Renewable energies: opportunities and challenges for the insurance sector

Andrés Lorenzana
Director
MAPFRE RE (Spain)

César López
Director of Risk Management
ITSEMAP STM (Spain)

"The lack of energy diversification and the crises which have affected oil supply, with significant price increases, have led to the need to increase diversification as a means of defence against possible supply and price fluctuations."

Constant technological innovation is presenting new opportunities for business which can, and should, be assessed by the insurance industry, both in order to comply with its social function of developmental support, and in order to take advantage of new business opportunities. This should always be done from a standpoint of adequate technical rigor in the assessment of the risks and an attractive and appropriate design of the cover conditions.

A very topical example is the evolution, or it might even be said "revolution" which for the last few years has been taking place in the energy sector where the serious environmental problems on the one hand, and the geopolitical tensions on the other, have driven a constant search for new sources of alternative energy that avoid the pollution, storage and cost problems affecting conventional energies at present.

Energy consumption is directly proportional to a society's level of development and is, therefore, affected by various social, environmental, technical and economic factors which affect its production and supplying. Worldwide energy demand is increasing in order to satisfy a number of needs (industrial production, transport, domestic use, etc) linked to development.

Traditionally, the energy market has been characterized by a dependence on a limited number of resources, especially the fossil fuels: coal and oil, which formed the backbone of our present development. The lack of energy diversification and the crises which have affected oil supply, with significant price increases, have led to the need to increase diversification as a means of defence against possible supply and price fluctuations.

Another factor that must be considered is the appearance of environmental problems arising from the use of fossil and nuclear fuels, chronic effects such as climate change (Kyoto protocol[1]) or serious accidents, such as Chernobyl, which have contributed to the search for alternative energies which allow for sustainable development.

Renewable energies are taking an ever more important place in this necessary search and evolution. The intention of this article is to describe, with a certain amount of simplification, the present-day situation of the energy sector, the principal characteristics of these new sources of energy and, above all, to point out the technical criteria which may favor rational insurance coverage.

Although the development of these energies has meant that difficulties such as investment profitability and the efficiency of the technologies have to be overcome, it is foreseen that these energies will take a fair share of the global energy generation market. The EU has set a target that these should account for 12% of primary energy sources by the year 2010.

The promotion of these energies will give rise to a certain number of installations which will need to be insured.
However a lack of information and in-depth technical know-how with regard to these gives rise to many uncertainties for the insurance sector, an attempt has been made to describe some of these in this article.

In order to explore the risks associated with the introduction of new sources of renewable energy, and in order to find possible insurance solutions for their financing, the following analytical framework is proposed:

- An account of basic concepts and the current situation regarding energy production, distribution and use, together with the legal framework of reference.

1. With the recent inclusion of Russia within the Kyoto protocol, member countries account for 55% of greenhouse gas emissions. Member countries are obliged to reduce their emissions by 5.2% between 2008 and 2012.

- Description of the new technologies used in its production.
- Identification of the impacts and risks associated with these technologies.
- An outline of possible strategies within the sphere of insurance which may be used to deal with the uncertainties caused by the use of renewable energies.

Basic Concepts

Before continuing we will here define essential concepts in order to facilitate the understanding of what comes later.

