country to launch open administration initiatives, with the full involvement of local authorities and civil society. This is with a view to fostering organisational and technological innovation.
Finally, the institutional contribution to the circular city might manifest itself in terms of an openness towards the community of innovators, both public and private. This could make the work of local government more dynamic, in addition to making it easier to find suitable solutions to managing the growing urban complexities and – equally important – to redefine the social function of public areas. In launching the Partnership of the Urban Agenda for the EU on Circular Economy, the European Union adopted a tool for stimulating the adoption of circular models and the exchange of innovative practices between cities, even between cities from different countries, with potential positive benefits for national competitiveness.
Since the circular model is cooperative by its very nature, the contribution from all players is of equal importance in order to overcome the paradoxes of the linear economy, offering tangible, immediate and sustainable answers to the unstoppable phenomenon of urbanisation.

The contribution from all players is of equal importance in order to overcome the paradoxes of the linear economy

2.8 Focus: startups

Startups, with the their contribution in terms of innovation and technology, are an essential driving force within the circular model. In view of this and within the context of Open Innovation, Enel collaborates with and supports these organisations by making its Innovation Hub & Lab available to them. This enables startups to engage with Enel's business lines and to test and develop their solutions in the real world, with the eventual aim of being able to offer these solutions to local government bodies in their drive towards circularity. Indeed, many of these start-ups operate within fields of particular relevance to circular cities: for example, energy flexibility, electric mobility, smart grids (the focus of Milan and São Paulo) and renewable energy (the focus of Catania). In the last three years Enel has assessed more than 5,000 startups across the globe, it has collaborated with more than 200 and has adopted, at an international level, around 50 solutions.

Focus

A. Circular economy and indicators

The circular economy brings together different approaches that promote, along the entire value chain, a new economic model based on sustainable inputs (renewables, from reuse and recycling), on the maximization of the useful life of assets and products and their utilisation factor (sharing, the product as a service), and on making the best use of assets at the end of their first life cycle. This vision can be described using the following **five pillars**:

1 **Circular inputs**
The use of inputs from renewable sources (both material and energy) or from reuse and recycling;

2 **Extension of the useful life**
Every specific action aimed at extending the useful life of an asset or product, via modular design, predictive maintenance, etc.;

3 **Product as a service**
A business model whereby the customer, rather than purchasing the product, purchases the related service, for example car sharing;

4 **Sharing platforms**
Platforms which enable private individuals to share their assets;

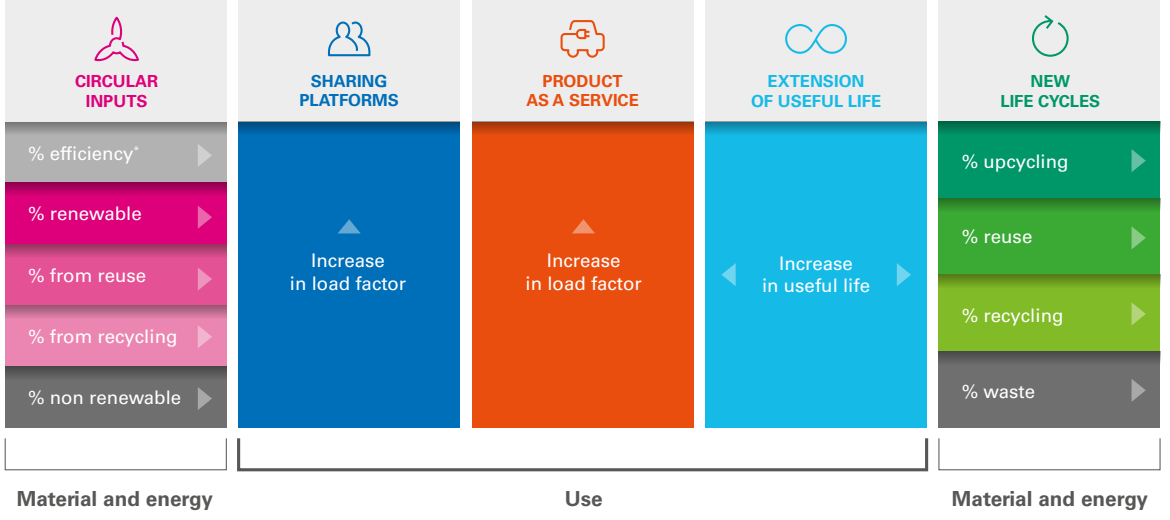
5 **New life cycles**
Any solution aimed at preserving the end-of-life value of an asset and reusing it in a new cycle through reuse, regeneration, recycling, etc.

One of the main challenges associated with the implementation of a circular economy model is defining the international reference criteria and metrics that enable us to distinguish between circular and non-circular solutions, measure their impact, define objectives and understand what the improvement measures might be.

The definition of such metrics was the very first question that Enel found itself trying to answer. There were a number of proposals, but none of them incorporated the entire value chain, renewable inputs or the subject of energy: all fundamental aspects for measuring the genuine effectiveness of circularity.

For this reason, around three years ago Enel developed and refined a model for measuring the circularity of its business and assets, as well as the services and products it supplies to customers. The model, which is called the CirculAbility Model and is also applied to suppliers, quantitatively represents the

CirculAbility Model



* Applicable only in specific cases

five pillars of circularity and combines both the material and energy components to give a single circularity indicator. For further information on the model, please refer to the following document: *KPI-Model_3.2018*.

The model has been shared with peers, competitors and institutions in order to stimulate dialogue, but it has also been made available online in order to publicise it as widely as possible and hopefully encourage the sharing of ideas to further improve it. To establish a uniform, internationally recognised reference metric you need the experience and expertise of those organisations which first addressed this subject and that have studied, tested and improved their solutions.
Using the CirculAbility Model as a starting point, which represents the integrated approach of the Group, Division-specific approaches have also been established.

