

OVERCOMING LOCAL CHALLENGES
TO BOOST CLIMATE ACTION

Solutions Guide for Cities An Overview





Foreword from Bertrand Piccard

When in April 2021, we attributed the Solar Impulse Efficient Solution label to the 1,000th solution, we had achieved our first goal in proving that a huge number of technological solutions exist today to protect the environment in an economically profitable way. These solutions represent systems, devices, products, materials and sources of energy, in the fields of water, mobility, construction, energy, industry and agriculture. Since then, our core belief and the evidence supporting it have only become stronger: reconciling ecology with the economy is not only possible, it is the obvious thing to do.

But the world is not moving fast enough. Each release from the IPCC paints an increasingly dire picture across ever shorter time frames. While respecting the commitments made at COP 26 in Glasgow would allow us to limit temperature rise to 1.8°C, we also know there is a chasm between those commitments and our progress toward meeting them.

It has often been said that cities hold the key. Whilst over 55% of the global population live in cities, they are responsible for three-quarters of all CO₂ emissions. Notably though, they generate 80% of global GDP, meaning they have an outsize importance and decision-making power when it comes to the mitigation of climate change. They are the primary generators of economic activity and are well placed to harness the opportunities of the ecological transition.

The 'Solutions for Cities Initiative' intends to help unlock this potential by looking at the "pain points" that exist in cities preventing the widespread adoption of cleantech solutions, and guiding users through our portfolio to demonstrate which solutions can contribute to overcoming these obstacles.

Proving that profitable solutions to protect the environment exist was critical to moving the debate forward, but it was far from the only piece of the puzzle. It is now in the political and regulatory realm where we must progress. We are launching this initiative to aid that effort, show what is possible, and shine a light on benefits that exist in doing so.

Bertrand Piccard
Founder and President of the
Solar Impulse Foundation

> The Solutions for Cities Initiative

The goal of this initiative is to suggest solutions to help decision makers to harness the economic opportunities of the ecological transition.



Since May 2022, the Solar Impulse Foundation has launched various efforts to advance the adoption of climate solutions in cities. Having already identified over 1400 efficient Solutions that are both environmentally and economically beneficial, the next step is to apply the most appropriate ones to a city context, recognizing the outsize importance and decision-making power that they have on the mitigation of climate change.

The Solutions for Cities Guide

An analysis of the obstacles faced by cities in their decarbonization efforts, and the solutions that can aid them. The Guide is complemented by a dynamic and interactive map to be released at COP27.

Sharing the Initiative at International Fora Throughout the Year

Upcoming events include: Mayors and Local Authorities Fair (Paris), Smart City Expo World Congress (Barcelona), COP27 (Sharm El-Sheik).
Follow our latest events at <https://solarimpulse.com/events>

Legislative Recommendations – “Prêt à Voter” Campaign

A series of proposals and a publicity campaign to encourage the modernization of laws and regulations that, if updated or adopted, could pave the way

for significant uptake of clean, efficient and profitable solutions, and yield significant decarbonization. Whilst not focused on cities per se, these measures would clearly have a knock-on effect in many contexts.

Media and Social Media Campaign

Telling the decarbonization stories of cities via podcasts, articles, videos, and interviews.

Identifying New Solutions

Adding to our portfolio of 1400+ Solutions, we launched a new call for solutions dedicated to overcoming the obstacles identified by cities in emerging economies to reduce their environmental impact.

A Solutions for Cities Coalition

Joining forces with key players to help cities, not only to find Solutions, but to engage their citizens, unlock financing resources, measure their impact etc.

Collaborating With Networks of Cities

In 2023, we intend to run matchmaking events bringing together decision makers and buyers in business and government to engage in quality, solution-focused discussions.

> The Solutions Guide for Cities

The Guide addresses mayors, city planners and public administrations, but also private companies or citizens. It aims to inspire them by demonstrating that sustainable solutions exist and that they can make use of them to reach their environmental goals in an economically profitable way.

A tipping point for cities to reach their climate targets

According to the United Nations, “since 2007, more than half of the world’s population has been living in cities”. This rapid urbanization has put severe pressure on the infrastructure and services provided by cities to their communities: energy supply, built environment, mobility services, waste management, and water infrastructure. Cities cannot achieve a 1.5°C trajectory without a massive effort in all those sectors. Hence, they are the primary target users of some of the Solar Impulse Efficient Solutions. From expanding renewable power generation in a reliable and efficient way, decarbonizing the construction value chain through buildings’ lifecycle, rethinking mobility services with optimization of travel, improvement of road vehicle emissions and micro-mobility, improving urban waste management by avoiding waste or valorizing it, to creating more resilient water infrastructure, “greening” cities, and decreasing the



impact of public lighting, all the solutions presented in this report seek to support cities’ decarbonization efforts with innovative technologies, approaches, and business models.

Examples of implemented Solutions and their enabling environment

We highlight case studies of clean and profitable solutions that have been awarded the Solar Impulse Efficient Solutions Label and that have been tested or adopted in urban environments, by either private or public clients. We recognize that these solutions only respond to a part of the problem. In order for such solutions to be mainstreamed and their use to become logical rather than merely ecological, the proper enabling environment must be created. That is why, in an additional section of the Guide, we collaborated with multiple actors in this space, highlighting various complementary approaches to integrate that would also facilitate adoption of these solutions.