Primary energies

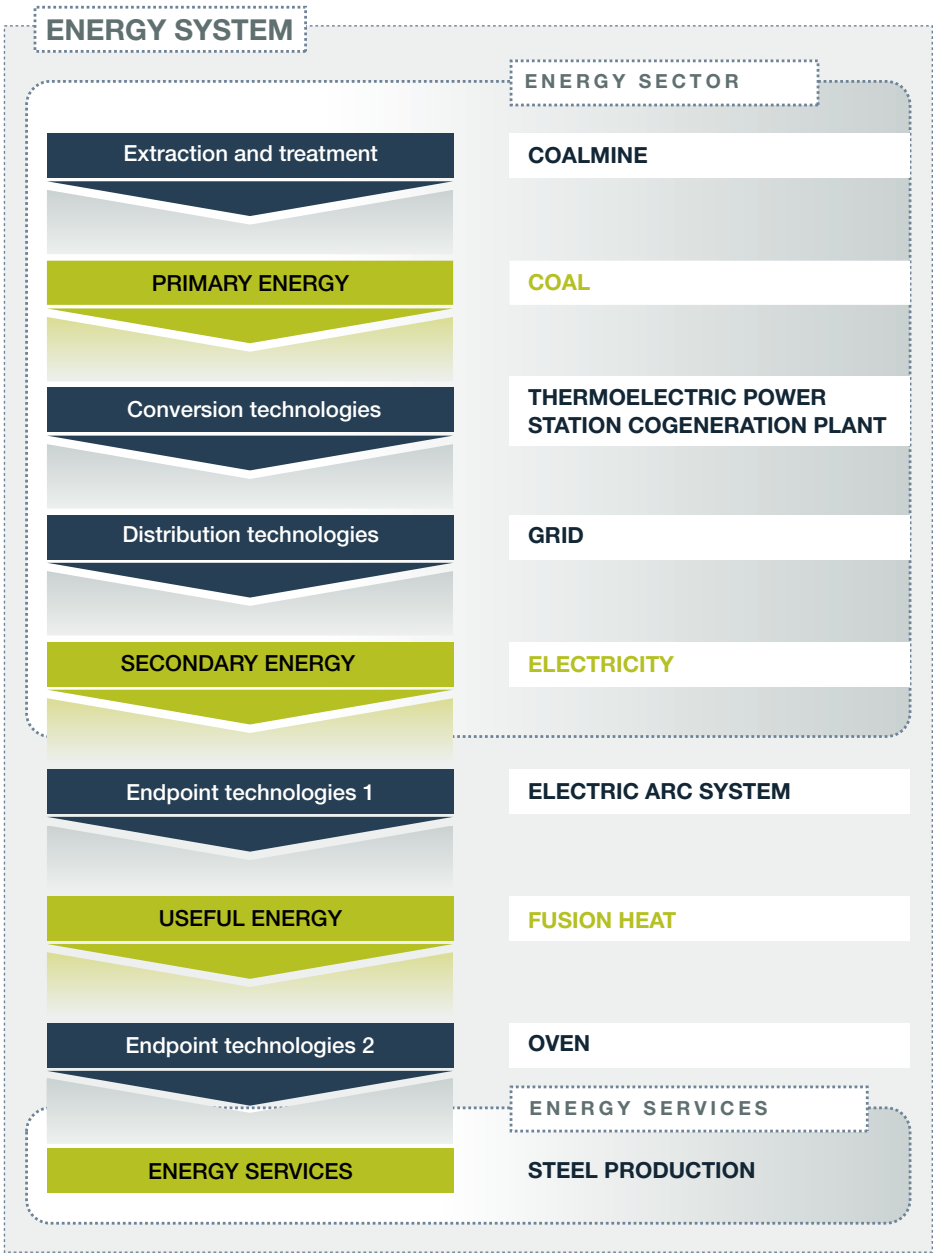
Are defined as those forms of energy that can be obtained from nature without undergoing any transformation process. This may be direct, as in hydraulic energy; after undergoing a process, as in hydrocarbons; or through photosynthesis, such as wood or biomass residues.

Renewable energies

Are those that are continually being produced and that are inexhaustible by human beings. They are also sources of energy supply that are environmentally friendly. There are different sources of renewable energy depending on the natural resources that are used to produce them; amongst them hydroelectric energy, wind energy, solar energy (photovoltaic and thermal) biomass, biofuels and geothermal, along with other experimental methods (wave energy). At the present time there are discrepancies as whether to consider other energies such as urban solid waste (USW) as being renewable.

Transformation centers

Installations where the transformation of primary energy is carried out, changing its form and/or structure in order to produce secondary energy.



Distribution Centers

Installations and grids and networks that allow the transfer of energy resources to potential customers.

Secondary or final energy

These are energy products or sources obtained through the transformation of some types of primary energy destined for the consumer sector. The only possible source of all secondary energy is a transformation center and the only possible destination is in a final point of use.

Final point of use

These are the economic sectors to which the energy is transferred for its final use, such as industrial, home, agricultural, etc.

Policies and development of the legal framework

The development of energy sector legislation favors and promotes the development

of renewable energies as a diversification strategy for energy sources.

In the European context there are two framework directives:

- Directive 1997/92/CE of the European Parliament and of the Council of December 19, 1996, on common regulations for the domestic electricity market. Resolution of the European Council of December 18, 1997, concerning a community strategy for the promotion of combined heat and electricity production.

- Directive 2001/77/CE of the European Parliament and the Council of September 27, 2001, on the promotion of electricity produced from renewable sources of energy in the domestic electricity market. This sets the aim that by the year 2010, 22% of electrical energy should be produced from renewable sources of energy.

The studies carried out by the European Union in 1996 on sources of renewable energy contained in the white and green books should be taken into account.

The principal legislative references in Spain are:

- Act 54/1997 of November 27, on the electrical sector. BOE number 285 of November 28, 1997. This defines the development objectives for renewable energies.

- Royal Decree 2818/1998 of December 23, on the production of electrical energy using installations supplied by renewable resources or sources of energy, waste materials and cogeneration. BOE number 313 of December 31, 1998.

- Royal Decree 436/2004 of March 12, which sets the methodology for the updating and systematization of the legal and economic framework of electrical energy production.

