The Growing Role of Digital Paper in Smart Cities.

"Sustainable digital paper enables a whole new paradigm for urban communications."

Kirk Talbott | Former Executive Director of Smart City of Atlanta

Smart City initiatives have been underway in cities globally for some time, and while there is no single definition for the term "smart city," most experts agree on the core principles at the heart of the concept. By nature, these principles are interrelated and supportive of each other to create broad impact across urban areas.

Smart cities are sustainable, designed to protect the environment over the long term. One hallmark of this focus is the drive to reduce greenhouse gas emissions (GHG) to slow climate change. Two hundred eighty-seven cities and counties across the United States have pledged to remain in the Paris Climate Agreement.[1] New York City's goal is to reduce GHG emissions 80 percent by 2050 compared to 2005 levels.

Smart cities promote wellness, incorporating ample green spaces such as parks to bring citizens closer to nature even in the most densely populated areas.

Smart cities have highly efficient public transit systems, reducing the need for cars while making their environments friendlier for walking and cycling.

But by far the most important principle behind smart cities is that they are **interconnected,** enabling the sharing of all kinds of data between citizens and governmental agencies to make everyday life more efficient.

A proliferation of Wi-Fi-connected Internet of Things (IoT) sensor devices can send data to a central "cloud" database, where it can be aggregated and made useful to citizens in a thousand ways. Parking spots can let everyone know when they're open. Transit signs can feature live updates for bus and train arrival times. Citizens can let their neighbors know about upcoming farmers' markets down the block. And governments can keep citizens up-to-date on things like local infrastructure projects —and get feedback from constituents in real-time.

In effect, each sensor acts as a kind of node that can capture and transmit data within a network. According to Metcalfe's Law, the value of a network is increased by the number of nodes in the network. A city with a large number of nodes/sensors will be better able to bring the value of data into everyday use by citizens to make life better.

"A smart city is powered by smart connections for street lighting, smart buildings, distributed energy resources (DER), data analytics and intelligent services, and smart transportation — the operative word being power."
Daily Energy Insider, June 2011

All this interconnectivity, however, requires electricity to function, and the more electricity is generated the more greenhouse gasses are produced, making sustainability goals harder to reach. As of 2018, only about 17 percent[2] of U.S. electricity was generated from clean energy. While cities are eager to ramp up their adoption of clean energy it will take until the year 2050 for 80 percent of global electricity generation to come from solar and wind.[3]

In the meantime, cities (being popular places to live and work), will be growing exponentially:

- More than half of the world's population already lives in cities, and another 2.5 billion people are projected to move to urban areas by 2050.[4]

- The United States currently has 10 cities with 1 million or more residents,[5] while China boasts over 100.[6]

- Cities consume approximately 70 percent of the world's energy.[7]

- On average in the United States for every 1,000,000 urban residents an additional 7,439,2000 kilowatt-hours (kWh) of electricity is required.[8] To put that in context, one kWh of electricity will run a vacuum cleaner for about 1 hour, or power a washing machine to clean 12 pounds of laundry.[9]

This is the smart cities' power paradox, a conundrum that's forcing city managers, corporations and citizens to ask: How can we create interconnected cities in the most sustainable way possible?

Many solutions will be needed. But one technology here today that's making its mark in urban areas is E Ink® digital paper for signage and displays. E Ink's technology requires an average of approximately 99 percent less power than other types of screens such as LCD.

Digital paper was broadly adopted in eReader devices such as the Kindle. Today, this sustainable technology has literally grown up, with a range of size formats used in numerous applications spread across entire cities, with more applications arising every year.

Applications in use today include:

- Signage that shares city management's 311 communications

- Wayfaring and bus stop transit signage

- Community news feeds

- Electronic shelf labels (ESLs) in factories and stores

- Corporate information displays

- Motion displays at retail

- Hospital communications

How does E Ink digital paper work?

Black and white particles within microcapsules or microcups are coated onto a thin film layer and act as a form of ink, but instead of ink being pressed permanently upon paper (which ultimately must be recycled or dumped in landfills), the ink particles in digital paper are automatically recycled to form new letters and images when the display image is updated. And herein lies part of the secret behind the technology's sustainable nature: Because power is only used when the image is changed, signage made with E Ink uses so little power that each unit can run off its own small solar PV panel or a battery, requiring no connection to electrical grids. Any number of signs can be deployed at a low cost, and they can run independently because each has its own green solar power station.

People have the feeling they're looking at paper, but the images bring the advantages of digital — Wi-Fi connected, easy to update with new information, and able to interface with social media apps.

Emergency management messages that keep working in an emergency (what a concept).

