# Digitalize for the environment!

A guide for municipalities and companies wanting to explore and realize the potential of digitalization

# What is this?

This is a guide for those working in public administrations at local, regional, national or global levels who are looking for concrete tips on how to use the potential of digitalization to address environmental problems.

It is also a guide for those who develop digital services and solutions, but may not yet have thought about how to help municipalities to solve environmental challenges.

No matter which of these groups you belong to, this guide will help you to collaborate with others. If it inspires you to engage in discussions about environmentally strategic digitalization, we have succeeded. We are convinced that strategic digitalization is central to building sustainable cities of the future.

> In the digital version of this guide, this symbol indicates that there are clickable links with more information about good examples and reading tips: The guide is available at: cesc.kth.se/digit-for-environ

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# Why is a guide for environmentally strategic digitalization needed?

More than half of the world's population today lives in cities, and according to a 2018 forecast by the United Nations, this number is expected to increase to nearly 70% by 2050. Those who work in or with public authorities play a decisive role in reducing society's environmental impact and in contributing to the sustainable cities of the future.

One way to solve environmental problems in society is what we call "environmentally strategic digitalization". Digitalization is a force that can affect the entire structure of society. It can be a tool for reducing environmental impact and reaching environmental goals locally, nationally and globally.

Digitalization can also support the implementation of environmental measures in other sectors. For example, if digital services make it easier to live without cars, an increased gasoline price would be more acceptable.

Digitalization can also promote unsustainable behavior. For example, e-commerce can induce additional consumption. This means that we need to think one step further when we create digital services to actively prevent unsustainable behavior and negative environmental outcomes.

So far, there is no actionable and credible guidance on how digitalization can contribute to achieving environmental goals. Our experience shows that those who work with environmental and digitalization issues in private and public organisations need to find better ways to cooperate and advance this kind of work. This guide provides information on digital solutions to real-world problems. It also seeks to encourage developers of digital services to focus on environmental challenges. We hope it will help to use the potential of digitalization to reduce society's environmental impact.

## Who are we?

This guide has been developed by Mattias Höjer and Tina Ringenson, KTH Royal Institute of Technology, Stockholm; Jan Bieser, University of Zurich; Steve Easterbrook, University of Toronto; Yusuke Kishita, University of Tokyo; Beat Koch, GreenITPLUS GmbH; Patricia Lago, Vrije Universiteit Amsterdam; Sam Mann, Otago Polytechnic, New Zealand; Birgit Penzenstadler, California State University Long Beach; Nicole Rigillo, Berggruen Institute; Colin Venters, University of Huddersfield, UK. The starting point of this international guide was a workshop held at the University of Toronto, in connection with the ICT4S conference 2018.

# Environmental goals

In September 2015, the United Nations adopted the Sustainable Development Goals, consisting of 17 goals to "end poverty, protect the planet, and ensure prosperity for all". As of February 2019, 195 UNFCCC members have signed, and 185 have become party to the Paris Agreement, which "aims to strengthen the global response to the threat of climate change" and to hold "the increase in the global average temperature to well below 2 ˚C above pre-industrial levels".

Apart from global goals, most countries have their own environmental targets. Most cities or municipalities in turn have their own targets, often connected to national and/or international ones. National environmental targets and environmental protection laws may also mention municipalities as important actors. However, different cities might require different approaches to develop and realize environmental goals.

## 99 Everyone has to contribute.

One of the main challenges for achieving global environmental targets is for countries to derive compatible and actionable targets. In addition to national environmental objectives, regional and municipal environmental objectives that respond to national objectives are required. In order to ultimately solve environmental problems at a national level, everyone has to contribute — not just municipalities and county councils but also businesses. Environmentally strategic digitalization is an important part of this work.

### READ MORE: ENVIRONMENTAL GOALS AT DIFFERENT MUNICIPALITIES

Montreal, Canada: Faire Montreal

Zurich, Switzerland: Creating a 2000 Watt Society

Copenhagen, Denmark – First carbon neutral capital by 2025: Climate Plan

Gothenburg, Sweden: Environmental program

**Other initiatives**

Global Covenant of Mayors for Climate and Energy

ICLEI – Local Governments for Sustainability

Clinton climate initiative

European Energy Award

Exponential roadmap

# Content of this guide

# A few central concepts

In this chapter we use recent research as a starting point to present several concepts that we will return to when we talk about environment, digitalization and sustainability.