1. Suppliers

Categories of supplies are subjected to a systematic Life Cycle Assessment (LCA) to track all material and energy flows throughout the entire life of the product or asset. In 2018, supplies of solar panels, wind turbines, isolators, smart meters and circuit breakers were assessed. The next implementation phases will include storage batteries, cables, EV charging stations, transformers, boilers and water heaters, street lighting and electrical panels. The data that suppliers upload into a specific tool enables the identification of circulatory factors to be added to tenders and leads to co-innovation with them. The data will also be used as an input into the circular metrics for the various business lines, demonstrating the centrality and cross-functional nature of Procurement.

2. Asset

The circular approach can be applied at each of the principal phases during the life of assets: design (design and input choices), construction/production (solutions for the management of activities and construction phases), operation (input/output management and maintenance) and decommissioning (management of areas, equipment, materials and infrastructure). Enel is applying circular economy principles to each of these phases and is also using its metrics to assess the expected impacts and to identify potential improvement measures.

3. Customer products and services

The Circular Economy Score

In view of the strategic objective of offering transparent and traceable products and services, Enel X has developed a Circular Economy Scoring method using the CirculAbility Model as a starting point, and working in line with the Global Procurement division. This makes it possible to calculate the level of circularity of each of the products and services offered to customers, thereby providing a useful comparison tool for final consumers who are concerned about environmental issues. However, the Circular Economy Score is a dynamic indicator since, once it has been calculated, Enel X uses it to identify a series of circular improvement opportunities through the "Circular Economy Boosting Program." In this way improvements in the general level of circularity can be passed onto customers and the market as tangible examples of commitment.

The scale of circularity of Enel X

The Circular Economy Report

Enel X offers the Circular Economy Report to companies and local government bodies. It's a robust tool for measuring the level of energy circularity, based on an approved methodology, and also provides indications for establishing a roadmap to improve that level.
The report provides the recipients with improved awareness of their energy performance, new energy saving opportunities through the identification of efficiency measures, and a more impactful communication to stakeholders using robust storytelling of the work undertaken in terms of sustainability and the circular economy.

The Circular Economy Report is also an integrated tool for outlining the Enel X model and the solutions that are available to clients.

The report is structured as follows:

1. **Assessment**
   a. City or Corporate Assessment
   b. Site Energy Circular Economy Assessment
2. **Roadmap for Improvement**
3. **Energy Circularity Sensitivity and Monitoring**: an evaluation of the percentage increase in the level of circularity based on the circular solutions outlined by the development plan.

Focus

B. Enel's commitment

Enel's vision

1

The majority of Enel's activities are focused on the urban context. Defining a coherent, long-term vision for the "city of the future," positioned within which is its own contribution, is a strategic priority for Enel. This means a systematic reappraisal of its offering, with the subsequent development of new solutions on one hand, and on the other the progressive integration of the numerous initiatives that have already been developed, both into its final products and services, as well as into its production processes.

Today, Enel's "circular vision" can be defined by a number of themes:

- **electrification of consumption** (electric cars, heat pumps, etc.);
- **renewable energy**;
- **flessibilità** (demand side management ecc.);
- **network technologies** (smart meters, smart grids, etc.).

Other initiatives, though not specifically aimed at the urban context, can make a positive contribution to this transition: for example, Circular Procurement or support for startups.
The contribution doesn't end with business activities but also, more generally, involves activities to support the transition of the system, through partnerships with all stakeholders and with companies from all sectors that are focussed on this issue.

2

Enel's activities

In organisational terms, Enel has been involved in the subject of the circular economy for over three years. This involvement has been continuous and in synergy with the strategic choices the Group has already adopted towards achieving a sustainable business model, such as the transition towards renewable energy and the Open Power approach. This unwavering commitment to the circular economy is not just limited to the strategic focus, but has been systematically subsumed into its business activities.

For more information:

Enel - Circular Economy

Global Procurement - Circular economy and the EPD project

Enel X - Sustainable innovation solutions

2.1 The customers

The circular economy is a central element of the interaction with customers, who are as environmentally aware and concerned as they've ever been. Our commitment concerns all areas of the business dedicated to the final customer, both energy market customers as well as those of Enel X, the Group division which was created in 2017 in order to develop new technologies for transforming energy into new opportunities. Enel X sees itself as a booster, or rather a circularity accelerator, within the new ecosystem of suppliers and customers, in which it has carved out an innovative and unique role in the market. With respect to the energy market, for both families and companies, Enel is implementing solutions aimed at transitioning towards the circular economy in essentially **three areas**:

1

Digitalisation and new technologies
Initiatives to increase the use of electronic and/or interactive billing rather than paper bills, the use of electronic channels to eliminate paper-based communications, the move towards completely digital selling (Enel Simplu, in Romania) and via energy contracts priced to assist vulnerable customers, with the level of poverty automatically certified on the blockchain (Fuel Poverty, in Spain).

2

Raising awareness
Programmes like Ecoenel in Brazil that incentivise the collection of paper/plastic/glass for recycling in exchange for discounts on the electricity bill.

3

Green energy
Selling green energy to the residential market that's exclusively produced from renewable sources.

Local government

Enel X is utilising urban street lighting and a digital platform to develop a number of smart city services, integrating information from sensors and video cameras spread throughout urban areas, in addition to information coming from the multitude of big data sources that are now available. Some of the outputs from this project are explained below:

- **Security.** Video surveillance, based on information provided by video cameras and sensors installed on Enel X's extensive street lighting infrastructure, makes it possible to promptly flag up events that threaten the security of citizens and to alert the appropriate authorities, while ensuring that the privacy of citizens is completely respected.

- **Optimised mobility.** Thanks to the digital infrastructure that's been developed, it is possible to reconstruct mobility flows of people and traffic. This enables city activities to be planned more efficiently with potential benefits for all stakeholders, both public and private.

- **A clean, green city.** A network of sensors to monitor the environment and a strong push to promote electric mobility, including through more widespread installation across the city of charging stations integrated into the street lighting (Juice Lamps). This allows the monitoring of urban pollution and encourages a more principled approach from citizens.

- **An online city.** Connectivity solutions through both local Wi-Fi and a wider coverage, linked to 3G, 4G and 5G, enable better use of the urban optical fibre infrastructure capable of transmitting data at very high speed.

