

PRESS KIT



Paving the way to
tomorrow's energy

wattwaybycolas.com

Colas invents the solar road

in partnership with the French National
Solar Energy Institute

For the first time ever, roads can produce electricity, while preserving their full capacity to bear vehicle traffic. Colas, a world leader in transport infrastructure, in a partnership with the French National Solar Energy Institute, has developed Wattway, a new concept of photovoltaic road surfacing that is now market-ready. This innovation is a major technological breakthrough, a building block for cutting-edge projects involving intelligent roads and Smart Cities.

Extra thin and extremely sturdy, Wattway photovoltaic panels provide excellent grip and durable performance. They are directly applied to existing roads, highways, bike paths, parking areas, etc., without any civil engineering work and can safely bear vehicle traffic of all types, while producing electricity. To supply an average single home (not including heating), only 20 m² of Wattway are needed.

Protected by two patents, the cutting-edge technique is a major breakthrough, as it provides the road with a new function: producing clean, renewable energy locally, in addition to a road's conventional use.

Thanks to the services it provides, the Wattway solar road is a cornerstone of the 5th generation of roads and Smart Cities.

How the innovation came to be

It all started in 2005

At the Colas Campus for Science and Techniques, teams were hard at work imagining how they could broaden the functions of roads, beyond being simple vectors for vehicle traffic. Roads cover tens of millions of kilometers on the surface of the globe. Jean-Luc Gautier, manager of the Center for Expertise at the Colas Campus for Science and Techniques, began by reflecting on the fact that *“roads spend 90% of their time just looking up into the sky. When the sun shines, they are of course exposed to its rays. It's an ideal surface area for energy applications.”*

An intuition, a simple hunch that the engineer confirmed with calculations. It quickly became clear that photovoltaic collectors on the road could be an excellent way to transform solar energy into electricity, both in terms of yield as in terms of technical feasibility and economic efficiency.

Alone in his garage, Jean-Luc Gautier continued his research. To test the idea, he bought solar cells and used them to build a solar panel, 40-cm in width, able to supply electricity to some one hundred LEDs. This experiment, which dates back to 2010, immediately showed that photovoltaic collectors had good yield, even when applied flat on the ground.

In the wake of his positive findings, the Campus for Science and Techniques launched an initial series of tests, while identifying the primary technological obstacles:

- ◆ How can cars and trucks drive over fragile solar cells?
- ◆ How can cars and trucks drive safely over smooth glass?



To respond to these two challenges, Colas formed a project team and proposed a partnership to the French National Solar Energy Institute (INES)

INES is a public research organization near the French Alps, in Chambéry, where 250 research specialists from the CEA, CNRS and CSTB and the University of Savoie work together. Franck Barruel, then head of the INES photovoltaic systems laboratory, found Colas' project to be utopian at the best when it was presented to him during the summer of 2011. Today, he still smiles when he thinks about his initial

reaction. *"Trucks driving over solar cells? It's like asking a cracker to hold up under a 10-ton load!"*

Then, he thought about it for a couple of days, and changed his mind. *"With our cutting-edge expertise in the field, it is also our role to support companies as a public research body. So why not have a look at the idea?"* Franck Barruel decided to meet the project team as quickly as possible.

A solar pavement test section is rapidly set up at the INES site

The 'Martyr Road' as it was known was made up of flexible thin-film amorphous silicon panels from Smac, a Colas company specialized in waterproofing and cladding, designed for a patented rooftop solution.

"At first, we barely dared to even walk on it!" recalls Franck Barruel. Then came the rolling tests, at faster and faster speeds, with

increasingly heavy vehicles. And the panels resisted. They resisted so well that two months after the initial contact, a three-year agreement was signed by Colas and INES, after which a shared laboratory was created. A 6-person team was formed and everyone quickly learned to speak the same language after training in each other's respective fields.

Progress came quickly...