> A bottom-up approach from cleantech entrepreneurs' experience of the market

The Solutions for Cities Guide was created by the Solar Impulse Foundation with the contribution of 180+ cleantech companies within the Solar Impulse labeled solutions ecosystem, 10+ experts, and 9 external organizations, between December 2021 and October 2022.

CHAPTER 1 TO 5

General Approach

Since 2018, the Solar Impulse Foundation has collected thousands of application forms from cleantech entrepreneurs that were applying to the Solar Impulse Efficient Solution label. As part of the selection process, they were asked to explain the challenges that they seek to solve with their solutions, and to compare themselves to the most widely used solutions to the problem they seek to solve. They had to detail how they had innovated and built unique features in their products, processes, or services to provide the most convincing value proposition to their target clients. The Solution for Cities Guide taps into these experiences to build a unique narrative on climate solutions and their implementation in urban environments.

The Solutions for Cities Guide content was built following a bottom-up approach as to its logic. It used the portfolio of 1,400 solutions labeled by the

We believe that the players that are most eager to boost climate solutions adoption are the ones that made a business out of it. Solar Impulse has built a unique ecosystem of such entrepreneurs over the past five years. The Solutions for Cities Guide leverages their knowledge of their clients' adoption barriers and highlights their success stories to inspire climate action.

180+ cleantech companies contribution

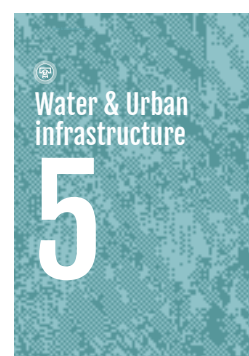
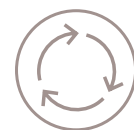
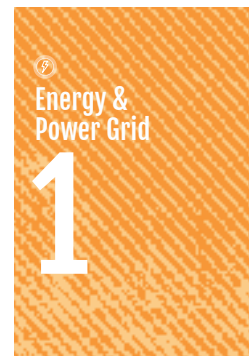
10+ experts

9 external organizations

Solar Impulse Foundation, finally providing a sample of 188 that fit the sectors, make sense within the city environment and that provided real-life case studies across 130+ cities and 28 countries. With the Guide, the Solar Impulse Foundation does not seek to make publicity for one business over another. It is rather to demonstrate what has been done to inspire others and unlock decision-making for cleantech adoption worldwide.

Thematic Sections – Levers of Action – Challenges

The five Thematic Sections of the Guide were first identified with inputs from subject-matter experts. They encompass industry sectors of interest for urban public authorities: Energy & Power Grid, Construction & Buildings, Mobility & Logistics, Waste Management, Water & Urban Infrastructure.





Their inputs were then supported via a literature review, to ensure that such sectors were indeed impactful – either directly or indirectly – on the quality of life, the natural environment, and GHG emissions in cities. Each Thematic Section outlines a series of Levers of Action identified.

Levers of Action are either related to a specific stage of the sector’s value chain (e.g. Chapter 2: Construction & Buildings, Lever of Action 2.2: Optimizing Design and Construction Methods to Save Resources), or to the level of disturbance of current systems in place (e.g. Thematic Section 3: Mobility & Logistics, Lever of Action 3.1: Reducing traffic congestion). The 14 Levers of Action are split into 48 Challenges that present the more detailed adopters’ pain points that the Solutions seek to address (e.g. Thematic Section 4: Waste Management, Lever of Action 4.2: Improving Recycling Rates of Municipal Solid Waste, Challenge 4.2.1: Integrating waste sorting throughout the value chain).

We would like to thank the individual volunteer experts who contributed to the definition of the main Levers of Action and their related Challenges: Enrico Benetto, Florinda Boschetti, Gilles Boudou, Xavier Denoly, Anissa Gerber, Luca de Giovanetti, Martin Hoyer, Mathieu Horgnies, Cosmin Koch, Janusz Linkowski, Jan Mertens, Rémi Perrin, and Sacha Stolp.

> 188 Solutions Case-Studies



> 130+ cities and 20+ countries

SECTION “POWERED BY” FROM URBAN VISION TO SOLUTIONS ADOPTION

The appropriate enabling environment is critical to the effective adoption of cleantech solutions. By integrating the measures indicated in this chapter, cities can identify priority areas, surface hidden benefits arising from their actions and create a whole-city movement toward reducing their footprint and improving the quality of life of their inhabitants.

For this topics, we teamed up with the following entities: Metabolic, CDP, ICLEI, International Cleantech Network, WWF, The World Business Council for Sustainable Development, BABLE, Net Zero Cities, the Global Covenant of Mayors for Climate & Energy, Makesense.

Each contribution was decided in accordance with the entity’s area of expertise on the drivers of climate solutions adoption in cities.





Energy & Power Grid

Urban areas account for 65% of the world's demand for energy, and 70% of the world's energy-related CO₂ emissions. To reduce their environmental impact, cities have countless Efficient Solutions at their disposal. Some, such as new IT tools and power-generating units, promote decentralized production of renewable energy in urban areas. Others, new digital tools, or new methods of consumption and storage, can adapt the grids to the energy transition.

