

Spain: Innovations and International Successes

S PAIN'S TECHNOLOGY SECTORS

have made dramatic advances in recent decades. In personalized medicine and electronic health records, in desalination, in renewable energy, and in many other areas, Spanish companies have built experience at home that they have taken overseas with great success.

In the transportation sector, Spain has built a remarkable network of high-speed rail lines, which stretch around the country and link major economic centers. This achievement has made Spanish rail a real inspiration. Here in the United States, President Obama presented Spain's rail success as a model when he detailed the administration's goals for our own rail system.



The Spanish health care system has consistently spent less as a percentage of GDP than other industrialized countries, while its citizens have enjoyed what the World Health Organization considers to be one of the very best health care systems. This has been achieved to no small degree because of the efforts and successes of Spanish companies.

The Spanish government, and Spanish companies, also bet heavily on renewable energy, and they are now enjoying the rewards. Not only does Spain boast a record percentage of electricity generated by renewable sources—wind, solar thermal power, and photovoltaic panels—but the companies that made it possible have since taken the lead in some of the most significant international renewable energy projects.

In the article that follows, you'll read about many accomplishments of Spanish companies, in sectors that span a wide range of technologies. Spain's advances have led to success for industries not just in Spain, but around the world.

Introduction by KATHLEEN D. KENNEDY

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Gemasolar is a concentrating solar plant in southern Spain that can provide power when the sun is not shining.

PRODUCING ENERGY, RENEWABLY

Last year, under the brilliant sun in the south of Spain, a concentrating solar power (CSP) plant called Gemasolar began operations. The 19.9 megawatt plant is the world's first commercial-scale tower CSP system to incorporate a storage system, allowing it to operate when the sun is not shining. (CSP is also known as "solar thermal," since it capitalizes on the sun's heat.)

The plant's 2,650 heliostats, each with 120 square meters of mirrors, direct the sun's rays to the top of the 450-foot pillar, where molten salts are heated to a temperature above 500°C. That heat transforms water into steam, which turns turbines that generate electricity. Most important, the salts retain their daytime heat well into the evening hours. The plant can provide stored power for as long as 15 hours so the tower can meet peak evening demand, around 8:00 PM in winter and 10:00 PM in summer. Torresol, a joint venture of the Spanish engineering company Sener and Abu Dhabi's renewable energy company Masdar, designed and built the tower.

Gemasolar is the latest of Spain's many successes in renewable energy, both at home and overseas. Spain's government, concerned about the country's dependency on oil and its relatively tenuous connection to the greater European power grid, created favorable conditions for renewable energy in Spain, particularly solar (both photovoltaic panels and solar thermal) and wind power. Spain leads Europe in wind-generated electricity, and its installed capacity ranks among the highest in the world. Spain leads the world in installed solar thermal capacity, boasting more than double that of the second-place United States.