Just as with paper, however, an image digitally printed on an E Ink screen stays there indefinitely until the page is refreshed with new content. This means cities can post emergency management notices that will stay on screen during long-lasting power outages, and even when there is no sunshine to power the solar panels. This is a mind-bending concept that completely upends the standard notion of what it means to be "ON."
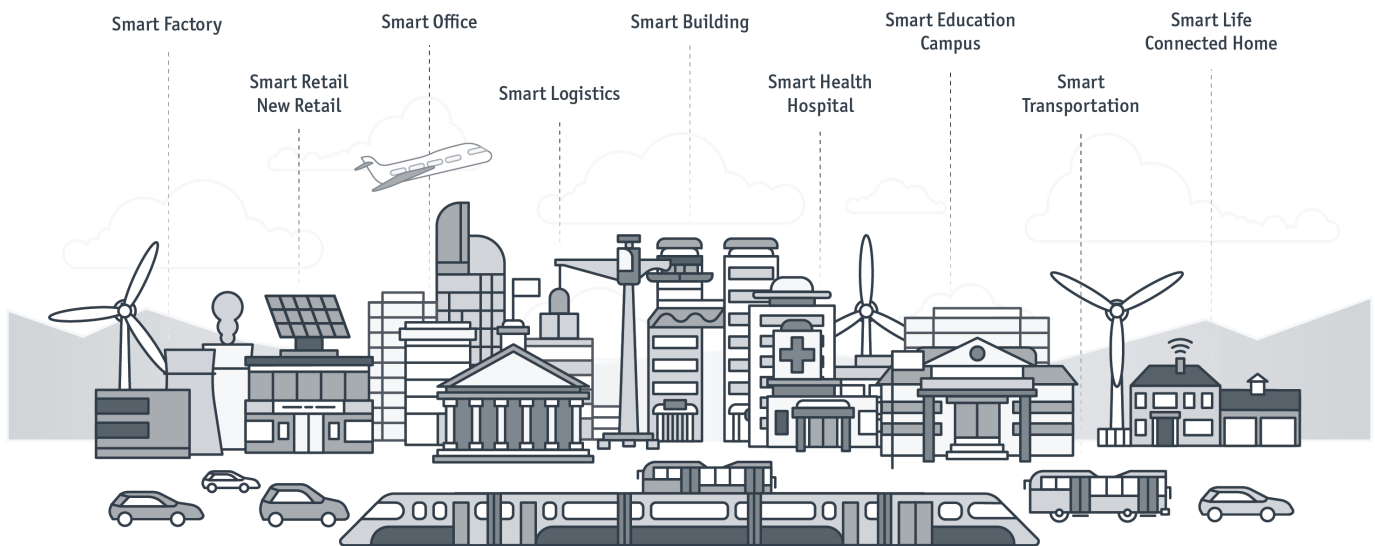
A real-world example of continuous operation for emergency communications occurred during the Fukushima disaster in Japan. Signs made with E Ink digital paper played an important role in keeping the public informed — and safe — during an extended power outage.

As climate change poses a rising threat to urban areas, particularly those near coastal waters, signs made with digital paper can provide the public with live updates on flooding, transit issues and evacuation routes.
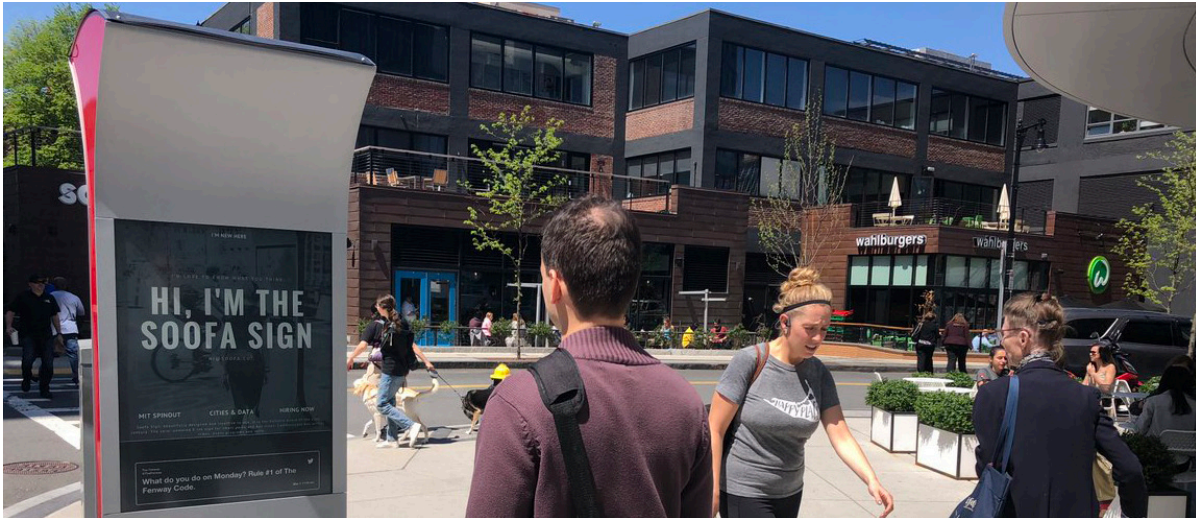
The antidote to urban light pollution and distraction.