Urban areas account for 65% of the world's energy demand and 70% of CO₂ emissions¹

¹ EU Mission: Climate-Neutral and Smart Cities. [n.d.]. European Commission. Retrieved July 20, 2022, from https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe/eu-missions-horizon-europe/climate-neutral-and-smart-cities_en

> Concrete Challenges & Solutions



Making Clean Electricity Generation Accessible and Cost-effective

> Challenge 01

Facilitating investment in centralized and decentralized renewable energy production

Use software that dynamically leverages data to guide decision making and plan/size cost-effective, sustainable infrastructure.

> Challenge 02

Quantifying the potential for local, decentralized clean energy production

Use tools to quickly evaluate the technical potential, costs and benefits of decentralized energy production (solar, geothermal, wind, etc.) and to easily find the right contacts.

> Challenge 03

Integrating solar energy into existing infrastructure

Propose new systems to capture solar energy that are more flexible in use, simpler to install and allow for better aesthetic integration.

> Challenge 04

Making wind energy production palatable for urban environments

Adopt new micro-wind turbine systems that combine efficiency, modularity, minimal space requirements, safety, and quiet operation.

> Challenge 05

Accelerating the uptake of geoenergy for heating and cooling

Implement ground-source heat pumps that are less expensive to install, take up less space and are more efficient.



> One of the Solutions From our Portfolio

Sunstyle by Sunstyle

Implemented by Saint Charles International in Perpignan (France) in 2011

A photovoltaic roof that provides water tightness and clean electricity while preserving the aesthetic of buildings. Each tile has a capacity of 115 Wp and the total weight of the system is 19.5 kg per square-meter. Tightness is ensured by a 30 mm overlap of each tile over the one below it. The standard system is designed for any roof with a slope above 15° and each tile has a capacity of 115 Wp.



Maximizing the Resilience of Electricity Distribution Networks

> Challenge 01

Designing smart and scalable distribution networks

Use new digital tools to make network planning & management and energy storage sizing more accurate and less expensive.

> Challenge 02

Ensuring reliable electricity supply given intermittency of renewable power

Adopt tools that allow for real-time, automated responses to power surpluses or shortages.

> Challenge 03

Incentivizing consumers to actively manage their electricity demand

Use IT tools to “move” consumption, to connect a multitude of objects/sites or to let consumers and producers of decentralized energy interact directly.

> Challenge 04

Making stationary battery energy storage financially viable

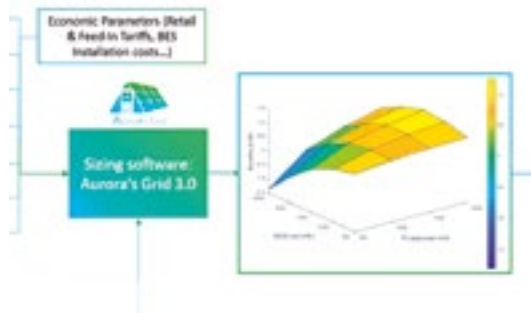
Recondition EV batteries at end-of-life and integrate them into adapted structures for Building Energy Storage systems.

> Solutions From our Portfolio



Celsius Energy by Celsius Energy Implemented in two offices in Clamart, France in 2020 and 2022

A drilling and installation service for geothermal heat supply which serves as a low-carbon alternative to gas boilers and refrigeration units for heating and cooling buildings. As a spin out of Schlumberger, Celsius Energy proposes a turnkey solution, available for new and existing buildings in dense urban areas, specifically designed to minimize land footprint without compromising on capacity.



Emma 3.0 by Aurora's Grid
Implemented by Romande Energie SA in Morges
(Switzerland) in 2022

A sizing software that enables to avoid under-sizing (avoid possible loss of revenue) or over-sizing (avoid large investment costs) of a Battery Energy Storage, at utility-scale, down to households. The software couples deep electrochemical knowledge of Li-ion batteries, power grid constraints, machine learning and forecast algorithms, to make the most out of the battery system. It operates the battery storage solution in a smart-way to increase lifetime along with revenue.



EcoStruxure™ EV Charging Expert
by Schneider Electric
Implemented by Renault in Guyancourt (France) in 2011

An EV charging infrastructure load management, access management and supervision solution. When the energy demand from a building is likely to exceed the available supply from the transformer when EV charging is installed, EcoStruxure EV Charging Expert redistributes the loads, eliminating the need to upgrade a transformer or electrical devices in the building. Moreover, it manages access control to EV charging, and registers charging transactions data for cost allocation or analytics.



Construction & Buildings

The lifecycle of buildings – from construction to decommissioning – is a major consumer of energy and resources. Making this sector more sustainable is fundamental to helping reduce energy poverty, ensuring the ecological transition is just and equitable and increasing quality of life. While Efficient Solutions in materials and construction methods have enabled greatly decreasing this impact while maintaining cost efficiency and performance, data science and artificial intelligence are opening new avenues for rethinking design, streamlining logistics, reducing waste, and better managing the consumption of resources and energy in buildings.