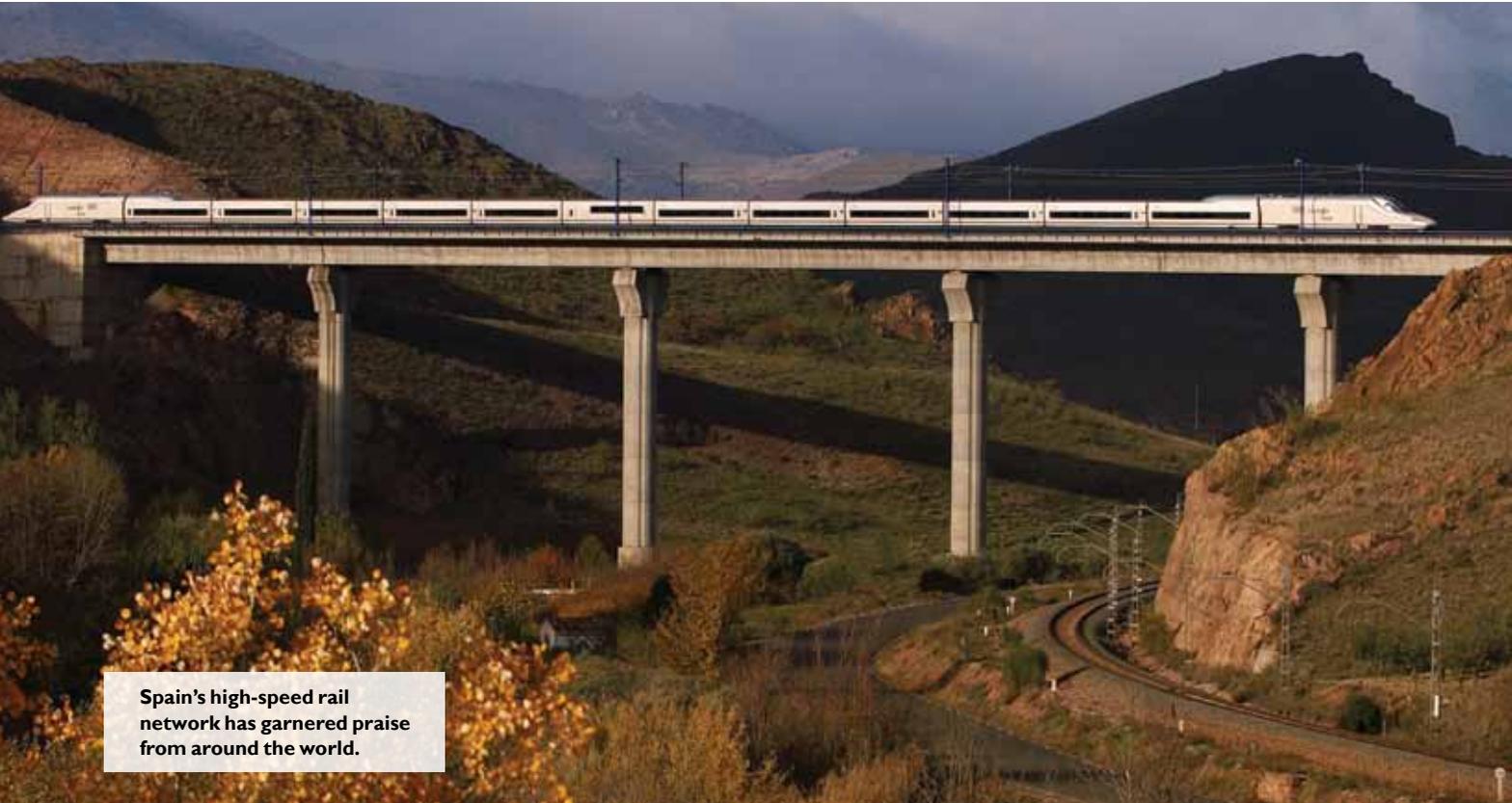
The U.S. provides a strong market for Spanish CSP companies. Abengoa is developing California's Mojave Solar, a solar thermal plant that will come online in 2014 and, with 280 megawatts of capacity, provide power for 54,000 homes. Mojave Solar will be the 16th Abengoa-developed solar thermal plant, and its second in the U.S. (Another is currently under construction in Arizona.) Another company, Acciona, has built a solar thermal plant in Nevada.

When it comes to solar thermal, says Luis Crespo, director of the Spanish solar thermal industry association Protermosolar, "most of the projects in the U.S. depend on Spanish technical assistance," even for installations not headed by Spanish companies.

Wind power continues to generate excitement as the relatively mature industry moves into new territories. Iberdrola, an international leader in wind farm operations, has completed the construction of one of the world's largest wind farms, with 304 megawatts of installed capacity, in Ohio. That farm also includes technology from wind-turbine powerhouse Gamesa, which supplied 152 turbines.

Both companies manufacture and operate technology for wind farms across the U.S., and in fact across most of the world. Iberdrola has installed more than 13,000 megawatts of capacity in 23 countries and is also moving into offshore wind. The Spanish

PHOTO: © TORRESOL ENERGY



Spain's high-speed rail network has garnered praise from around the world.

enterprise Acciona, which operates on four continents, is the leading wind power company in Mexico.

The recent growth of wind and solar in the U.S. has come about in part because of the Obama administration's interest in promoting the development of energy from multiple sources, including renewables. Speaking at a Spanish conference on "smart cities" in June, 2011, Joseph Hurd, the U.S. Department of Commerce's senior director for export promotion and trade policy, discussed the proposed American Power Act (which attempts to set standards for energy savings and the emissions of harmful gasses) and the American Recovery and Reinvestment Act of 2009 (which supports renewable energy). Hurd noted that Spain is the ninth-largest investor in renewable energy in the U.S., and second in terms of investment growth, employing 70,000 Americans.