... until the Chinese took a strong hand on the global photovoltaic market and prices plummeted. Many manufacturers went out of business, including the company that supplied the amorphous silicon panels used in the project.

But that didn't dissuade the team from moving forward. *"We started from scratch in 2013 with polycrystalline silicon, which represents over 90% of the global photovoltaic market"*, explained Jean-Luc

Gautier. Since then, the project team has used French-manufactured photovoltaic cells.

In 2015, after two years of intense research, a product is now ready to be industrialized and launched on the market. The cells, which are encapsulated in a substrate, form high yield solar panels that are traffic resistant, skid-resistant and can be used on all types of road infrastructure (roads, highways, parking lots, bike paths, etc.).



Wattway panels and their applications

This new generation of solar collectors will first surprise you by how thin the panels are (just several millimeters thick), by the fact that there is no glass panel, and by the overall impression of sturdiness. Their size can be adapted to fit any kind of road around the world.

Each panel contains 15-cm wide cells making up a very thin film of polycrystalline silicon that transforms solar energy into electricity. These extremely fragile photovoltaic cells are coated in a multilayer substrate composed of resins and polymers, translucent enough to allow sunlight to pass through, and resistant enough to withstand truck traffic. The composite “sandwich” is also designed to adapt to the pavement’s natural thermal expansion. The surface that is in contact with vehicle tires is treated to ensure skid-resistance equivalent to conventional asphalt mixes.

In this perfectly watertight layer cake, the electrical system is designed to ensure that the entire system does not short circuit if one cell is down. Electrical connections can be hooked up on the side of traffic lanes, in gutters or in ducts integrated in the panels themselves. Lastly, electronic circuit breakers ensure safety.

Numerous applications

By producing renewable energy, Wattway will play a major role in building smart, environmental roads of the future.

As of today, Wattway can provide power to:

- ◆ street lights: 1,000 linear meters of Wattway pavement can supply a town of 5,000 inhabitants (ADEME);
- ◆ traffic lights, variable message panels, etc.: 15 m² of Wattway panels can provide electricity to all the traffic lights at an intersection;
- ◆ energy for nearby households: 20 m² of Wattway, i.e., 4 linear meters of roads, with 1,000 sun-hours/year, can provide power to an average French household (ADEME/CEREN 2014);

- ◆ charging stationary electric vehicles via induction: 100 m² of Wattway panels can provide enough power for an electric car to travel 100,000 km (INES).

And paving the way to intelligent roads:

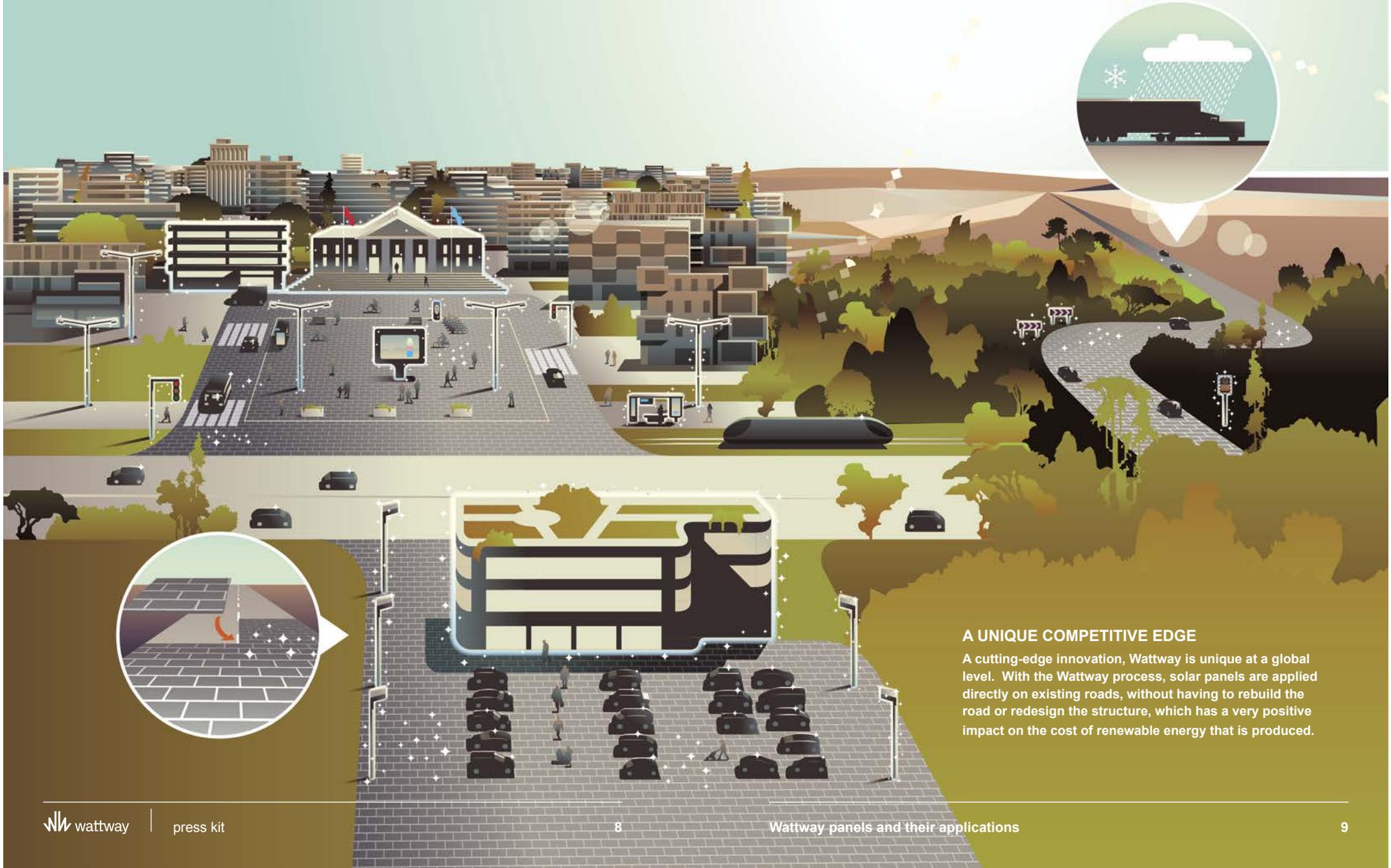
- ◆ real time traffic management
- ◆ self-driving cars
- ◆ charging moving electric vehicles
- ◆ eliminating black ice, etc.

WATTWAY, A BUILDING BLOCK FOR “SMART CITIES”

Exploding population figures, global warming, pollution, traffic jams, congested mass transit systems, waste treatment, scarcity of land: towns and cities today are facing major challenges in terms of resources. By combining the full potential of digital technologies, renewable energy, innovations in the construction of buildings and public infrastructure, major cities are now working on a new development model based on the Smart City concept.

The idea is to design cities differently, using a more integrated, participative approach, by pooling local resources (energy, parking, local services), with, in particular, delocalized energy production, making it possible to envisage urban areas that produce more energy than they consume. The Wattway Solar Road is a fundamental cornerstone of the durable and user-friendly cities of the future.

What if the road produced tomorrow's energy?



A UNIQUE COMPETITIVE EDGE

A cutting-edge innovation, Wattway is unique at a global level. With the Wattway process, solar panels are applied directly on existing roads, without having to rebuild the road or redesign the structure, which has a very positive impact on the cost of renewable energy that is produced.

Mass production

Wattway has already gone from the prototype phase to the industrial phase. On a TRL scale (Technology Readiness Level) that evaluates the degree of maturity of a technology up to its integration in a completely operational system and industrialization, Wattway is at the 7th level: “*system prototype demonstration*

in an operational environment.” Today, the photovoltaic panels are manufactured by the FabLab at the INES, and will move on to industrial scale production in the very near future. Colas is finalizing a partnership with a company to ensure the migration from demonstrator production to industrial scale production.