The construction sector is responsible for 39% of energy-related CO₂ emissions worldwide²

² Abergel, T., Dean, B., & Dulac, J. (2017). GLOBAL STATUS REPORT 2017: Towards a zero-emission, efficient, and resilient buildings and construction sector. https://www.worldgbc.org/sites/default/files/UNEP%20188_GABC_en%20%28web%29.pdf



> Concrete Challenges & Solutions



Decarbonizing the entire life-cycle of construction materials

> Challenge 01

Making more sustainable concrete or concrete alternatives, whilst retaining integral qualities

Implement innovative and cost-effective materials, production technologies suitable for multiple applications, and promote reuse.

> Challenge 02

Identifying effective insulation materials with lower carbon footprints

Adopt better performing bio-based insulation materials, less carbon-intensive high-performance insulation, and hybrid structural materials with embedded insulation layers.

> Challenge 03

Integrating demolition and plastic waste into construction materials

Adopt innovative technologies that allow for the reuse of various types of waste locally, while respecting constraints of strength, durability, cost, and volume.

> Challenge 04

Creating a market for reusing construction waste

Use business-to-business digital platforms to sell or purchase salvage materials and identify the best options for reuse, including in other industries.



> One of the Solutions From our Portfolio

Arqlite Smart Gravel by Arqlite

Implemented by the Los Angeles Department of Water and Power in Los Angeles (United States) in 2021

A filler made 100% from mixed plastic waste. This product takes the best of plastic polymers and generates a filler, three times lighter and ten times better insulator compared to mineral gravel at a cost comparable to landfill tipping fees. The output is long-lasting and safe for the environment, and can be used by the Civil Engineering industry, Concrete Mix companies, Landscapers, and Hydroponic growers.



Optimizing design and construction methods to save resources

> Challenge 01

Integrating circular and efficient construction and renovation techniques

Adopt designed-for-disassembly elements, 3D-printing, and new techniques to avoid waste and pollutant emissions during construction and renovation.

> Challenge 02

Optimizing logistics for construction sites

Adopt user-friendly digital tools to rationalize and improve the supply of materials and equipment from an ecological perspective.



> One of the Solutions From our Portfolio

3D Printing Construction by *Holcim* Implemented by Holcim 14Trees in Lilongwe (Malawi) in 2020

A printing service which is sold to NGOs and international organizations which includes the manufacturing of a 3D ink, and the operation of the printer, using only local staff. This Solution pioneered in introducing 3D printing in Africa for the construction of schools and houses. It aims to disrupt the way constructions are built to make housing solutions available for the majority.



Equipping buildings with efficient heating, cooling & lighting hardware systems

> Challenge 01

Maximizing natural light in buildings

Adopt innovative solutions that bring sunlight into confined areas and efficient shading systems that control light and heat.

> Challenge 02

Adopting external insulation, and passive heating & cooling technologies

Promote simple complementary insulation systems on windows, walls, as well as heat reflecting roofs.

> Challenge 03

Popularizing clean micro generators or heat pumps for all buildings

Offer affordable, efficient and easy-to-install systems for special constructions such as historic buildings.

> Challenge 04

Boosting the use of heat-recovery systems

Adopt economical and easy-to-install devices to recover thermal energy from shower wastewater or restaurant ventilation.

> Challenge 05

Exploiting excess heat from data centers

Take advantage of systems allowing to decentralize the work of the servers by using their residual heat for the heating of buildings, industrial sites or swimming pools.

> Challenge 06

Highlighting building retrofit benefits for businesses and consumers

Opt for digital platforms to optimize choices in energy renovations and guide on the work to be done for maximum profitability.



> One of the Solutions From our Portfolio

Lepido by Enjay AB

Implemented in all new Burger King restaurants in Scandinavia being built since 2021

An energy recovery system adapted to restaurant ventilation, with a special design allowing most particles to pass through rather than stick to the unit. At night, a system refrigerates the circuits, using the built up condensation to freeze remaining grease, creating a maintenance-free and self-cleaning recycling system. The delivered effect per converted restaurant varies from 17 to 106 kilowatts, lowering the average annual CO₂ emissions by circa 34 metric tons.



Optimizing energy consumption and building management with existing assets

> Challenge 01

Demonstrating consumption-reducing smart systems for real-estate companies

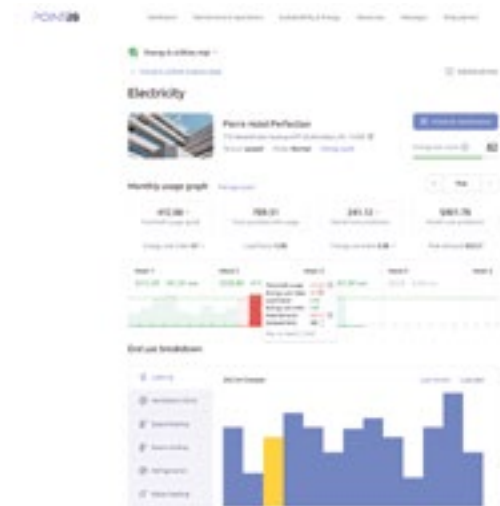
Adopt digital platforms to track energy consumption in real time across a wide variety of buildings and implement efficiency strategies across a fleet.

> Challenge 02

Making HVAC and lighting optimization accessible to all buildings

Use flexible, scalable and easy-to-implement solutions for automated and intelligent management of existing facilities' HVAC and lighting systems.