Connectivity solutions through both local Wi-Fi and a wider coverage enable better use of the urban optical fibre infrastructure capable of transmitting data at very high speed

Real-time information. Thanks to a unique control platform, which utilises new technology such as data analytics and the Internet of Things, Enel X can now collect, analyse and direct information to enable continuous learning and improvement of services, making it possible to offer the information to citizens, local government or to third parties with an interest in the development of smart applications for urban communities. The information, for example on traffic, the weather or air quality, is used to prompt action and to therefore influence behaviour, creating an active community participation mechanism for making a contribution to the city's performance. All of which makes for a more resilient city.

The platform developed by Enel X is a digital environment that radically changes the traditional user experience of interfacing with the physical infrastructure, increasing its potential and making management simpler, more immediate and more direct. This digital environment is:

- **interoperable and open**: open to every possible type of device (video cameras, street lights, sensors and other devices) and works with all kinds of connectivity (radio or fibre, currently available or future generation);
- **customisable and constantly evolving**: designed to cater for the continuously evolving needs of all stakeholders, adapting its functionality and performance depending on the situation, both current and future;
- **secure and reliable**: information processed and analysed in a way that fully protects the privacy of citizens, as laid down by recent General Data Protection Regulation (GDPR) legislation, and which completely complies with cyber security requirements, without impacting on the speed or immediacy of the data supplied.

Electric mobility

The role of electric mobility is absolutely key to transitioning towards sustainable urban areas, in both a private and a public context.
Thanks to its pioneering experience and investment in the private electric mobility sector, Enel X is also able to offer green transport solutions to local government bodies, thus facilitating the transition towards the electrification of public transport. In Chile, for example, Enel X provides a series of integrated services to a fleet of electric buses in Santiago. These services include the installation and management of the charging infrastructure (batteries and charging stations), the energy supply (100% from renewable sources) and the optimisation of consumption through innovative Demand Response techniques.

A digital environment that radically changes the traditional user experience of interfacing with the physical infrastructure, increasing its potential and making management simpler

For companies

Enel X is also implementing solutions aimed at companies, in particular flexible services such as Demand Response, strategic advice services, energy efficiency technologies, as well as distributed generation and off-grid solutions.
Quite often companies do not fully understand how energy is actually used within their production processes; waste and poor consumption management can mean that any solutions aimed at optimisation and improved efficiency are essential. Here are some of the principal services that are offered to companies:

- **energy efficiency solutions**, including high-efficiency lighting, cogeneration and trigeneration facilities, as well as consultancy services such as energy analysis and audits;
- **renewable energy sources**, the installation of solar panels, for example;
- **flexibility and direct marketing**, as a world leader in Demand Response, Enel X is turning to companies that decide to modulate their energy consumption depending on the needs of the grid operator. By participating in the Demand Response programme, the client can benefit from having a new revenue source while actively contributing to the stability of the grid.

For citizens

Enel X also offers new ways to manage the domestic environment that make it more comfortable and efficient, simplifying the lives of residential customers with services like the installation and maintenance of advanced technological solutions for smart homes capable of offering energy savings and improved well-being. The main services offered are as follows:

- **Commodities, insurance and finance**. In addition to innovative and green domestic products, such as solar panels and storage batteries, Enel X also offers financial and microinsurance services to support people living in poor areas.
- **The smart home.** Smart home technologies that render houses smarter, more energy efficient and which offer improved well-being.

Alongside these services, one of the many solutions being made available to citizens that is particularly interesting is the Energy Efficiency for Condominium project, which is looking to drive the energy requalification of buildings with a view to improving their energy performance, thereby minimising emissions and their overall environmental impact. Enel, through the acquisition of tax credits linked to the Ecobonus, enables the owners of properties in condominiums to renovate their flats with huge savings on the cost of the work in return for the transfer of those tax credits.

Energy Efficiency for Condominium project, which is looking to drive the energy requalification of buildings with a view to improving their energy performance

FOCUS

The Enel X Circular Economy Boosting Program

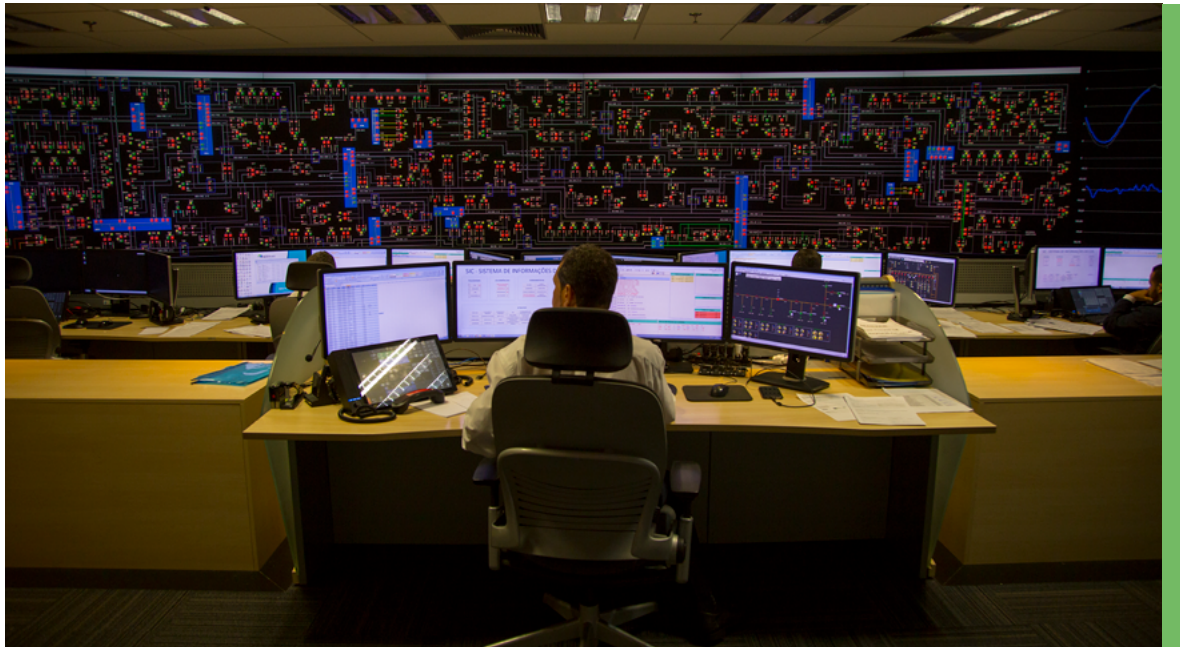
The Enel X Circular Economy Boosting Program adopts a certified methodology to boost circularity both internally and externally.