TRL – TECHNOLOGY READINESS LEVEL

Initially designed by the Nasa and the Esa for space projects, the Technology Readiness Level system measures the degree of maturity of a technology in nine levels, broken down into three phases:

Basic and Applied Technology Research

1. Basic principles observed and reported
2. Technology concept and/or application formulated
3. Experimental proof of concept

Technology development and demonstration

4. Component validation in laboratory
5. Component validation in relevant environment
6. Demonstration of prototype in a simulated relevant environment

System development, Test, Launch & Operations

7. System prototype demonstration in an operational environment
8. Actual system completed and qualified through test and demonstration
9. Actual system proven through successful operations

Sales and Marketing

Wattway is now available on the market. During the pre-industrial phase, Wattway is being proposed for pilot sites of 20 m² to 100 m², to public (local authorities) and private partners (companies) who want to play a role in the launch of this innovation as part of their drive to foster the energy transition.

With time, Wattway technology will be commercialized at some €6/Wp. Mass production should rapidly enable the price to be adjusted.

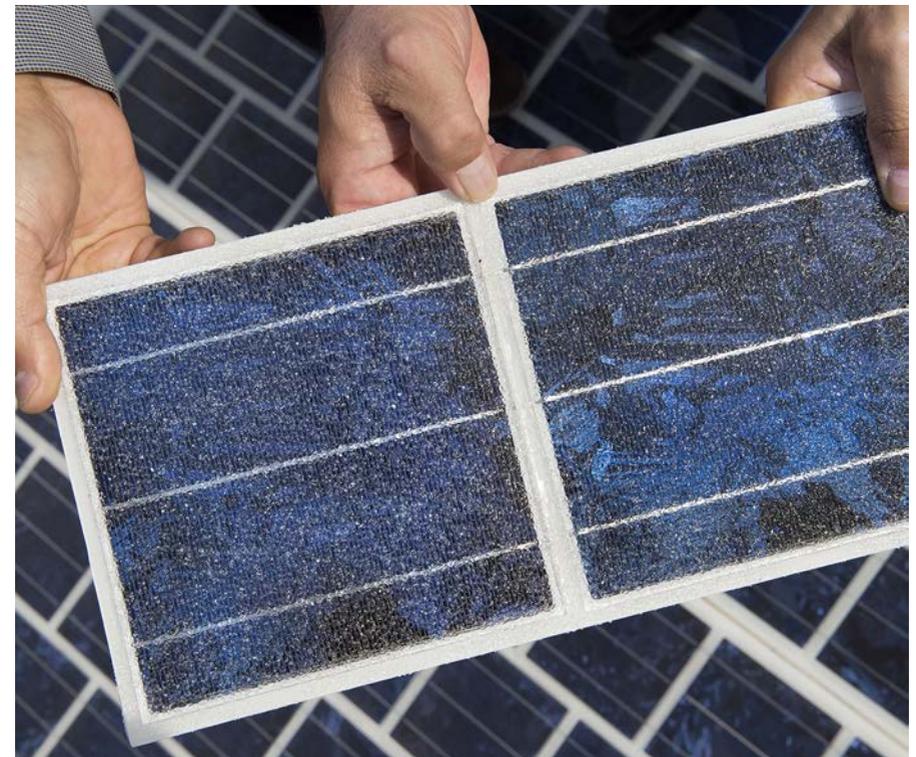
Two growth markets

As soon as the mass production phase has been launched, Wattway will be available for sections of highway that run several kilometers, thus making a considerable contribution to the share of solar energy in the overall energy mix in France and in many other countries.

In towns and cities, Wattway is at the heart of energy transition issues, and is a building block for “Smart City” solutions (see

box). This cutting-edge solar technology will provide renewable energy, as close as possible to where consumption is the highest and demand is constantly increasing.