Because digital paper reflects light instead of creating its own light, and movement is limited to the screen content changing, the technology is embraced by communities seeking to avoid light pollution and distraction from LCD displays. While New York's Times Square signs may be visually stimulating for short periods of time, most neighborhoods would find them a nightmare for day-to-day living. In many ways E Ink's digital paper is the antithesis of the blaring color and full motion of LCD screens. With its crisp black and white image quality, digital paper promotes a sense of permanence, credibility and focus. Which is why E Ink displays are fully compliant with the Vision Zero initiative to reduce distraction in urban environments.

Digital Paper — Sustainable Applications for Today's Smart Cities

Smart Factory

Smart Office

Smart Building

Smart Education Campus

Smart Life Connected Home

Smart Retail New Retail

Smart Logistics

Smart Health Hospital

Smart Transportation

As the properties of digital paper have become more widely known by system integrators, the range of sustainable applications that make cities smarter has grown — touching nearly every aspect of smart urban living.

Soofa, a startup based in Cambridge, Massachusetts, has created a community news feed for the 21st century. The company's Soofa Signs, made with 42" black and white E Ink displays, create an open platform allowing everyone to communicate with each other. Instead of pushing information out to communities, the signs foster a dialog that's fueling community engagement and economic vitality at the neighborhood level. Governmental agencies can centralize their community outreach communications, instantly sharing information such as 311 updates. Local businesses can open a Soofa account and post ads, or pay for sponsored posts like "We're hiring!" notices to reach the best and brightest job candidates who live close to their offices. And citizens can post notices about upcoming events in their neighborhood. Best of all for city governments, Soofa Signs are solar-powered and require no digging for installation or connection with electrical grids. And oh, by the way, they're free.

Solstreet has invented a solar bench that lets citizens hang out and plug in their phones to recharge while an E Ink display shows digital updates for public events happening nearby plus paid advertising. As their name implies, all power comes from the sun. Solstreet conducted a successful demo in Times Square in May 2019 as part of Design Week.


Solstreet's solar bench helps people plug in and recharge their batteries, and get plugged in to local community events while they're at it.

The GDS e-Tela solar-powered bus stop sign provides live updates on arrival times.

Across the globe, smart products made with E Ink are preventing frustration at bus and train stops with live transit updates. As just one example, GDS deployed its solar-powered e-Tela bus stop signs in Berlin as part of the city's "future green stations" initiative. GDS cites research that shows that passengers are more relaxed when they know when their bus is coming; in fact, passengers are happier even when their bus is late!

In 2019, Avalue will be disrupting one of the last vestiges of error-prone hospital communications — the whiteboard. Instead of caregivers needing to interpret each other's scribbles on a whiteboard, they'll see crisp black and white information on an E Ink screen that can be easily updated with precise digital accuracy. Unlike glowing LCD screens that could disturb patients trying to sleep, Avalue's E Ink screens are unobtrusive while maintaining high readability in hospital rooms. The same technology is being used to replace handwritten pharmaceutical storage labeling, as well as bedside patient charts. It's a sign of good health when doctors and nurses gain the power of clear, error-free communications.
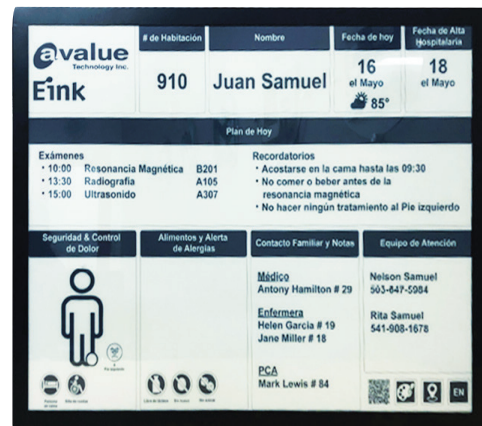
Avalue is helping tackle hospital patient safety errors with their new E Ink whiteboard.

Visionect is using digital paper to create smarter ways to reserve office meeting rooms and parking spaces.