Spanish companies design critical parts and systems to support these massive renewable energy installations. Gamesa, which continues to innovate in blade and turbine design, has provided the technology for more than 24,000 megawatts of wind power in 35 countries. And Siliken has been recognized internationally for the quality of its PV modules; it has developed proprietary systems to purify solar-grade silicon. The company recently opened a new manufacturing facility, Siliken's fourth factory, in Ontario. (Siliken also operates in Spain, Romania, and Mexico.) Siliken has also begun production of a significantly more efficient solar cell, which will lead to a reduction in both the size of a given installation and its cost.

FROM CITY TO CITY

The road between Madrid and Barcelona, Spain's two largest cities and the country's economic centers, stretches nearly 400 miles, roughly the same distance as from Los Angeles to San Francisco. By automobile, this trip takes about six hours. But by high-speed rail, which cruises smoothly at an average of 200 mph, the trip takes just over 2.5 hours.

The Madrid-Barcelona line opened in early 2008 and is one of the key achievements of the Spanish high-speed rail network, which has garnered praise from around the world. Spain's web of more than 1,800 miles of high-speed lines is centered on Madrid and also links cities along its coasts; the country is second only to China in high-speed track mileage. Spain was also the first country to equip its high-speed network with the most advanced signaling system, which will eventually become the European standard.

This domestic experience has given Spanish companies expertise in rail construction and management, train building, signaling, and the accompanying telecommunications and control systems that high-speed rail demands to compete on the international market.

"We have a model in Spain that has worked because citizens and politicians have supported railways," says Pedro Fortea, director of MAFEX, the Spanish railway association. "So people from other countries come to see what we've done—how we have cities with trams, metros, and integrated public transport systems, with

PHOTO: INDRA

high-speed connections with airports—and how institutions and private companies together have financed these projects. These are excellent references for Spanish companies.”

Spanish companies have completed or are involved in rail projects in more than 90 countries on five continents, including Turkey, Brazil, the U.S., India, and Ireland, and countries across North Africa and Central Asia. One Spanish consortium—CAF is furnishing the trains, the OHL group is in charge of engineering and construction, and Dimetronic is supplying signals—won the bidding for construction of a high-speed line between Ankara and Istanbul. OHL also recently won a contract to extend the Miami-Dade County Metrorail to the nearby airport.

India presents major opportunities for Spanish rail companies: the Talgo train manufacturing company will soon be opening an office there, and CAF is already building a factory in New Delhi. The engineering company Ineco won the feasibility study contract for one of India's planned high-speed lines.

In the most significant news for the Spanish rail industry, a consortium of a dozen Spanish companies and public authorities was recently awarded a 12-year contract to construct, operate, and maintain a new high-speed line between Mecca and Medina in Saudi Arabia, in partnership with the Saudi Railway Organization.

This rail consortium is the largest one created to date by Spanish companies, and the project is the largest so far of its kind. Talgo, one of the country's two top train manufacturers, will supply the trains. OHL, Copasa, and Imathia will develop the infrastructure, and Dimetronic will supply the signaling. The information company Indra will manage telecommunications and control, and Cobra, Inabensa, and OHL will install the electrical infrastructure.

Three government-owned companies will also provide services to the Saudi project: Renfe, Spain's national service provider, will manage operations, and its infrastructure administrator, Adif, will provide the critical expertise for the management of stations and traffic control. Ineco, a government transportation consulting company, serves as the project's lead contractor.

“Even though we have a lot of experience developed in Spain, this is a huge opportunity to show our experience abroad,” says José Solorza, Ineco's Asia and Africa area manager.

Manuel Benegas, director of operations at Ineco, estimates that the on-track tests should begin by the end of 2014. The Spanish Ministry of Development hopes to capitalize on this success to sell similar complete projects in the U.S., Russia, and Brazil, whose governments have stated their commitment to developing high-speed rail.

Advances in transportation management extend beyond railways, onto highways and city roads as well. Spanish companies are world leaders in the management of toll roads, expert at developing and integrating sensors and barrier-free tolls to enhance traffic flow and make ticketing easy. Other companies are pioneering parking guidance systems, which direct drivers to free spots in parking garages or along city streets.