On the one hand, Enel places all the new solutions proposed for the city in the new portfolio under the circular economy's microscope, assessing them against the five pillars of the circular economy, so as to assign them a score and identify potential improvements. The ultimate aim is to offer the market an overall solution that's as circular as possible.
On the other hand, Enel X directly supports companies and local government bodies on their circularity journey with the Circular Economy Report, through which it measures the circularity of the company or city and identifies the best solutions which would increase its circularity level.

Enel's circular economy approach has been adopted at both strategic and corporate levels and subsequently established within the Group's various divisions, as well as along the entire value chain: customers, businesses, partners and suppliers.

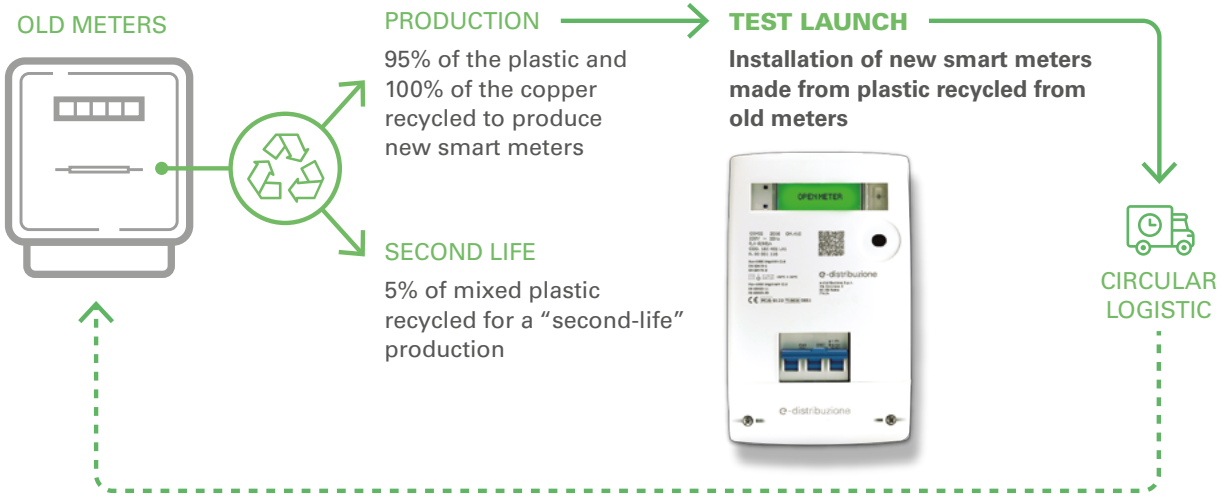
2.2 The networks

The role of distribution system operators has changed significantly in recent years: from one electricity grid efficiently transmitting electricity in one direction from large production facilities to the final user, we now have a situation whereby the flows are bi-directional and thousands of parties can simultaneously be both producers and consumers (prosumers), thanks to the introduction of new technologies such as distributed renewable sources, microgeneration and Vehicle-to-Grid. The grid is increasingly becoming a system catalyst which should be facilitating the integration of distributed generation and ensuring the efficiency, security and quality of the service. To tackle the challenges of energy transition and climate change, it is of vital importance to be able to count on the flexibility of an increasingly digitalised network that is more resilient to potentially catastrophic natural or meteorological disasters while also offering better and more sustainable management over the long term. Furthermore, the capacity to manage and analyse vast volumes of data offered by new technology has played a role in permitting the network to increasingly become a platform that enables the supply of new services and the creation of new business models. It is a vehicle for energy, as much as it is for data and information. The circular economy becomes a part of this transformation through the provision of new tools and business models that guide the design and management of the network and its assets (e.g. smart meters, transformers, cables, etc.) by considering renovation, the recovery of high value-added components and



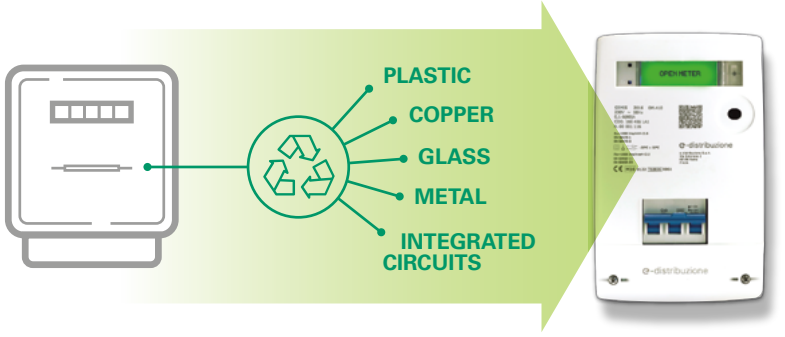
The grid is increasingly becoming a system catalyst which should be facilitating the integration of distributed generation and ensuring the efficiency, security and quality of the service

materials and by minimising the use of virgin resources.
Innovative resilience, the reduction in technological waste, reverse logistics and second-life materials are the new drivers of "Circularity by Design," the basic principle that underpins the digitalisation of the distribution networks that looks to derive benefits from circular economy concepts right from design.
The modular design and implementation of the new smart meters, based on the reuse of materials (principally plastic and copper) from old meters, as well as the implementation of innovative tracing techniques for reverse logistics, making the new smart meter the enabler of "Circular Digitalisation," are both good examples. Smart meters and other network components that have been used to increase intelligence and control have led to the network's digitalisation. This has contributed to improving service continuity and enabling more effective and accurate management of the resources connected to it, and has helped increase the level of distributed generation that's connected to the network without impacting on the quality of supply. Furthermore, it has also contributed to upgrading the smart meter value chain and that related to other network components, modifying disposal methods and favouring the recycling of materials.
Therefore, this evolution from a linear network to a high value-added circular network will enable the discovery of new areas for improvement, which in turn will inevitably lead to new synergies and business models.
The infrastructure will therefore become the backbone of the circular city as the enabling factor for new technologies and solutions in terms of energy, material and information flows, electric mobility and integration. However, in order to respond to the specific needs of different geographical areas, we are also concentrating on specific circular projects that are focused on innovative, clean and sustainable technologies.
For example, in Italy in 2017, a drive