## Watch out for buzzwords

Digitalization, sustainability and smart cities are concepts that have become so-called "buzzwords" – words used often and in many different contexts. As a result, the concepts become ambiguous. We often think we are aiming for the same thing, but actually mean different things.

## 99 Ask the question: What do you mean by this?

Our first tip is to watch out for buzzwords! For example, in this guide, we use the concept of smart cities sparsely, because there are so many different ways to look at what that is. Our second tip is to dare to ask the question "What do you mean by this?" when someone uses a buzzword. This way you can be sure that you talk about the same thing, which will prevent many misunderstandings and save a lot of time.

## What does digitalization mean?

Digitalization is the ongoing, system-wide, societal transition from analogue to digital information streams and the profound consequences of these changes, such as new working methods, organizational processes and community structures.

A distinguishment can be made between "digitization" and "digitalization". "Digitization" refers to the transition from analogue to digital information, while "digitalization" refers to societal and behavioral changes. If the former is about scanning a piece of paper into a PDF, then the latter is about completely new opportunities to communicate at a distance. It can affect everything from where we live, how we travel and how the labor market works.

## Five aspects of digitalization

In our research for this guide we have specified the five basic aspects of digitalization.

**1** **Measuring.** Measurement and data acquisition via sensors is an important part of the connection between the digital and physical world. In an environmental context, this might be information about air quality or carbon dioxide ($CO_2$) emissions.

**2** **Connecting.** In order to transfer data between different devices, they need to be connected through a common digital infrastructure. High connectivity is a prerequisite for digitalization.

**3** **Positioning.** For many applications it is important to know where the devices that send data are located. Therefore, positioning, for example via GPS, is an important prerequisite for digitalization.

**4** **Storing.** Data storage capacity has increased dramatically in recent years. It is increasingly happening in what is called the "Cloud", which usually represents a virtualized data center with high computing and storage capacity, hosted in specialized data centers.

**5** **Processing.** Data in itself might not always hold much meaning. It needs to be processed and interpreted.

Although people can interpret and understand data in other ways than computers, a processor can process digital data to a much greater extent than humans.

### Some digitalization concepts

**Big data.** Big data consists of digitally stored data of such size (usually terabyte and petabyte) that it is difficult to process using traditional computing methods. Large amounts of data are, for example, created in meteorology and social media. There is a large amount of possible applications for big data, including trend analysis and artificial intelligence.

**Internet of Things (IoT).** This means that everything – from household appliances and clothing to vehicles and buildings – is equipped with built-in sensors, internet connectivity and sometimes computers. These "things" can then communicate and take smart decisions – creating many opportunities for improving processes.

## ❞ People can interpret and understand data in other ways than computers.

**Open source.** Open source programs and applications have a source code that is available to use, read, modify and redistribute at no cost to anyone.

**Smart.** The concept of smart in the world of digitalization simply means that something uses digital technology. However, the term often creates confusion by using it in other contexts to describe anything that is "a well-thought-out solution".

**System integration.** Connects multiple independent IT systems and enables them to communicate automatically without the need to manually enter data.

**Open data.** Digital information that is freely available without intellectual property rights, such as copyright and patents.

### Some environmental concepts

**Bioeconomy.** A buzzword that indicates increasing the utilization of biomass instead of fossil raw materials, so that our economic prosperity becomes less dependent on fossil fuels, such as oil. Energy, chemicals and plastics are some areas where development towards a bioeconomy has come the furthest.

**Circular economy.** Used to describe an economy in which materials and resources are kept in use for as long as possible, e.g. by extending the useful life of products through reuse and repair and by minimizing waste. Often, the emergence of a sharing economy with reduced personal ownership is seen as part of the circular economy.