> Solutions From our Portfolio



Akeptus by Akeptus™

Implemented by Ben and Jerry's in several states in the United States in 2021

An intelligent energy management system that uses state-of-the-art smart technologies (sensors, actuators, controllers etc.) and Artificial Intelligence (AI) capabilities for optimal energy management of buildings. The Solution monitors and controls HVAC, lighting, and other systems by integrating information obtained from sensors on a range of outdoor environmental (temperature, humidity), indoor environmental (temperature, humidity, carbon dioxide), and equipment sensors to reduce energy use.



LightFi by LightFi
Implemented by the University of Cambridge (United Kingdom) in 2018

An IoT device using WiFi radio and smart algorithms to count the number of people present in a space in real-time. The device is integrated with the building management system to optimize consumption from lighting. The system does not require rewiring, enabling a 10 minute installation process for monitoring and control, which significantly reduces installation costs.



Hive Optimal by BeeBryte
Implemented by the DHL Advanced Regional Center in Singapore (Singapore) in 2018

A remote operation & maintenance service for large heating-cooling-refrigeration systems (HVAC) using a proprietary predictive control technology, functioning without any equipment replacement. Using weather forecast and activity patterns, the Artificial Intelligence-based Solution anticipates energy demand then adjusts the set points and operation of the equipment accordingly. It improves the reliability of the installations (early detection of anomalies) and reinforces temperature uniformity in different zones, guaranteeing compliance with prescribed constraints, such as air quality, and comfort.



Mobility & Logistics

Mobility and logistics are key ingredients of any urban policy – but also of a city’s environmental footprint. Ensuring that people, vehicles and goods can enter, leave and circulate the city in an optimal way and with minimized impact on the environment is a demanding task. Many Efficient Solutions that are both ecological and profitable already exist to meet these growing challenges. They range from optimizing the flow of people and goods to adopting soft mobility schemes; from promoting electric and hydrogen propulsion to developing charging infrastructure; from carpooling to ‘zero carbon’ public transportation.

18% of global energy-related emissions are due to road vehicles, 60% of which are from private vehicles and half of which are from urban travel³

³ Surprising reasons why cities are struggling to slash emissions | World Economic Forum. [n.d.]. Retrieved June 17, 2022, from <https://www.weforum.org/agenda/2022/02/cities-emissions-mobility-climate-data/>

> Concrete Challenges & Solutions



Reducing Time and Distance of Travels

> Challenge 01

Reducing traffic congestion

Provide tools to plan infrastructure and control systems (parking, traffic lights, etc.) that take into account actual conditions to limit congestion.

> Challenge 02

Optimizing vehicle routes

Process individual and technical urban mobility data as a dynamic source to enable users to plan their trips.

> Challenge 03

Planning grouped transport services

Integrate real mobility data to design services that are adapted to the needs of the population and thus combat “under-utilization” of public transportation lines.



> One of the Solutions From our Portfolio

URBAN RADAR by *Urban radar* Implemented by the City of Versailles (France) in 2020

An all-embracing data platform that enables city planners to determine more clearly which actions or regulations can have an impact on various drivers of negative environmental impact – such as traffic congestion. It draws on (anonymized) data from multiple static and dynamic sources to provide visualizations, analyzes and recommendations for non-expert city employees. Specificity is that data is not only shown geographically but also through clear and simple visualizations, allowing to reveal hidden trends and patterns.



Reducing Emissions per km for Road Transport Vehicles

> Challenge 01

Reducing the emissions of combustion engines

Propose technologies that increase the efficiency of thermal engines, while preserving production standards, profitability and driving comfort.

> Challenge 02

Transitioning to low-carbon vehicles

Develop turnkey clean mobility offers as well as standardized and more economical retrofit processes.

> Challenge 03

Creating the infrastructure for EV adoption

Make investments in these facilities more economically attractive by addressing the right players, enabling small scale uptake or by pooling the facilities with several types of charging modes.



> One of the Solutions From our Portfolio

HYDROGEN INJECTION SYSTEM (H.I.S.)

by *Logikko*

Implemented by the Région Grand Est Mobile Professional Work Teams (EMOP) fleet (France) in 2022

A technology which, by electrolysis of water, injects hydrogen in small quantities into any thermal engine to trigger a more complete combustion of the fuel. This results in a reduction in consumption and pollution of gasoline and diesel engines. The technology is «on board» and easily adapts to any thermal engine. The system requires a small water tank as well as an electrolyzer while its installation does not need changes in fuel or registration, nor homologation.



Promoting 'Zero-carbon' Modes of Transport

> Challenge 01

Incentivizing the use of bikes for in-city mobility

Develop systems to increase the safety, comfort and versatility of small electrically assisted vehicles.

> Challenge 02

Developing micro-mobility platforms

Propose both software facilitating the implementation and management of fleets of scooters, bicycles or electric scooters and educational platforms to motivate citizens to use them.

> Challenge 03

Persuading urban delivery companies to use small electric vehicles

Develop more practical and versatile types of micro-mobility vehicles for merchants.

> Challenge 04

Encouraging multimodal delivery methods for the final kilometer

Provide IT tools or turnkey services to combine various modes of transport in a simple and efficient way.