We have created a new open meter and 31 million units will be installed over the next few years

to replace first generation smart meters with new open meters was launched, and this should see 31 million units installed in the coming years. The materials the meters are made of (plastic, iron, copper, integrated circuits and others) were recovered at authorised facilities to be reused in other production cycles. Regarding future developments, circular economy principles are being incorporated from the design and testing phase right through to the roll out of the meters (for example in Brazil).



Much of the plastic and all of the copper recovered from existing meters will be recycled and reused in the production of the new meters as if they were virgin materials. Furthermore, we are also working on ways to utilise the leftover recycled plastic from second-life products.

3

The suppliers

The role of procurement has transformed in recent years, becoming an increasingly more important player in the implementation of company strategies, as well as being one of the key aspects of the circular production process. Everything a company purchases is an important element of the overall circularity of that company, both informatively, so as to be able to evaluate the overall impact of the business, and transformatively, since it's through its partnerships with suppliers that it's able to devise new and improved solutions, including in terms of circularity. In light of these considerations, Enel placed particular attention on the role of Procurement right from the very beginning of its strategy, considering it to be one of the foundations of the Group's overall approach: being able to trace and track materials (inward and outward) and having a detailed understanding of flows in terms of components, environmental impact and the recyclability of products means that suppliers become vital allies in the transition of companies and cities towards a circular economy.

That is why Enel launched the Circular Economy for Enel Suppliers Engagement project, based on the adoption of the Environmental Product Declaration (EPD), an environmental certification document that quantifies and objectifies data (water consumption, carbon dioxide production, soil consumption, emissions, etc.) related to the entire lifecycle of supplies, which until now had never been homogeneously collected and analysed in a way that enable comparison.

The benefits of this process are that it makes it possible to set benchmarks for the supplies we procure and to monitor the Group's environmental footprint. This then triggers a "continuous improvement" process for internal performance and for suppliers, making the production and distribution of goods as sustainable as possible.

> The role of procurement has transformed in recent years, becoming an increasingly more important player in the implementation of company strategies, as well as being one of the key aspects of the circular production process

A web tool which suppliers use to enter their data to determine the company's circularity index

This is a medium to long-term project: indeed, before creating a database that classifies all products with their regularly updated sustainability values, it's necessary to create the baselines and to define the average start values.

The Circular Economy for Enel Suppliers Engagement project involves the use of a web tool which suppliers use to enter their data to determine the company's circularity index. This tool makes it possible to set average sector standards and to quickly intervene, with innovative projects or the adoption of sector best practices, where companies need to improve certain processes in their supply chain.
For the supply chains that the EPD concerns, there are projects having an impact on the urban environment, such as work to install charging stations for electric cars and optical fibre or work on medium and low tension lines. It is only through well-structured and proper collaboration between Enel and local government that we can establish circular agreements and protocols on the correct use of resources, waste management and the reuse of components from these activities. It will be necessary to involve all stakeholders (citizens, administrations, suppliers) in order to foster fruitful and shared circular economy processes at the local level.

Another possible application of Circular Procurement for cities is through the use of bonus evaluation criteria during the tendering phase (the so-called "tech K"), linked to the adoption of sustainable and circular practices (for example, reducing carbon dioxide emissions, percentage of recycled materials used, designing products with a view to reuse and recycling). In so doing, and assuming an equal financial proposal, the supplier that demonstrates they've responded to the circular K factor will win the contract.

Focus

C. Examples of Enel circular projects

1. Urban Futurability São Paulo (Brazil)

As of today, São Paulo in Brazil has an urban population in excess of 21 million, and it's destined to grow further. It's here that in October 2019, Enel Global Infrastructure & Networks launched an ambitious project with the involvement of all the city's stakeholders: Urban Futurability São Paulo, the purpose of which is to meet the urgent challenges of urbanisation, decentralisation and the electrification of consumption through a highly digitalised circular city model.
In the district of Vila Olímpia, the Network Digital Twin, an exact virtual copy of the distribution network, will be capable, in real time, of reproducing and testing components, operations and dynamics

in order to increase the efficiency and resilience of the entire structure. The Network Digital Twin is an enabler for the creation of an ecosystem of services for the municipal authority and for citizens, built using a sustainable logic that also embraces the stakeholders.

A highly digitalised circular city model

2. The Living Lab, Malaga (Spain) and Milan (Italy)

The penetration of electric mobility and the integration of renewable sources into the network, as well as the exponential growth of state-of-the-art technological solutions such as devices for advanced monitoring and management, digitalisation technologies, data analysis platforms, etc., are increasing the strategic importance of smart grids for achieving energy transition goals. It is for this reason that Global Infrastructure & Networks set up Living Labs in Milan and Malaga, experimentation laboratories for the technologies of the future that consider the need to reduce the environmental impact and look to make maximum the use of information sharing activities. Living Labs are not just tools aimed at the efficient and sustainable management of the network, but are also becoming important enablers for the entire urban ecosystem (citizens, companies and institutions) and for the creation of new business models.

3. Demand Response

The range of full electric solutions that Enel X offers to local government organisations includes access, where and when applicable, to the new market of flexibility that is Demand Response. This enables the city to play an active role in helping to efficiently balance the electricity grid, while generating extra income that can be invested in services for its citizens. Since it completely fulfils the vision of two of the five circular economy business models, as shown in the figure, Demand Response is a clear example of a circular service.