**Sustainability.** A buzzword that occurs everywhere. Most often, it means a society with a prosperous environment, social justice and well functioning economy, which is able to meet its needs in the long-run. The Brundtland Definition and the Sustainable Development Goals are the most well known concepts of sustainable development.

This guide focuses on how digitalization can contribute to environmental sustainability.

**Environmentally friendly.** A word to use with caution. Most products or activities have some form of environmental impact. More often than not, "environmentally friendly" options might have a smaller negative environmental impact than other options, but do not contribute to a better environment, as with "environmentally friendly cars".

# Paths towards environmentally strategic digitalization

Digitalization entails structural changes in society. These can relate to how we work, how we travel, how we consume and how we get information. All social change can have an impact on the environment, but it can sometimes be difficult to see exactly how.

> 99 **You can use any of the four approaches to tackle any environmental challenge.**

In this guide we focus on four ways of using digitalization for environmental goals. You can use any of the four approaches to tackle any environmental challenge.

However, we want to emphasize that there are also risks with all the proposed paths — one needs to consider the social consequences that may arise from the changes, safety and security risks, and any indirect effects on the environment. Often you need additional tools to get the best possible effect.

**1** **Inform.** Digitalization results in large amounts of data and information that can highlight various environmental issues. But it may be hard to know exactly what information is needed.

It is also not easy to know how the information should be presented in order to assist in the development of environmentally-friendly digital services.

**Ask yourself:**
- What data do we already have and how can it support the environmental goals?
- What information do we need and do not have?
- How can we collect information with digital solutions, for example by means of sensors connected to cloud-based services?
- How can we present the information in a way that helps us to map environmental problems and find solutions?

**2** **Replace.** It is possible to replace many physical products, services and phenomena with digital services. Today, for example, we can carry out banking matters, work and study without dedicated spaces, and tablets let us read books and magazines without wasting paper.

In other words, we can use digital services to replace things, which could save on resources. This may include reduced travel, and reduced need for premises that require electricity, heat and water.

**Ask yourself:**
- Can the environmental problem be solved by replacing something with a digital service?

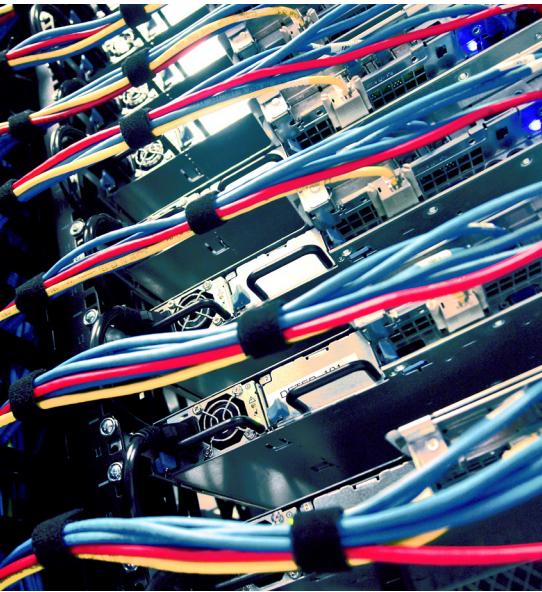By intensifying the use of what already exists, we can save resources, simply by utilizing the existing ones more and better.

**Ask yourself:**
- Can the environmental problem be solved by intensifying the use of an existing resource, using a digital service?

**4** **Streamline.** Sometimes digital services can be used to completely change how something is done, e.g. by replacing something or by intensifying the use of something. But they can also be used to streamline things using technology, which means we waste less resources without actually changing the phenomenon.

For example, we can use sensors to adjust ventilation and heating of a room according to air quality and presence of people. Another example could be cars with navigation support shortening the route and reducing emissions.

**Ask yourself:**
- Can the environmental problem be solved by streamlining the processes that cause the problem through digital services?

**3** **Intensify.** With the help of digital services, we can increase the use of things that already exist. For example, digital services can enable car sharing or support that public buildings are used for several purposes such as when schools are used for non-school activities during off-school hours.