PURIFYING WATER

In the 1960s, Spain's government saw a potential problem brewing. The rocky, sunlit Canary Islands, off the coast of northern Africa, were attracting tourists in increasing numbers. But while there was plenty of space to house those tourists, the supply of potable water could not increase to meet the demand. And so Spain turned a challenge into an opportunity. The government invested in developing brand-new technology that uses membranes to filter the salt out of salt water, and Spanish companies eventually developed the technologies to utilize those membranes in treatment plants. The result: Europe's first desalination plants.

Today, Spain produces more desalinated water than any other country in Europe, and is one of the world's top producers. Spain's more than 500 plants treat more than 200 billion gallons of water per year.

“In only a short period of time in Spain, we developed a great deal of infrastructure,” says Angel Cajigas, director of ATTA, the Spanish business association for water treatment. “And this has given us a lot



The Alicante desalination plant is one of more than five hundred in Spain.

of experience in design, construction, and operations. The technology has developed as well,” making Spanish companies extremely competitive on the world market. In fact, Cajigas adds, of the top 20 companies in the world active in desalination, seven are Spanish.

In 2009, a new large-scale desalination facility was completed in the city of Barcelona. The Prat de Llobregat plant, which can supply up to 20 percent of the city’s drinking water, won a 2010 Global Water Award for technical achievement from the industry magazine *Global Water Intelligence*.

The plant employs more than 5,200 solar panels and a wind turbine, along with energy efficiency technologies and energy recovery features. All together, these reduce the facility’s environmental impact and its operating costs. (A significant percentage of the cost of running a desalination plant derives from its energy requirements.)

“Companies are always innovating,” says Cajigas. He adds that companies are beginning to use filtration membranes to reuse wastewater. Companies are designing more compact plants, and ones that are powered by renewable energy. Some companies are also developing new methods to disinfect water, increasing the ability to

treat extremely low levels of contaminants. Information technology companies have developed systems to manage and integrate the massive information stream water treatment plants require—pressure and flow data, home meters to measure consumption, information about the available and consumed volumes of water, among other data—to enable smarter water management.

Innovations such as these have made Spain’s desalination plants some of the best in the world, and have enabled Spanish companies to compete worldwide to design, construct, and operate water treatment and desalination plants. Some Spanish companies are involved in building and operating the plants, while others manufacture products to serve the water treatment market, such as valves, motors, pumps, and filtration systems.

Spanish water purification companies are active today in more than 30 countries, from Chile to Australia, in North Africa, the Middle East, India and China. They’re developing more than 30 desalination plants, along with dozens of other water purification plants. Acciona Agua is part of the partnership behind one of the world’s largest desalination plants, in Adelaide,

Australia, and Valoriza Agua is constructing one in Perth. And discussions are underway for the first desalination plant in sub-Saharan Africa, in Namibia. Other companies, including Befesa, Aqualia, and Cadagua, are also well-positioned internationally.

The U.S. is also home to three desalination plants built or operated by Spanish companies: two in Florida and one outside Boston. In Tampa, the Tampa Bay Desalination Plant had been beset with problems since its construction began in 1999. After Acciona Agua took over the plant, in partnership with American Water, it finally began operations in 2008. Today the plant purifies 25 million gallons a day and supplies 10 percent of the drinking water for the region.

Water treatment extends, of course, beyond desalination, into conventional water purification for drinking water and beyond, and into industrial purification to deal with waste from industries like mining.

“Spanish companies are very competitive in water treatment,” says Cajigas. “This is one of our fundamental strengths.”

INDUSTRY TO SUPPORT INDUSTRY

Industries in sectors as varied as power generation, aerospace, automotive, rail, and domestic appliances depend on machine tools to create their products. And the Spanish companies that support their efforts—machine tool manufacturers as well as companies that produce accessories, component parts, and tools—provide the necessary means. In 2011, exports from Spain reached 120 countries and accounted for more than 80 percent of the country’s overall business in this sector.

Spain’s machine tool industry has been “supplying technology and production equipment to the main sectors of the economy for more than 65 years,” says José Ignacio Torrecilla, president of Advanced Manufacturing Technologies, the Spanish trade association. This has helped Spanish companies “improve their competitiveness and that of the country,” he adds.