This enables the city to play an active role in helping to efficiently balance the electricity grid, while generating extra income that can be invested in services

A state-of-the-art lamp for providing street lighting with two charging stations for electric cars

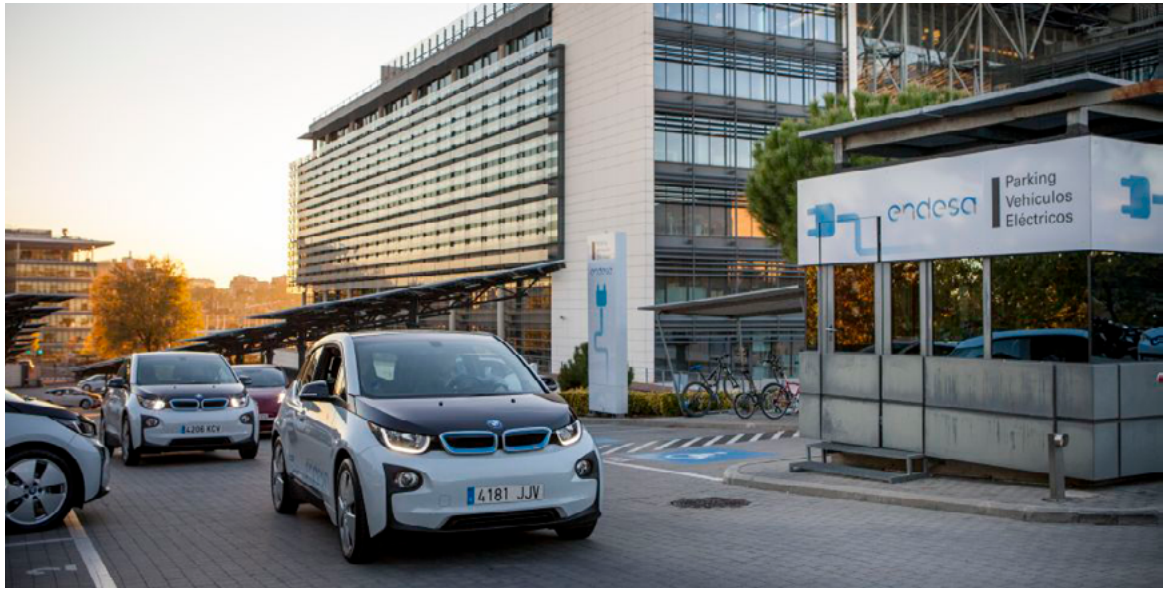
4. Juice Lamp

The Juice Lamp is a highly innovative product that forms part of the Intelligent Charging Solutions package. In line with the sharing approach that's typical of the circular economy, it combines a state-of-the-art lamp for providing street lighting with two charging stations for electric cars.

5. Electrification of public transport (Santiago)

Thanks to its pioneering experience and investment in the private electric mobility sector, Enel X is now able to offer green, circular transport solutions to local government bodies, thus also facilitating the transition towards the electrification of public transport. For example, in Santiago, Enel X provides a series of integrated services to a fleet of 285 electric buses. These services include the installation and management of the charging infrastructure (batteries and charging stations), the energy supply (100% from renewable sources) and optimisation of consumption through innovative Demand Response techniques.

A series of integrated services to a fleet of 285 electric buses



6. Car sharing (Madrid)

A car-sharing service that enables Enel employees to share electric vehicles. There are currently 23 vehicles situated at Endesa's main offices and facilities available for employees to use for their business journeys during working hours. This increases the use of the fleet of vehicles and promotes electric mobility.

7. Replacing old wood burning stoves with air-conditioning systems

In Chile, Enel X has implemented an initiative to replace old wood burning stoves with air-conditioning systems, free of charge. The benefits for both citizens and the environment are clear: improvement in air quality both inside and outside houses, financial savings and the fact that there's a single device for both heating and cooling are all sufficient evidence. This replacement of stoves is just one of many good examples, but it could help to drive similar projects in other countries.

8. Reuse of working components on charging stations

As part of its tendering process, Enel X has added a mandatory requirement for maintenance workers to reuse functioning components on electric charging stations. If, when there is a breakdown, the maintenance worker isn't able to carry out the repair remotely, and they need to go and replace the defective column with one that's working, they should take that defective station back to the depot and recover any working components that can be reused, those components should then be kept in the installer's storage room for future reuse on other repair jobs.

Focus

D. Enel around the world. Some examples

Chile

The creation in Chile of a centre for clean technologies and the lithium industry, specialising in the development of the renewable energy and mining sectors, has opened up an interesting opportunity for the circular economy in terms of technical solutions and the training of human capital.
This governance framework enables the involvement of other players in the value chain, such as technology suppliers, research centres and power generation and distribution companies. The partnerships may involve either local Chilean organisations or other organisations from around the world. As well as the promotion of development initiatives related to mining activities, there are also those associated with sustainable projects for low carbon dioxide emissions, electric mobility and the green job concept.
Subsequently, the Chilean government, through the Corporación de Fomento de la Producción (CORFO) which is aimed at promoting development, innovation and competition, launched a new competitive tender for the creation of a circular economy centre for the macrozone of north Chile.
In December 2019, Chile will host the United Nations Climate Change Conference (COP 25). The subject of the circular economy, together with that of decarbonisation, will play an important role in the debate. With that in mind, the EuroChile foundation, the Chilean government and the European Union, together with the European Commission's Directorate-General for Environment, are working on preparations for a side event focused on the circular economy in order to encourage partnerships between companies.
The government has confirmed Enel's involvement as a supplier of clean energy to the area where the conference will take place (Parque Cerrillos), with energy produced by the Enel Green Power renewable energy facilities.
From a sustainable cities perspective, Santiago, in partnership with Enel, has put South America's first fleet of electric buses on the road: there are currently 285

Electric buses entirely dedicated to public transport
With respect to sustainable cities, Santiago de Chile, in partnership with Enel, has put South America's first fleet of electric buses on the road.