## READ MORE: TECHNOLOGY INTEGRATION

Technology integration can create opportunities to improve a city's infrastructure. One significant step to achieve this is to integrate and enrich data across systems.

This can enable much more intelligent processes in the operation of urban infrastructures. For example, integrating air quality, weather and

traffic forecast systems can enable dynamic traffic control to reduce fine dust pollution.

Researchers at the University of Huddersfield have developed an intelligent planning system using sensor data to identify traffic signal strategies to react to unforeseen events such as road closures or road traffic saturation.

GOOD EXAMPLE

# Stockholm City Environmental Barometer

The City of Stockholm's Environmental Divison collects all of the city's environmental data on a portal that is accessible to all.

For example, you can find information on greenhouse gas emissions, water quality of lakes or air quality in different districts.

The Google Environmental Insight Explorer is a related example, covering more cities but only the building and transportation sectors.



STOCKHOLM, SWEDEN. PHOTO: JON FLOBRANT ON UNSPLASH

# Steal good ideas!

A common pitfall for environmentally strategic digitalization is to start from scratch instead of looking for good examples. Why should you reinvent the wheel when someone else has already tested and learned important lessons from it?
Start by looking at the many innovative projects in the field of environmentally strategic digitalization and beyond.
Get inspired by successful solutions in your home country and abroad. And equally important, also look for solutions that have passed the innovation stage. Many of the people involved in successful and purposeful digitalization projects might even be willing to support you in finding and realizing your project! Spend time on this!

## 99 Get inspired by successful solutions.

Many digital solutions to solve environmental problems do not receive the attention they deserve. One good example is smiile, a service and resource sharing platform built and used by 40,000 neighborhoods across France.

## READ MORE: HERE ARE SOME GOOD EXAMPLES

🔗 In Japan, there are a number of smart city projects focusing on energy savings and technology diffusion (e.g. renewable energy, battery storage and electric vehicles). Some examples in the context of digitalization for environmental protection include Yokohama Smart City Project and Kashiwa-no-ha Smart City.
See also Page 13.

🔗 The European Innovation Partnership on Smart Cities and Communities (EIP-SCC) is a forum for municipalities, industry and citizens to improve urban life through more sustainable integrated solutions. The forum also contains a marketplace where you can find different projects.

🔗 In Vinnova's (Sweden's Innovaiton Agency) project database there are descriptions and reports from all research and development projects they have financed. Search for "digitalization" to find relevant projects.
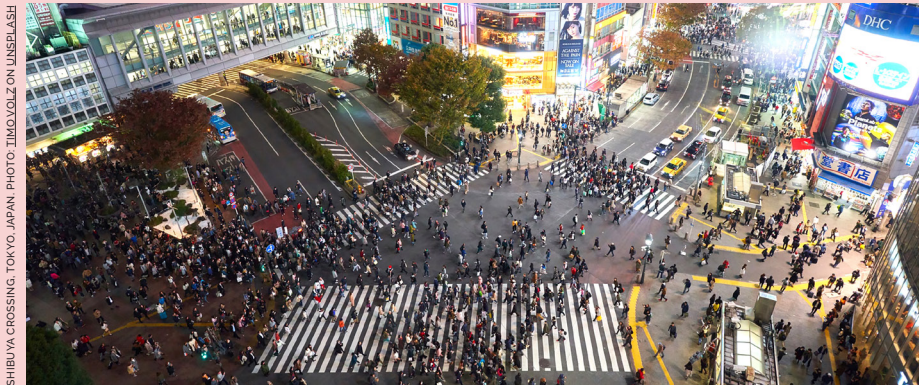
GOOD EXAMPLE
# Kashiwa-no-ha Smart City

🔗 Drawing on collaborations between public, private and academic actors, The Kashiwa-no-ha Smart City Project provides an open platform to tackle social challenges Japan will face before other countries, such as an ageing society. The project aims for optimal solutions for environmental symbiosis, creation of new industries, health and longevity.

To demonstrate a future vision of the city, digital technologies are used as exemplified below:mIn pursuit of energy savings and disaster resilience, the city has been developing a smart energy management system and smart grids, which use solar energy and battery storages.