Today, Spain’s machine tool sector is the third largest in the European Union, and includes some of the world’s leading companies. “To make things in steel—machinery, foundry, mills, stamping, lathes—these are traditional skills of people here,” explains Félix Remírez, commercial manager of the machine tool company Fagor Arrasate, referring to the long metalworking tradition along the lush, green mountains in the north of Spain.

Machine tools can transform coils or sheets of metals into all the shapes and components needed for the trappings of modern life. They perform tasks such as rolling and stretching metal into flat sheets; stamping it into all manner of shapes; cutting, drilling, and grinding to precise specifications. And their precision has increased dramatically in recent years, as companies such as Nicolás Correa,



which makes milling machines, and Fagor Arrasate, which designs and builds machines such as stamps and presses, have taken advantage of the latest motors and computer controls to enable faster, more exacting manufacturing.

For the automotive sector, Fagor, which tailors all its machines to a company's needs, has completed a new line of completely automated and synchronized presses that operates nearly 50 percent faster than previous models. They recently installed one such press for Volkswagen in South Africa. They have also sent the latest development of a blanking line (which creates shapes in sheets of material), 50 percent faster than previous ones, to a company in South Carolina that manufactures parts for BMW.

In fact, many Spanish machine tool companies excel in the automotive sector, combining the national expertise at machining with a history of hosting manufacturing from automakers that include Ford, Volkswagen, Renault, Mercedes, and Nissan.

Last year Nicolás Correa provided milling solutions to British Aerospace, which manufactures parts for military aircraft. And Danobat, another major manufacturer, supplies milling and turning machines to companies that create parts for aerospace, wind turbines, and railways.

Though many of these companies manufacture their machines

primarily in Spain, some also maintain overseas offices and plants. Danobat opened an office in China in 2011, and Fagor has a manufacturing facility there. Spanish automotive companies, including Cie Automotiva, Gestamp, Trimplast, and Fagor, are expanding into the rapidly growing South American market, particularly in Brazil.

Spanish machine tool companies have a tradition of pooling and coordinating their resources to benefit the industry as a whole, both in jointly-financed research centers and in national and international projects. Some of these projects have resulted in, to take a few examples, ultraprecise new milling machines; better “intelligent” features to enable higher-precision machines that can be operated more easily; and improved sustainability and energy-saving features of machines and parts, minimizing the environmental impact.

For the food production industry, Spanish companies export their solutions around the world. Spanish food has exploded in popularity over the past few decades, along with the popularity of Spain's agricultural products, and Spain's experience in irrigating, cultivating, cleaning, separating, processing, and packing its products has grown as well.

Innovations in technology led Metalquimia to develop machines that dramatically shorten times to cure and dry meat such as salami and chorizo. NC Hyberbaric has created machines that take advantage of high levels of water pressure to kill microorganisms, endowing food with a longer shelf life without extensive processing or salt and additives. Other food sector companies market faster seeding machines, packing machinery that incorporates radio-frequency ID tags, and artificial vision to sort and classify products and produce more efficiently.

HEALTHIER FOR LESS

The Spanish health care system enjoys two remarkable accomplishments. It is among the least expensive per person among industrialized nations, in terms of the percentage of GDP it spends on health care. At the same time, it is ranked by the World Health Organization as among the best in the world, based on a number of parameters including effectiveness and financial fairness. Spain has achieved this because of successful partnerships between government authorities and private companies, producing innovations in patient treatment and technology solutions for managing the health care system.

Spain gradually introduced electronic health records (EHRs) during the past decade. By 2010, more than 95 percent of primary health care providers in Spain had used them, and more than 250 million prescriptions were being submitted electronically to pharmacies. These statistics place Spain among the leading users of this technology. A number of Spanish companies, including El Corte Inglés, Everis, Indra, and Oesia, are international leaders in EHR technology.



Spanish machine tool companies export to 120 countries.



New approaches in personalized medicine have the potential to improve care and trim costs.

The move to EHRs provides significant cost and time savings, facilitating coordination and use of resources and granting opportunities for improved treatment. Everis, whose health care solutions cover more than 20 million users, is now building software to improve chronic disease management. The new product helps determine the level of care required for a variety of chronic diseases and the types of technologies that can meet a patient's needs at home. Everis began implementing its solutions in Spain in 2011; business director Santiago Martín says that so far the range of savings for chronic patients is 20 to 40 percent over traditional care.