In isolated, off-grid areas, when population density is so low that the cost of hooking up to the electricity network is prohibitive, Wattway solar roads make it possible to create infrastructure to produce short-circuit energy locally and durably.



Colas, a world leader in transport infrastructure

Colas is a world leader in the construction and maintenance of transport infrastructure, responding to global challenges inherent to mobility, urbanization and environmental protection.

With locations spanning more than 50 countries on five continents, the Colas Group operates via a decentralized network of 800 construction business units and 2,000 material production units.

The 60,000 employees at Colas undertake 100,000 projects each year. In 2014, the Colas Group posted consolidated revenue at 12.4 billion euros (of which 47% outside of France) with net profit attributable to the Group at 604 million euros.

Business

Roads account for 80% of the Group's total business activity, including:

- ◆ the construction and maintenance of roads, highways, runways, ports, industrial platforms, logistics facilities, city streets, urban development, reserved-lane public transport networks (tramways, buses), bike paths, automobile racing circuits, environmental projects (wind parks, retention basins), etc., as well as civil engineering and building in certain regions;
 - ◆ upstream activities involving the production and recycling of construction materials (aggregates, emulsions and binders, asphalt mixes, ready-mix concrete, bitumen) used on Group projects or sold to third parties via an international network of 701 quarries and gravel pits, 128 emulsion plants, 528 asphalt plants, 208 concrete plants and two bitumen production plants.
- Colas also operates in Specialized activities: Railways (Colas Rail), Waterproofing (Smac), Sales of refined products (SRD), Road Safety and Signaling (Aximum), Pipelines (Spac), thus enabling the Group to offer a full range of products and services to all its customers – both public and private.

Global network

The Group's solid business platform in France has enabled it to move on to international markets, first in Africa and in the French Caribbean in the 1930s, then North America at the beginning of the 1960s, followed by most of

Europe, the Indian Ocean, Asia and Oceania over the last 30 years. In 2014, Colas recorded 53% of its revenue in France, 20% in North America, 19% in Europe, excluding France, and 8% in the Rest of the World.

People at Colas

The Group boasts a total workforce of 60,000 people, 40% of whom work outside of France.

The cornerstones of the Group's human resources policy are:

- ◆ recruitment that is open to diversity,
- ◆ safety (work accident and traffic accident prevention programs),
- ◆ training (Colas Campus, Colas Universities),
- ◆ mobility and internal promotion,
- ◆ decentralized management based on respect and trust.

Colas and Innovation

Founded in 1929 to ensure the development of a new technical process called **Cold Asphalt**, innovation has been at the heart of Colas' strategy from the very start.

The Group's international technical network boasts 2,000 research experts, engineers and technicians, who work in close synergy with operatives in the field.

The network's flagship is its Campus for Science and Techniques, the road industry's premier worldwide private research and development center located near Paris, France, along with some 50 regional laboratories and 100 engineering design offices worldwide.

In line with the Group's strategy, research at Colas focuses on:

◆ **Environmental protection issues, in two forms:**

- saving resources (energy, natural materials) by recycling asphalt mix; reducing carbon impact, using solutions such as warm mixes. Green Chemistry principles are used to provide techniques that substitute oil-based ingredients with plant-based components or recycled household waste;
- producing clean, renewable electrical energy, thanks to Wattway, a photovoltaic road surface that can be applied on existing pavement;

◆ **Road surface performance** in terms of safety, comfort and noise: heavy-duty skid resistant pavement, retro-reflective road marking paints, aesthetically pleasing light colored binders, noise-reducing mixes;

◆ **Controlling road infrastructure maintenance costs**, by proposing durable crack-resistant products and surface dressings that can be used even under heavy traffic;

◆ **Preserving road assets**, using imaging-based inspection technologies;

◆ **Managing mobility** using sensors that are integrated into the infrastructure.





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