In the district of Kashiwa-no-ha an area energy management system (AEMS) has been developed to reduce peak electrical loads and $CO_2$ emissions.

At the household level, a home energy management system (HEMS) has been developed to raise citizens' environmental awareness through the visualization of $CO_2$ emissions for each household on digital devices (e.g., computer, tablet, and smartphone).

Digital health devices (e.g., wristband data recorders) are used to monitor and visualize health-related information of residents such as sleeping patterns.



SHIBUYA CROSSING, TOKYO, JAPAN. PHOTO: TIMO VOLZ ON UNSPLASH

GOOD EXAMPLE
# New Zealand minister of Statistics

🔗 During the negotiations between the Green and the Labour Party after the 2017 general election in New Zealand, James Shaw, the co-leader of the Green Party, became head of the Climate and the Statistics Department. By itself, these were not considered to be important cabinets. However, being Minister of Statistics, Shaw can ensure that emission data and climate data are collected, prioritized and visualized. From this position, he can influence many other cabinets and be a strategic partner for anyone interested in using data as a tool for change. This shows how important data is.

# Innovate with purpose!

One of the major challenges when society embarks on digitalization is that it places new demands on knowledge and skills. You may find it difficult to find people with the necessary qualifications to run environmentally strategic digitalization projects. In order to better leverage the potential of digitalization, it is important to recruit the right people and provide them with the right working conditions. It is also important to strengthen a culture where we dare to try out new methods and solutions.

## 99 Learn from others.

**Keep two things in your head at the same time – not one or three.** The most important and at the same time the most difficult advice we have to give is to focus specifically on both the environmental goals and the potential of digitalization simultaneously! This is harder than it may sound, because you will hear that you also need to capture economic, social and cultural factors. However, try to bracket these aspects at least occasionally. Economic, social and cultural perspectives must be considered before implementation, but you need focus to progress!

**Counter digital incompetence.** It is impossible to do anything if you don't have the necessary knowledge and skills. This is especially true with digitalization, which happens at a fast pace and constantly requires us to learn new things. Therefore, it is important to have the time to learn from others.
Find people who are willing to learn how to transform digitalization's potential into reduced environmental impact. Create opportunities for inspiration and learn from each other. Arrange workshops — use this guide as a starting point for the discussion!

**Recruit people with the right abilities.** It's not just about finding people who have experience in driving digitalization and a strong environmental commitment. Being able to collaborate with others, good communication skills and a willingness to learn new things are three qualities that are crucial for innovation. But it is especially important to recruit people who dare to challenge and not let existing structures stand in the way of new thinking.

## 99 Dare to reorganize.

**Provide time, resources and mandates.** Talk about new ideas in a positive way to create a culture that welcomes change and counteracts owners who want to do things "as we usually do".
Allocate resources as well as time and give clear mandates and ownership to those who will work on and solve environmental issues. Dare to reorganize if needed!

**Celebrate failures.** Test new things and dare to fail to raise innovation capacity. Not all ideas will be successful.
Run projects which allow for failures so you dare to try out new ideas that could solve environmental issues. With complex problems, where challenges, goals and solutions are not obvious at first, it's good to work "iteratively" — produce a prototype, test it, get feedback and then further develop the solution.

# Switzerland Innovation

On a former airfield in the Greater Zurich Area, the city of Zurich and Dübendorf, together with local research institutions and private companies, have developed the Switzerland Innovation Park Zurich, a platform for promoting knowledge and technology transfer from research into practice.

By building upon on the expertise of local research institutions, the Park focuses on three key areas: "life sciences and quality of life", "engineering and environment" and "digital technologies and communication".



PHOTO: TWII ON UNSPLASH



PHOTO: JORRIT LOUSBERG

"World's leading smart playground". The goal of the project is to create new Smart City and Smart Stadium applications to improve profitability, sustainability, safety and customer experience, while testing novel digital ideas.

The Innovation Arena does that by inspiring leaders and businesses to adopt a "systems approach" rather than the optimization of separate systems, to co-create and experiment in a pre-competitive environment, to engage all target groups and stakeholders.