The vast amount of information that electronic records can amass and process will help advance the field of "personalized" medicine, where diagnoses or therapies for illnesses such as cancer will be individually tailored, assisted by data on a patient's genetic profile and other relevant information. This has the potential both to improve patient treatment and trim health care costs, avoiding trials of expensive medicines that won't work. The Indra information company has initiated a "FutureClinic" project to research new algorithms and genomic information processing systems to meet such needs.

In order to provide a personalized approach to cancer, many companies are developing approaches that tailor appropriate medications to a patient's individual genetic makeup. One, Vivia Biotech, created a platform that evaluates the most popular combinations of drugs to treat blood cancers (leukemias, lymphomas, and myelomas). The technology can analyze thousands of blood samples and medication combinations in 48 hours, then rank the

samples by how many tumor cells the protocol has killed.

Internationalization is a fundamental principle of all Spanish biotechnology and health care companies. Vivia Biotech has signed drug-development partnership agreements with U.S.-based pharmaceutical companies, and plans to enter the American market after it launches its personalized medicine test in Europe this year.

Progenika, which is also well positioned in the U.S., has developed a DNA chip that analyzes blood for a number of blood type variants in addition to the typical A/B/O and Rh positive or negative types. The chip has already been adopted to test for rare antigens in blood banks throughout Europe: identifying these variants can help avoid reactions that a chronic patient might suffer from repeatedly receiving blood that doesn't match perfectly. From its satellite office near Boston, the company has received U.S. approval for its tests, and has signed distribution agreements with multinationals that include Pfizer and Novartis.

AB-Biotics has also created a DNA chip, one that analyzes the patient's saliva for genetic variations that indicate responses to various drugs for psychiatric and neurological diseases. The company has already patented a number of its products in the U.S.

Spain's National Cancer Research Center (CNIO) partnered with Stanford University and the Life Length company (a CNIO spinoff) in a study published in *Cell* in 2012 that focuses on what the human genome may eventually tell us about diseases. The Spanish team helped to analyze the personal molecular and health data of Michael Snyder, director of Stanford University's Center for Genomics and Personalized Medicine.

Says CNIO Director Maria Blasco, "This study shows that diseases are a product of an individual's genetic profile as well as interaction with the environment. So far we know little about this correlation, while the use of human genome information to prevent and treat disease is still clearly in its infancy. But what we can see—the tip of the iceberg—is fascinating."

THE INFORMATION AGE

Information and communications technology, or ICT, now underlies nearly all the world's major commercial sectors. Spain has risen to the top in a number of these sectors, as Spain's information companies have provided international solutions for needs such as air and road traffic control, security in public spaces and digital ones, and mobile telecommunications. Spain was also the first country to employ a single broadcasting network for digital television. As a result, Spanish companies became experts in both low- and high-power transmitters and are active around the world in digital processing and transmission.

"The ICT sector in Spain boasts a large group of solid and competitive companies that are favorably positioned internationally, and are leading in their activity areas," says Jesús Banegas, president

of AMETIC, Spain's association of information technology and communications companies.

A number of key factors in Spain have encouraged the flourishing of the ICT sector. Since autumn 2008, all national identity cards have been issued in an electronic format. Spain was one of the first countries in the EU to adopt this technology and, with more than 25 million e-ID cards issued, Spain is an international leader in electronic signatures. Spain has also experienced rapid growth in the use of electronic health records.

Both have led to advances in information processing, and in security systems that safeguard a user's digital data and all transactions the citizen makes electronically. Companies have developed solutions to verify personal identification and allow safe and secure card use both in person and online.