Visionect is bringing their ultralow-power digital paper displays to smart offices and smart parking spaces. Their Joan™ suite of products includes office signage that helps employees book meeting rooms and see at a glance when a room will be available. Or reserve parking spaces.

Traditional shelf labels in stores and factories have to be changed manually, opening the door to inaccurate pricing and product information. Companies like Altierre are seeing their business boom with smart Electronic Shelf Labels (ESLs), made with E Ink, that give customers and employees accurate information that can be updated digitally.

Altierre's Electronic Shelf Labels are making traditional paper shelf labels a thing of the past.

Across smart college campuses, offices and homes people are rediscovering their love of paper—but updated for our digital world. reMarkable™ and Sony™ offer digital paper tablets that let users make handwritten notes, or sketches, and organize all their files just as they would on a computer.
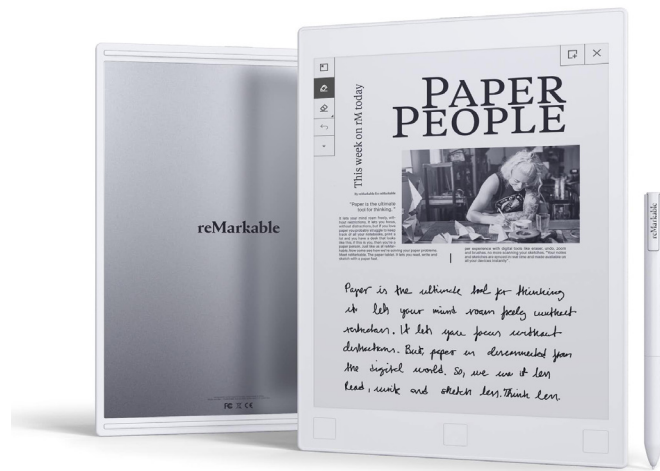
reMarkable's E Ink tablet lets users write, draw and stay organized, all with the look and feel of paper.

What's next?

The applications for E Ink digital paper for smart cities is limited only by our collective imaginations, with an accelerating pace of innovation as more products are invented. As of this writing, E Ink's digital paper has been used to create fashion that changes colors moment to moment. And turned the exterior of a parking garage into an art installation.

On the near horizon are products such as E Ink license plates, luggage tags, boarding passes and 21st century newspapers. As more cities move toward surge pricing to limit traffic and make their neighborhoods more walkable, there will be a proliferation of urban signage with live updates to keep drivers informed of new pricing along with parking space availability.

The impact of all these products will be cumulative. Cities will be able to keep millions of public transit passengers informed at stops across an entire metropolis while using zero energy for zero greenhouse gas emissions. Corporations will keep their employees interconnected and informed, in the moment, while limiting energy use (and saving money in the process). One Soofa Sign keeps a neighborhood connected. Dozens of Soofa Signs across multiple boroughs and neighborhoods will create new levels of civic engagement through active dialog between city governments and their constituents. Solstreet benches, located everywhere the sun shines, will give us a place to recharge and connect with our communities, sustainably. Thanks to error-free digital communications, healthcare professionals will be better able to live the Hippocratic Oath: First, do no harm. And new applications not yet dreamed of will continue to push the boundaries of what's possible in the smart cities of the future.

About the Author

Ted Page is a Co-Founder and Principal of Captains of Industry. He is the author of the top-ranked e-Book "Branding and Marketing for Renewable Energy," as well as the Climate Declaration for CERES that was signed by over 1,700 corporations including Apple, Nike, Starbucks and Levis.

About the Sponsor

E Ink is the originator, pioneer and commercial leader in ePaper technology. The company delivers its advanced display products to the world's most influential brands and manufacturers, enabling them to install extremely durable, low power displays in previously impossible or unimaginable applications and environments.

E Ink encompasses the combined E Ink Corporation, which was spun out of the MIT Media Lab in 1997 to commercialize electronic ink and EPD technology, and Prime View International, which was established in 1992 as the first TFT LCD company in Taiwan, focusing on high quality small-to-medium sized TFT LCDs. In 2009, Prime View acquired E Ink Corporation to further integrate and expand the EPD supply chain and the new combined companies were branded as E Ink.

E Ink's corporate philosophy centers around delivering revolutionary products, excellent user experiences, and environmental benefits through advanced technology development.

Sources:

1) We Are Still In

2) U.S. Energy Information Agency

3) DNV GL Energy Transition Outlook

4) Peter Calthorpe, "7 Principles for building better cities," TED talk

5) The United States Census Bureau

6) The Guardian

7) Office of Energy Efficiency & Renewable Energy

8) Arcadia Power

9) North American Power