The Arena hosts multinational companies, SMEs, digital artisans, start-ups and students, urban farmers and everyone who wants to make our world a better place by developing state-of-the art novelties and solutions.

## Amsterdam Innovation Arena

The municipality of Amsterdam, Johan Cruijff Arena and leading technology companies initiated the Amsterdam Innovation Arena project to create the

# Create alliances!

Environmental problems and digitalization are complex challenges that transcend existing administrative and conceptual divisions between the public sector, businesses and society. Complex challenges require cooperation.

**Step out of the silo.** It is common that those responsible for developing digital solutions and those responsible forenvironmental goals are different people, in completely different departments. Therefore, look everywhere for people who share your ambition to explore how digitalization can contribute to environmental targets .

**Find the right civil servant.** Civil servants have different competences and interests. Put some effort into finding the right one to talk to - and if you are one of them - look for motivated colleagues in other departments.

**Get politicians on the train.** The majority of politicians have tremendous workloads and do not have the opportunity to address all the issues - they rely on recommendations from others. That's why it's up to you to engage with politicians who are passionate about digitalization and environmental issues and provide them with information to help them act as ambassadors for your ideas and solutions.

**Talk directly to those who need your services.** Businesses and the public sector need to work together to find solutions to major societal problems.
Talk not only about digitalization, but focus on what the municipality needs to solve its environmental problems. How can digital services be matched with environmental problem solving? This can yield concrete business opportunities or better selling arguments.

PUENTE RASARIO-VICTORIA, ROSARIO, ARGENTINA.   PHOTO MAXIMILIANO PIU ON UNSPLASH

# GROW Observatory

The GROW Observatory, a European citizen science project, is empowering citizens to monitor environmental variables.

Equipped with low-cost sensors and a mobile application passionate growers and enthusiastic citizens are collecting in-situ soil moisture observations to generate a reference dataset for remotely-sensed soil moisture products of unprecedented extent.

Thousands of low-cost sensors are currently being deployed in nine high-density clusters distributed over Europe, establishing the basis for validating high-resolution satellite soil moisture products. To ensure reliable data collection at representative locations, citizens are being trained via massive open online courses (MOOCs), and on the ground through field handbooks and face-to-face workshops.

The community is supported by local community champions and an online forum. Vital for the creation of a reliable and valuable dataset is not only quality, provided by the low-cost sensors, but continuity, which strongly depends on the citizens' ongoing engagement and motivation. In contrast to conventional contributory citizen science projects, which are organized entirely by scientists for the benefit of new knowledge, and often require only a one-time activity, GROW is a collaborative endeavour.

GROW relies on a long term commitment by its participants to create a continuous in-situ soil moisture dataset to aid decision-making by stakeholders, including the citizens themselves. To this end, the GROW citizens' observatory framework bridges the gap between citizen science for scientific knowledge to longitudinal environmental monitoring for potential benefit on a local — global level.

# Find the arguments!

In order to convince politicians, bosses or colleagues about the potential of digitalization to reduce the municipality's environmental impact, you need concrete and clear arguments, no matter if you work within the municipality or not.

HUNTINGTON BEACH, US. PHOTO: RYAN FRANCO ON UNSPLASH

**▌ Consider societal interest, not self-in-
● terest.** Avoid being stuck in your own perspective, and, instead, think about what is important for the municipality or the region at large.
Start by answering three questions: What is the environmental problem, what is the solution and how does your idea contribute to that solution?

**▌ Do your homework.** Connect your
● solution to an environmental goal. Many municipalities in the world have local environmental objectives. Show why your digitalization project is particularly effective to achieve one or more specific environmental goals.

**▌ Find what topics the decision makers'
● are most committed to.** Identify positions, promises and central concerns of local politicians, decision makers or clients. Provide suggestions for concrete digital solutions that not only reduce environmental impact but also meet the objectives and

challenges of these people, for example, public health, time efficiency, livable city or the like.

**▌ Make it easy and talk about the citizens.**
● Few can relate to carbon dioxide levels, emission curves or digital infrastructure. Use simple words to describe how your digital solution leads to positive effects for citizens, here and now, and in the long run.