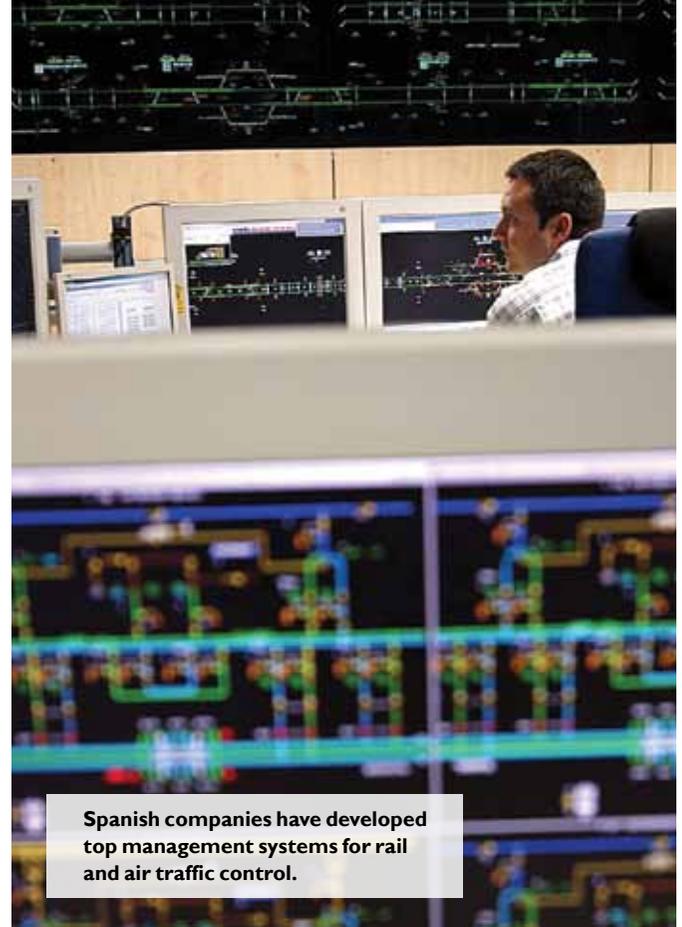
The implementation of the electronic ID has prompted the development of additional technologies. Informática el Corte Inglés, working with Investrónica, created the first digital TV decoder that is compatible with the electronic ID card. The device contains an ID reader and even allows users to access services via the television, if they have no computer or are unfamiliar with computer use.

Tourism, according to Juan José González, Indra's director of development strategy, temporarily doubles Spain's population every year. The country has built a modern network of internal flights and high-speed rail to accommodate their travel—and its companies developed sophisticated technology to manage air traffic and rail traffic. Indra's air traffic control system, implemented around the world, helps three out of every five flights in the world land safely.

The high demands of tourism and travel have also led to new technologies to securely identify travelers. One such solution, which the Ministry of the Interior has installed, is called the Automatic Border Control System, or ABC System. The first of its kind in Europe, the system pairs facial recognition with the signals from electronic passports or electronic IDs, and links the information to four large databases: passport inspection, electronic ID authorization, police data, and border control. And for the financial security of tourists and residents, in Spain and internationally, the company GMV developed a system to ensure monitoring of all ATM operations, and prevention of any unauthorized access.

Transportation and security systems come together in intelligent traffic systems, which can manage and operate sections of road, and also communicate data related to public transportation to riders. Spanish companies are implementing intelligent traffic control in a number of cities in China, and are also operating toll roads in North America.

The smart electrical grid provides another opportunity for ICT companies to manage huge amounts of data from electric companies together with usage information from consumers, in order to conserve energy and save money. South and Central America may be important new markets for this technology, as their emerging economies are deploying the new technologies from the bottom



Spanish companies have developed top management systems for rail and air traffic control.

up rather than substituting for old ones.

The migration of digital services to the cloud has influenced the activities of Spain's two largest ICT companies, Indra and Telefónica (which is the world's fifth largest telecom company). Both Indra and Telefónica, along with other major ICT companies, are moving into digital services and cloud computing, and are integrating data from different services in order to create the smarter cities of tomorrow. Their solutions might involve integrating traffic control, police notifications, and hospitals and paramedics in order to deal quickly with any emergency.

Spanish digital skills extend to excellence in visualization as well: its companies created graphics for the televised vote tally in the U.S. 2008 presidential elections and the NASDAQ displays in Times Square. A Spanish company designed a program to create the realistic water images used in computer graphics in Hollywood. Yet another is playing a key role in the postproduction stereo 3-D processing for Peter Jackson's two upcoming film adaptations of *The Hobbit*.

Connectivity remains crucial across all sectors, says AMETIC's Banegas, pointing out that Spain heads European countries in smartphone ownership and use of 3G networks, and Spanish companies lead in providing Internet and broadband access. He says the sector will surge ahead "anywhere connectivity and mobility are a key factor."

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