BYD electric buses that are completely dedicated to public transport. This will mean a significant reduction in both city pollution and the use of fossil fuels for public transport, creating the first electric corridor on the subcontinent. This electric corridor also includes smart bus stops which will significantly improve the passenger's travel experience.
The transport authority hopes to have around 30% of the city's entire fleet made up of electric buses by 2022. This will reduce NO_x and CO_2 emissions by 35%.
The same development strategy that has been implemented in Santiago will also be applied to other major urban centres in the south and north of the country.

Colombia

The state of Colombia, through the Misión de Crecimiento Verde (Green Growth Mission), 2015-2018, led by the Departamento Nacional de Planeación de Colombia (Colombian National Planning Department), recognised the need to create an environment that favoured the transition towards a circular economy model by promoting SDG 12 ("Responsible Consumption and Production"). The path to achieving such an objective starts with identifying opportunities for the business sector through fostering innovation, efficiency and the creation of jobs in the production of goods and services. The foundation to work from includes measures associated with waste management, production, consumption, the promotion of business initiatives and extended producer responsibility.
With respect to environmental issues, Colombia has demonstrated a willingness to become a pioneer in Latin America; in November 2018 it launched the subcontinent's first circular economy strategy, a strategy that is designed to

The El Quimbo hydroelectric power plant
One of the Enel Group's largest investments in South America. The plant will be capable of producing approximately 2.2 TWh/year, providing the country with around 4% of its energy requirements. Furthermore, once the plant is operational, it will contribute to reducing the impact of droughts caused by the El Niño phenomenon on the country's electricity supply.

ensure sustainable consumption and production patterns by simultaneously reducing the intensity of material usage and encouraging recycling and reuse. The Estrategia Nacional de Economía Circular forms part of the Plan Nacional de Desarrollo (National Development Plan) requested by the President of the Republic for the 2019-2022 period, called the "Pacto por Colombia. Pacto Por la Equidad" (A Pact for Colombia. A Pact for Equality), aimed at "producing by conserving and conserving by producing."

There are a number of key challenges contained within this framework:

- bring the private sector and universities together;
- get entities such as the Ministry of Environment and Sustainable Development and the Ministry of Trade, Industry and Tourism to take the lead;
- strengthen the capacity of institutions to apply and monitor these new business policies and to implement any related tools.

Similarly, the development plan also includes a circular approach to the supply of public services, in particular drinking water and basic sanitation services. The objective is to exploit existing efficiency and modernisation opportunities in the processes associated with those services, to protect water resources and to promote the reuse of treated waste water.

To this end, the Ministerio de Medio Ambiente y Desarrollo Sostenible (Ministry of Environment and Sustainable Development) will work in collaboration with the Ministerios de Comercio, Vivienda, Educación, Transporte, Minas y Agricultura (Ministries of Trade, Housing, Education, Transport, Mining and Agriculture), the production sector unions, over 50 businesses and the academic sector. The strategy focuses on six lines of action:

- industrial materials and products;
- packaging materials and packaging;
- optimisation and use of biomass;
- water circulation;
- sources and use of energy;
- management of construction materials in urban areas.

For each of these lines of action the strategy specifies both short and long-term objectives, invites the players to transform their traditional models into circular models and proposes promotion mechanisms to be developed as promoters of the circular economy.

Italy

Italy has a solid foundation from a circular economy perspective making it one of Europe's leaders: first in terms of the per capita consumption of materials (8.5 t per capita, compared to the European average of 13.6 t per capita) and first in terms of recycling rate (79% of waste recycled/ waste produced)[41]. Considering the overall circularity index[42], a metric which,

[41] Duccio Bianchi, *Economia circolare in Italia. La filiera del riciclo asse portante di un'economia senza rifiuti (Circular Economy in Italy: The recycling supply chain: backbone of a waste free economy)*, Edizioni Ambiente, Milan 2019.

[42] Enea and Circular Economy Network, *Rapporto nazionale sull'economia circolare in Italia 2019 (National report on the circular economy in Italy 2019).*

using Ispra and Eurostat data, assesses the level of efficient use of resources, the use of secondary raw materials and waste management – Italy is ahead of the United Kingdom, Spain, France and Germany. It is, however, important to underline that Italy is growing more slowly than these other countries, which have actually improved their circular economy performance more markedly over the same period of time.

These positive indicators are also accompanied by a number of areas where improvements are possible: from the wider use of new technologies such as electric cars and sharing models, to the increased awareness of consumers regarding the impact of their purchasing decisions.

It's also important to highlight the fact that in public and political discourse there is no such thing as a consolidated definition of the circular economy. In a systemic sense, aside from waste management and recycling systems, reuse and maintenance services, and secondary raw material based production, the flows of energy and materials must be considered, as should the entire renewable energy sector.

The Italian government recognised the importance of this: it established technical discussion forums and published a strategic position paper in November 2017, entitled *Verso un modello di economia circolare per l'Italia (Towards a circular economy model for Italy)*[43]. Work continued in 2018 with the publication of a document on the circular economy and the efficient use of resources - Indicatori per la misurazione dell'economia circolare (Indicators for measuring the circular economy)[44], written by a technical working group coordinated by the Ministries of the Environment and of Economic Development.

The circular economy brings with it the unbridled transformative potential of an approach that's capable of combining a number of the country's key drivers in terms of its economic, industrial and social policies: digitalisation, Industry 4.0, transforming the energy system across to renewable sources, sustainable mobility, changing consumption behaviours, urban requalification, job creation, innovation and competitiveness. Establishing a national circular economy action plan will enable the creation of structured strategies, and will facilitate legislative

Establishing a national circular economy action plan will enable the creation of structured strategies

[43] Web page.