> One of the Solutions From our Portfolio

VUF BIKES by Vuf bikes

Implemented by Oleorecycling in Toulouse (France) in 2018

An electrically assisted three-wheeled bicycle specific to the transport of heavy and bulky loads. It is modular, enabling its adaptation to all transport-needing activities (equipment, food, heat, cold, freezer, packages, waste, etc.). Driving comfort is ensured thanks to a technology developed in-house combining a double transmission (which increases the force) and a pendulum system which reduces the inertia of the load.

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Waste Management

It is projected that between 2011 and 2025 solid waste generated by cities worldwide will surpass 1.3 to 2.2 million tons per year⁵, which will have a significant environmental impact. There are a number of Efficient Solutions which can slow down and even reverse this trend through a variety of methods – by integrating end-of-life waste planning into the design phase, by encouraging consumers to reduce the amount of waste they produce, by improving waste-sorting systems, and by treating waste as a resource that can be reused as opposed to something that needs to be eliminated.

In 2016, solid waste treatment and disposal generated 1.6 billion tonnes of CO₂ equivalent greenhouse gas emissions⁴

⁴ C40 Cities Climate Leadership Group. (2019). Why cities need to advance towards zero waste. https://www.c40knowledgehub.org/s/article/Why-cities-need-to-advance-towards-zero-waste?language=en_US

⁵ D.Hoornweg, P.Bhada-Tata, What a waste. A Global Review of Solid Waste Management, World Bank, Urban Development Series, Knowledge Papers No.15, 2012

> Concrete Challenges & Solutions



Address Upstream Production of Municipal Waste

> Challenge 01

Avoiding food waste

Offer attractive platforms to book your menu in advance, buy unsold items or get discounts on food close to the expiration date.

> Challenge 02

Reducing waste in packaging

Encourage new types of reusable, environmentally friendly, multi-purpose packaging for e-commerce, and refill systems.

> Challenge 03

Prioritizing renting over buying

Enable a sharing economy via digital platforms that offer peer-to-peer renting, leasing, giving or sharing access to physical goods in a community.

> Challenge 04

Incentivizing the repair-resell economy

Give a second life to objects with end-to-end resell platforms for household or electronic waste and more attractive buyback pricings.



> One of the Solutions From our Portfolio

Wasteless by Wasteless

Implemented by the supermarket chain Edeka (Germany) in 2021

A turnkey pricing system for supermarkets which optimizes food price markdowns based on expiry dates. Wasteless developed a proprietary dynamic pricing algorithm for products with a limited expiration date, allowing retailers to deploy Artificial Intelligence to mark off prices. Objective is for supermarkets to sell more, waste less while consumers get to choose how much they want to pay for a product based on its expiration date.



Improving Recycling Rates

> Challenge 01

Integrating waste sorting throughout the value chain

Mobilize robotics, artificial intelligence and new technologies to develop systems to rationalize and automate waste sorting.

> Challenge 02

Valorizing organic waste locally

Introduce compact, scalable and cost-effective systems to transform organic waste locally into resources (energy, compost, fertilizer, food protein, etc.) that can be reused locally.

> Challenge 03

Implementing alternatives to landfilling for plastic and other municipal solid waste

Transform multi-component plastics and hazardous waste into fuels, chemicals, products or high-value materials that can be re-injected into the market.

> Solutions From our Portfolio



HolyGrail 2.0 by Procter & Gamble – P&G Tested by the City of Copenhagen (Denmark) in 2021

A digital watermark that addresses the issue of accurately identifying packaging material in post-consumer waste, resulting in more efficient and higher-quality recycling. The digital watermarks are printed or molded on the packaging and its imperceptible codes can carry a wide range of attributes relevant for high quality sorting and recycling. Information could include type of plastics used and composition for multilayer objects or if the packaging has had a food or non-food application.



**Anaerobic bio-digester to proceed organic waste
by Enwise**
Implemented in Auchan Supermarket in Shanghai (China)
in 2017

A dry anaerobic digestion technology that generates biogas to be turned into green energy such as electricity, hot water, cool water, steam to help users to save the energy used. The installed on-site solution is a combination of hardware and software coupled with high efficiency digesters. The equipment is composed of a pretreatment module and a digestion module, including a phase separation that produces a solid fertilizer and wastewater (that can then be discharged in a centralized treatment facility).



UBQ by UBQ materials
Implemented by PepsiCo in São Paulo (Brazil) in 2022

A melting process that converts unsorted landfill-destined waste – including organics like food waste together with mixed plastics – into UBQ, a sustainable alternative to oil-based plastics. The bio-based thermoplastic can be used in thousands of applications and is seamlessly incorporated into standard manufacturing processes, from injection to compression molding through to extrusion. The system is modular and can address both micro / local needs through to state and even national levels depending on waste and material off take demand.



Water & Urban Infrastructure

Water, green spaces, air, and light: every city must strive to satisfy the basic needs of its inhabitants by providing efficient infrastructure and services for a better quality of life. But these missions are becoming increasingly complex. Today, Efficient Solutions abound to limit water losses during distribution and adapt treatment capacities to the growth of urban areas, to improving the quality of life of residents by greening urban spaces and reducing urban heat islands, optimize air quality, and limit the ecological footprint of public services such as lighting, all while pursuing cost-effective strategies.