**▌ Do the job and find out the procurement
● challenges.** Many municipal decision makers or clients are uncertain about procuring innovative digital solutions without knowing about their actual impacts.
Use good examples from other municipalities to show how they resolved challenges in the procurement process.

**READ MORE:
EU GUIDANCE ON INNOVATION PROCUREMENT**

🔗 The EU guidance on innovation procurement includes examples for procurement innovations, e.g. the Car Fleet Shared Management Platform of the Portuguese Ministry of Health.

# City Bikes in Long Beach

The City of Long Beach in California, USA, specifically the Office of Civic Innovation and the Office of Economic Development have compiled and linked a commendable amount of information about all areas of life in their portal: DataLB is a geospatial and open data hub that provides access to data about business, health, recreation, schools, transport, and safety according to the Long Beach Sustainability Action Plan.

One specific area of environmental impact is transport - here the city made a big improvement by enabling the Long Beach Bike Share. The Long Beach Bike Share has 400 bikes in 60 stations and 156 miles of bike paths. Users register once and can choose either pay-as-you-go or a type of membership that suits their needs, unlock a bike with their personal code, ride it to where they need to go, and lock it at a different station at their destination. The 60 stations in Long Beach cover the most frequented areas around downtown, several entertainment areas, and the university campus. The provider, Social Bicycles, also performs frequent maintenance and can be notified of repair needs.

Similar programs have been installed in many European cities already, but many more can still join in – promising a decrease in emissions (specifically in downtown areas because of reduced need to circle for parking), an increase in air quality, and increased health for the users of the system.



MELBOURNE, AUSTRALIA. PHOTO: SHAUN LOW ON UNSPLASH

## CSULB SBD Dashboard

CSULB is developing a small business delinquency dashboard. The SBD Dashboard aims to track relevant indicators that help foresee when a small business is struggling. The input sources for that dashboard are, several social media outlets like Yelp, Twitter, Instagram, Facebook, and Google Reviews, and other publicly available data. The aggregated data overview of the SBD Dashboard displays a heat map of which small local businesses are struggling and need more support. This support can be provided by the Office of Economic Development as well as individual citizens who may choose those businesses' services or promote them in their local neighborhood.

# Engage Citizens!



NORTHWEST WASHINGTON, WASHINGTON DC, USA PHOTO: VLAD TCHOMPALOV ON UNSPLASH

Citizens globally are increasingly active in leading and participating in movements for digitalization for the environment. Much of this involvement comes through activities broadly falling under the banner of "citizen science", or monitoring and collecting environmental data that can be used for the public good.

Such data is usually crowdsourced, or obtained via inputs from a number of different people through the Internet, and made publicly available online by a sponsoring organization, often a university or NGO.

Citizens may collect data with nothing more than their smartphones. For example, eBird,

an initiative of the Cornell Lab of Ornithology, allows users to upload geotagged photos of birds and then develop new approaches to science, conservation and education.

Citizens may also generate data through "citizen sensing", where special sensors are used to crowdsource environmental data. For example, SafeCast is an international, volunteer-centered organization devoted to open citizen science for the environment launched in Japan following the 2011 earthquake/tsunami and the subsequent meltdown of the Fukushima Daiichi Nuclear Power Plant. SafeCast now makes devices available for users worldwide to source radiation and other environmental data, and today has the largest dataset of its kind.

Engaging and partnering with existing citizen-led initiatives can help governments boost and democratize their own digitalization efforts.

Citizen-sourced data is often classed as "open data", freely available to anyone to use and republish. Marshalling the involvement of citizen volunteers as data collectors may therefore be an extremely cost-effective means of collecting data. Citizen-led data initiatives can help to raise citizen awareness for environmental issues, and also generate a sense of environmental stewardship.

## READ MORE: 108 ICT-ENABLED CITIZEN SCIENCE PROJECTS

🔗 For more examples, see this 2018 article on the practices, trends and challenges of 108 ICT-enabled citizen science projects around the world.