[44] Web page.

consistency of existing regulations as well as the adoption of measures in unregulated areas.
Italy, a country not blessed with large quantities of raw materials, has always needed to devise forms of use that are more efficient, intelligent and innovative by developing solutions that today could be defined as circular. Italy's fabric of SMEs (small and medium enterprises) shows how it has understood the opportunities in this context and that it has taken a proactive approach to many of its aspects. A priority is undoubtedly to involve their supply chains. This is both a prerequisite of a circular approach and also fosters the evolution of the entire industrial sector. This contribution must be synergistic and complementary with the guidance laid down by local government through Green Public Procurement, a tool for public authorities to favour green products and services.
We are also witnessing at the local level across Italy both an increasing interest and the first concrete initiatives. This is the context for the Città per la Circolarità (Cities for Circularity) memorandum of understanding, agreed by Bari, Milan, Prato and by the Ministry of the Environment.
The regions, in coordination with national government, can and must consider themselves responsible for implementing measures across their areas – the process could be supported financially through European programmes, in particular by European Structural and Investment Funds – and thus contributing to making the lives of their citizens increasingly sustainable.
The many examples include the circular economy and energy transition watchdog supported by Regione Lombardia (the Lombardy Regional Council).

Spain

In order to facilitate the transition towards a circular economy model in Spain, the draft Strategy for the Spanish Circular Economy (Estrategia Española de Economia Circular: EEEC) was published in February 2018, under the guidance of the Ministry of Agriculture, Fisheries, Food and the Environment. This strategy is in line with the objectives of the European Commission's action plan, which was approved in December 2015. It takes into consideration Spain's particular characteristics and establishes a national framework to enable the deployment of measures necessary for encouraging the Spanish economy to become fully sustainable and internationally competitive by 2030.
The strategy's long-term vision will be achieved through the implementation of

successive short-term action plans which will enable the integration of necessary measures to complete the transition by 2030. To this end, the EEEC is also accompanied by the first action plan which is to be implemented over the 2018-2020 three-year period.
Five priority sectors have been identified for this purpose: construction, food and agriculture, industrial, consumer goods and tourism. The 2018-2020 action plan includes five principle lines of action: production, consumption, waste management, secondary raw materials and water reuse. Three more will be added to these: awareness and participation; research, innovation and competitiveness; employment and training.
This initial plan comprises 70 actions identified by the various ministerial departments involved, which are to be completed within the 2018-2020 period with a budget of more than 836 million euros.
Following the public consultation phase which completed in February 2018, the strategy is now awaiting approval by the cabinet.

The circular economy pact
The Ministry of Agriculture and the Ministry of the Economy and Industry have initiated a circular economy pact, the objective of which is to involve Spain's key economic and social players in the transition towards a new economic model. So far, over 330 signatories have committed to facilitating the transition towards a circular economy through a number of concrete actions, the most notable of which are:

- the progressive reduction in the use of natural, non-renewable resources;
- encouraging the analysis of product life cycles and the development of criteria for eco-compatible design;
- encouraging the concrete application of the principles of the waste hierarchy;
- promoting a model of responsible consumption.

Brazil

The Ministry, in its role as coordinator of the Solid Waste Program (Programa de Resíduos Sólidos), as part of the federal government's long-term plan, via the Secretariat of Water Resources and Urban Environment (Secretaria de Recursos Hídricos e Ambiente Urbano: SRHU), led the drafting, in collaboration with other federal bodies, of a proposal for a national policy on solid waste.
Law No. 12.055 of 2 August 2010, which sets out national legislation for the management of solid waste, is the first step to introducing new instruments into Brazil's environmental legislation. Here are some of its main aspects:

- **Industry agreement**. A contract signed between the public authorities and producers, importers, distributors or traders, with the purpose of sharing responsibility for the product lifecycle.
- **Shared responsibility for the product lifecycle**. A collective responsibility shared between producers, importers,

distributors and traders, and also by consumers and public service contractors, for the cleanliness of the city and the management of solid waste. The objective is to minimise the volume of waste as well as the impact on human health and on the quality of the environment as a result of the product lifecycle.

- **Reverse logistics**. An economic and social development tool that features a series of actions, procedures and means to enable the collection and recovery of solid waste for the business sector, for reuse in the production cycle or for another purpose that's favourable to the environment.

- **Selective waste collection**. The collection of solid waste that has already been sorted according to its constitution or composition.

- **Product lifecycle**. A series of phases that includes product development, obtaining raw materials and inputs, the production process, consumption and final disposal.

- **Recyclable waste collectors**. Incentive mechanism that strengthens the activities of associations or cooperatives, a fundamental element in the management of solid waste.

- **The country-wide management of solid waste**. The national solid waste plan must be developed with significant social participation, and must include objectives and strategies that cover the entire country. Solid waste management plans for state, micro-region, city, inter-municipal and municipal levels are also included.

The objective is to minimise the volume of waste as well as the impact on human health and on the quality of the environment as a result of the product lifecycle

In 2014, in the city of São Paulo, following much discussion involving a broad range of population groups, a package of actions and strategies were established. These were designed to cover the next 20 years, for the implementation of national legislation regarding this issue.
Approval of the Integrated Solid Waste Management Plan (Plano de Gestão Integrada de Resíduos Sólidos: PGIRS; legislative decree no. 54.991 of 2 April 2014), had a significant impact on the collection, transport, treatment and disposal of solid waste.
The document sets out a series of strategic actions to be implemented progressively.
It is the commitment and involvement of all the parties (governments, companies and citizens) that will bring about cultural change and a change in the approach towards waste management.
The basic guidelines set out by the PGIRS relate to the non-generation, reduction, reuse, recycling and treatment of solid waste, and for waste that cannot be reused, its final disposal in a way that respects the environment. By following these guidelines, the entire supply chain should maximise the recovery of different types of recyclable waste, so as to reduce the quality of material sent to landfill.
In addition, the National Confederation of Industry (Confederação Nacional da Indústria: CNI) supports circular businesses by organising seminars for industrial and government representatives.
According to the CNI, this programme is beneficial on three distinct levels:

- economic, through improved efficiency in the use of resources;
- social, through the creation of new jobs in sectors like the renewable energy sector;
- environmental, reduction in the use of natural resources and a reduction in greenhouse gas emissions.

The model also offers opportunities for the development of new types of business for the industry, such as the provision of legal services associated with the sale of products.
In a context that includes a culture of recycling, sustainable consumption and an awareness of the circular economy logic, Brazil and in particular São Paulo are showcasing an environment that offers development opportunities for business models that favour sustainable inputs, products as a service, and make the best use of end-of-life products.

For further information
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