A key emerging challenge for urban areas is how to manage climate risks – like drought, flooding, heat waves, and air pollution – whilst accommodating for a growing population and increased housing⁶

⁶ Reu Junqueira, J., Serrao-Neumann, S., & White, I. (2021). Managing urban climate change risks: Prospects for using green infrastructure to increase urban resilience to floods. *The Impacts of Climate Change*, 379–396. <https://doi.org/10.1016/B978-0-12-822373-4.00013-6>

> Concrete Challenges & Solutions



Develop and Maintaining Resilient, Efficient Water Distribution Systems

> Challenge 01

Preventing water leaks

Adopt intelligent and interactive tools to detect losses in the network and optimize the profitability, sustainability and efficiency of water distribution.

> Challenge 02

Maintaining water infrastructure

Implement low-cost, non-intrusive inspection and repair systems and intelligent tools to improve pipeline management and maintenance.



> One of the Solutions From our Portfolio

Shayp by Shayp

Implemented by the professional highschool Le Balcon des Ardennes in Saint-Laurent (France) in 2021

A plug-and-play sensor ("datalogger") connected to the utility's water meter that collects meter's data every 30 seconds and up to 7. It sends data to an online consumption monitoring platform for building managers, and a maintenance service in case of leaks. The fine granularity of data collection allows to know in real time what your water consumption is and to detect anomalies and leaks more quickly. The system that can be implemented without touching the plumbing of the building.



Adapting Wastewater Treatment Processes to Population Growth and Increasingly Strict Regulations

> Challenge 01

Increasing capacity and efficiency of wastewater treatment plants

Implement systems that tackle new micropollutants, energy passive processes, and technologies to increase treatment capacity while reducing sewage sludge volume.

> Challenge 02

Increasing water saving and recycling in situ

Introduce recycling possibilities for “greywater” (shower water, etc.) in homes with modular, durable, passive and easy-to-install systems.



> One of the Solutions From our Portfolio

Hydraloop by *Hydraloop Systems BV* Implemented by Upgrade Real Estate in Ghent (Belgium) in 2022

An in-house greywater recycling system which can recycle 85% of mains water, reduces the sewage load and saves energy. It is accessible to install like a home appliance that collects bathroom and washing machine water; cleans and disinfects it, thereby saving water by recycling it. The technology works without using a filter, membrane or chemicals, ensuring low maintenance, and can be added as a home appliance to the building.



Improving Quality of Life, Biodiversity and the Efficiency of Utilities

> Challenge 01

Creating more green spaces in urban areas

Provide urban planners with digital mapping tools to monitor land use and model the climatic and environmental impacts of existing and urban developments.

> Challenge 02

Combining stormwater recovery, vegetalization and temperature regulation

Promote easy-to-install systems to transform roofs and public spaces into green recreational areas capable of capturing and recycling rainwater.

> Challenge 03

Democratizing access to air quality monitoring and air purification

Adopt innovative, simple and inexpensive devices to continuously monitor air quality in streets and homes, automate indoor control and remove air pollutants.

> Challenge 04

Decreasing the footprint of public lighting

Adapt public lighting operations and technologies by taking into account the variety of lighting needs (intensity, frequency, time of day, etc.).



> One of the Solutions From our Portfolio

Urban Heat Vulnerability Map

by Ecoten Urban Comfort

Implemented by the municipality of Vienna (Austria) in 2019

A service based on the analysis of the UHVI (Urban Heat Vulnerability Index) and the UHVM (Urban Heat Vulnerability Map), designed to provide valuable information to city administrations and urban development stakeholders on the level of vulnerability to extreme heat of each area. The service takes on a collaborative approach with the city at the very early stage. Data is collected and analyzed, maps are built and finally a report with the study and recommendations is provided to help cities find the optimal location for heat mitigations strategies.



> From Urban Vision to Solutions Adoption

Create a favorable cleantech adoption environment in cities using key practices such as innovative procurement, partnership & financing strategies, city metabolism scans and citizen engagement, to name but a few.

Urban diagnosis: analyzing cities as urban organisms

When it comes to reducing a city's ecological footprint, it is tough to know where to start. But by mapping material, energy, water, and waste flows – thereby defining the urban metabolism – cities can identify where value is being lost and understand which levers to pull to have an impact.

Powered by [Metabolic](#)

Disclosing environmental data to drive change

To know where you're going, you must first be able to measure where you are and where you were. Collecting and disclosing this environmental data improves awareness and ensures sustainability

measures are well informed, whilst also allowing cities to course correct if they go off track.

Powered by [CDP](#)

Integrating green public procurement criteria

Once there is clarity on environmental footprint and targets, cities should link purchasing to these objectives. In so doing, those responsible will be both mandated and empowered to include the sustainability dimension in their tenders. Designing this criterion requires training and is a careful balancing act between function, cost, and environmental impact.

Powered by [ICLEI](#)

Leveraging public demand to accelerate innovation

Whilst linked to Green Public Procurement, Innovation procurement recognizes the role of the city to both describe its need and prompt service providers to develop innovative products that meet that need. The city acts as an early adopter, creating a market or value chain that may be significantly different from existing systems.

Powered by the [International Cleantech Network](#)

Mobilizing cities for science-based climate action

Bringing evidence- and science-based tools to cities empowers decision-makers to adopt appropriate strategies to meet climate targets that represent their fair share of the contributions to global environmental impact, and thereby execute their long-term vision.