GOOD EXAMPLE

# Citizen-led Mapping of Informal Garbage Dumps

In Bangalore, India, a city of 12 million, garbage is a major issue. Municipal infrastructure and services have not kept step with IT-sector-fuelled population growth. Municipal garbage collection is absent in many areas, and illegal dumping is common, even in areas that have garbage collection. Informal neighbourhood dumps, or "black spots" are often set on fire, worsening already high levels of air pollution in the city.

Bangalore's municipal government has developed several apps allowing citizens to take geotagged photos of garbage dumps and other civic issues for reporting to municipal authorities (e.g. BBMP Sahaya, I Change My City).

But much of the information collected via these apps remained black-boxed and available only to the government. Problems were being addressed in a singular fashion, and aggregate data was often not shared with the public, foreclosing the possibility of collaborative solutions.

In response, Open City, an open data platform initiated by the nonprofit Oorvani Foundation and Data Meet (a community of data enthusiasts) developed a crowdsourced mapping strategy for Bangalore's black spots, while local news media platform Citizen Matters made a call for volunteers. The team used a data collection tool from MapUnity to create a citizen-sourced map of Bangalore's informal garbage dumps.



INFORMAL DUMP ON BANNERGHATTA ROAD BANGALORE. PHOTO BY: JORRIT LOUSBERG, LICENSED UNDER CC-BY-SA 2.0

By August 2016, participants had mapped nearly 1,100 garbage dumps, uploading photos and information that helped understand the root cause of black spots (lack of collection, private land, bulk source of garbage etc.).

The map offered never-before collected data on an urban issue, prompting a governmental response and making it easier for civic groups to organize cleanup drives.

# Think one step further!

Sometimes it can be hard to see how the things we do every day can play a decisive role in reducing our environmental impact and contributing to sustainable development. But they do.

Digitalization can be both a barrier to and an opportunity for sustainable development. It can help us achieve environmental goals, but can also affect the environment in a negative way by making it easier to use more resources.

Unintended effects of digital services can potentially offset environmental gains. For example, think of autonomous cars: They could reduce traffic jams, but they can also lead to increased car traffic as public transport loses market share, and as more people travel more often as personalized car travel gets easier, and as infrastructure is developed to manage more cars.

## 99 The outcome depends entirely on us.

In order for digitalization to help solve our environmental problems, we need to see how implemented services also contribute to achieving environmental goals, for example by counteracting unsustainable behaviors or facilitating environmental measures.

We are convinced that sustainable societal development requires us to think one step further and focus on environmentally strategic digitalization.

We hope this guide will help you see both obstacles and opportunities, and inspire you to Digitalize for the Environment!

MOUNT ASPIRING NATIONAL PARK, NEW ZEALAND. PHOTO: ALEKS DAHLBERG ON UNSPLASH

## 99 Go for environmentally strategic digitalization

# What do frogs have to do with digitalization?

Sometimes it can be difficult to see the connection between digitalization and environmental problems. Is it reasonable to think that endangered frogs could be saved using an app? Yes, of course.

Frogs are a so-called indicator species, which means they are more sensitive to changes than many other species. Studying the health of frogs can show how the environment is doing in general. Frogs are especially sensitive to fragmentation of natural areas, as it prevents them from the annual journey they need to take to reproduce. The main reason why urban neighborhoods become fragmented are highly frequented roads.

Let's take the Stockholm region as an example, which grows by about 35,000 inhabitants each year. Many of these have a car. Thus, the pressure on the Stockholm roads is constantly increasing, and our response is building more and broader roads. Our car dependence thus leads to increased fragmentation of natural areas, which affects many species negatively — not least the frogs.

In this context, environmentally strategic digitalization can be used to get more people to interact through car pools, or even get us to work from home and shift the commute.

A consequence of this may be a reduction of cars on the roads and thus a reduced need to build new roads that further fragment natural areas. And it is good for Stockholm's ecosystems in general, and the endangered frogs in particular. Again, it depends on us, if we solve these issues by building more infrastructures or create innovative solutions that use what we have more efficiently.

So yes, you can actually save frogs with an app.