Powered by [WWF](#)

Aligning city and business climate ambitions

Cities are able to measure their environmental footprint but are only directly responsible and in control of a small portion of it. Coordinating with businesses that operate within their territory has huge potential to reduce emissions on a greater scale than the city itself or individual businesses could manage alone.

Powered by [WBCSD](#)

Smart policy mapping

Analyzing the current policies in place will allow cities to determine if they are achieving their intended aims, acting against their environmental objectives, and providing advice on which policies to implement where. This is especially complicated as the execution of policies will have social, economic, and practical knock-on effects, particularly in constantly evolving cityscapes.

Powered by [Metabolic](#)

Finding and unlocking public funding

It's clear that funding is critical to achieving a city's

targets – especially for innovative projects. Public funding can help meet these sorts of ambitions, and whilst crowding in of private-funding is central to being able to scale up as projects advance – unlocking that initial public spend is vital to being able to execute a city's plans.

Powered by [Bable Smart Cities](#)

Unlocking new financing mechanisms for city transition needs

The investment required to reach our climate targets are significant and need to be made sooner rather than later. There is a need for funding mechanisms that can help overcome the high initial capital costs of implementing these technologies, and incentivizing investors to become involved in the first place.

Powered by [Climate-KIC](#)

Robust plans to bridge climate ambition and climate action

Most urban population growth will come from emerging economies in the coming decades, and it is critical that their environmental footprint does not balloon. Investment is key and yet these markets have less predictable returns. By helping cities to develop the capacity to execute projects within these locations will contribute to building that confidence.

Powered by the [Global Covenant of Mayors](#)

Engaging citizens to co-create and participate in public policy

Cities are living, breathing entities where change can happen quickly but also be disruptive. Residents of a city must be engaged to help them understand, accept, and make use of sustainable technologies. This will require training and engagement from public entities that moves beyond one-off contributions to exchanging with citizens consistently over time.

Powered by [Makesense](#)

> The Solutions Explorer

The search-engine for climate action



All the Solutions to be highlighted in the ‘Solutions for Cities Guide’ and even more can be found on the Solutions Explorer search engine, a dynamic free-access database allowing in a few clicks, to discover the clean and profitable products, processes and services that can help everyone achieve their sustainable development objectives, from decision-makers to citizens.

The result of five years of continuous research and analysis, the Solutions Explorer is a one-of-a-kind search engine. This dynamic, free-access database showcases today 1400 clean and profitable solutions from all over the world which have been assessed by independent experts for their environmental and economic performance. Businesses, public authorities, and individuals can navigate the Solutions Explorer to help them work towards their climate objectives in a cost-competitive, profitable manner.

The Solutions Explorer’s user-friendly filtering tool enables solutions to be selected based on sectors, clients, applications, environmental benefits, and technologies. This unique instrument allows the user to discover new and efficient ways of producing, consuming, and adding value to resources with already available innovations.

From the design, the choice of materials, the manufacture of the product to its transport and recycling, the Solutions apply to all stages of the value chain in these sectors to consume less fossil energy, improve the quality of air, protect ecosystems, reduce and recover waste in a circular economy, and save water.

> Access to Solutions Explorer



> Beyond 1000 Solutions...

Leveraging a powerful community to boost Efficient Solutions adoption

The task of identifying 1,000 solutions that reconcile ecology and economy and prove that protection of the environment has become profitable was critical to changing the narrative around sustainability. This truth becomes ever more relevant as political and economic pressures demonstrate the importance of integrating cleantech solutions rapidly and at scale.

Beyond the technologies, what we created was a powerful community comprised of innovators, subject-matter experts, key industry players and institutions from across the globe.

The Solutions for Cities Initiative is the result of activating this community. It makes use of the extraordinary knowledge to understand – when it comes to solution implementation – what works and what doesn't, what is preventing them from being adopted at scale, and where success has been achieved.

Efficient Solutions to help cities reach their environmental and economic targets

This Solutions Guide for Cities has tackled the challenges cities face to adopt such technologies. Whilst not exhaustive, our approach serves to show that the solutions do exist. It is critical that we address the technology stereotypes that have kept actors stuck in the old ways of thinking and doing. This goes beyond the financial argument – which itself has become compelling – and extends to the often difficult to quantify “hidden” benefits such as health or wellbeing that can improve inhabitants' quality of life.

We learned much about the kind of features that matter most when seeking to integrate such solutions into a city: modular, plug & play systems, insightful data analysis software, flexible one-fits-all equipment, non-invasive sensors and energy recovery units, ecosystem matchmaking platforms, enablers for the mutualization of assets and space – these features are common across the solutions presented throughout the complete Guide. In addition, we have highlighted case studies from almost 200 Solutions that are currently used in cities.

Ultimately, the Solutions Guide for Cities serves to prove that these solutions are ready to be adopted, that they are already affording benefits to those adopters, and that with the right enabling environment we can scale them and start to drive down the environmental footprint of our cities.

This overview has provided you with an introduction to the levers of action and challenges facing cities in their ecological transition as well as some examples of possible solutions to address them. The Solutions Guide for Cities, available on our website, will take you through a detailed and complete presentation of this content.



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Solutions Guide for Cities

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