- The Promotion of Renewable Energies Plan which aims to specify the actions which are necessary in order to achieve the obligations set by Act 54/1997 (that renewable energies should account for 12% of primary energy consumption by the year 2010). The main principles of these activities are the diversification of primary sources, efficiency and environmental friendliness and a favorable impact on industry.

The directive on environmental liability of companies recently received approval by the European Parliament (EP) and the Council of Ministers. Both bodies have reached an agreement in the Conciliation Committee. This is the first piece of EU legislation that sets the principal that “he who pollutes, pays”. It’s principal objective is to ensure that future environmental damage produced in the EU should be prevented or remedied by those responsible for the damage.

One of the most important points of discussion was the obligatory purchase of insurance on the part of companies to cover environmental liability. The agreed text does not include this obligation although the possibility for the Commission to include this option has been left open. As of today this agreement is pending ratification by the Parliament and the Commission.

Renewable energies in Spain

Renewable energies account for around 6% of primary energy consumption. Oil accounts for more than 50% of the present market.

The contribution of each one of these renewable energy sources to the total is variable. The types of renewable energies that are being most used are biomass, wind and mini-hydraulic.

Technologies which make use of renewable energies are characterized by their decentralization and dispersal. This differentiating characteristic has a decisive effect on the business structure of the sector.

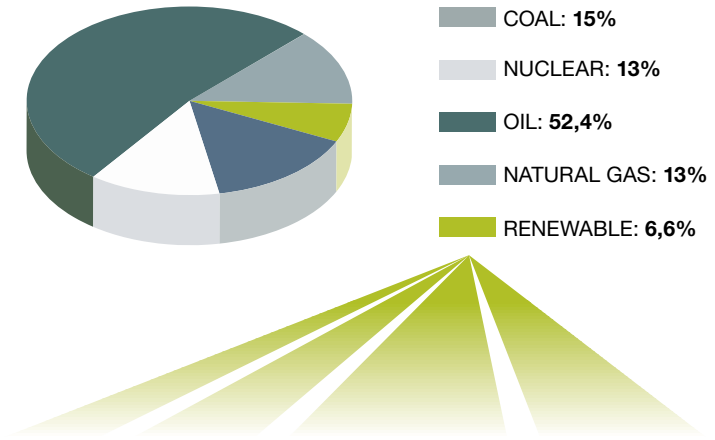
Small and medium-sized businesses dominate this sector. According to figures published by IDAE, 52% of companies have less than 25 workers and only 3.8% of companies have more than 500 workers. Currently there are some 700 companies working in the area of renewable energies, of which approximately half are involved in development and the rest in installation and maintenance.

The greatest number of companies are working in wind energy, with 310, photovoltaic, with 285, and low temperature solar, with 283. The future prospects for the renewable energies market are dependent on the EU objectives and the part played by the state, especially with regards to financing. Depending on these factors, it is foreseeable that a larger number of companies involved in the development and exploitation of renewable energy resources will enter the market.

Identification and description of the different technologies

When analyzing the risks associated with the main technologies for making use of renewable energies - technologies which are still undeveloped and give rise to uncertainties - we can also include cogeneration, which despite not being a source of renewable energy, is however a more efficient use of energy, contributes to

Consumption of primary energy by source (2001) in Spain



Hydraulic: **2.80%**
Wind: **0.50%**
Biomass: **2.90%**
Biofuel: **0.04%**
Biogas: **0.10%**
Solar photovoltaic: **0.00%**
Solar thermal: **0.03%**
Geothermal: **0.03%**
USW: **0.20%**

Data en Ktoe[2]

Primary consumption of renewable energies in Spain

	2001	2010
MINI-HYDRAULIC (<10MW)	415	594
WIND	623	1852
BIOGAS	114	150
BIOFUEL	51	500
BIOMASS	3664	9465
SOLAR PHOTOVOLTAIC	2	19
SOLAR THERMAL	35	336
SOLAR TERMOELECTRIC	0	180
GEOTHERMAL	8	

Data en Ktoe[2]

energy saving and has special importance in the operating activity of the insurance sector.

We will not however be including a detailed and differentiated study of this type of energy production, which could be included within, for example, what we refer to as biomass.

Using the technical information published by the Association of Renewable Energy Producers (APPA) there now follows a description of the characteristics of these types of energy sources.

Hydraulic energy

Hydroelectric power stations work by converting the kinetic and potential energy of a mass of water when moving from one level to another into electrical energy. The water moves a turbine whose rotary movement is transferred through an axis to an electrical generator.

If output is 10 MW or less then they are considered to be mini-hydroelectric power stations, formerly this threshold was set at 5 MW.

There are principally two types of hydroelectric power stations:

- Flowing water power stations
  are those which take advantage of part of the flow of a river by tapping into it and conducting part to the power station turbine. This water is then returned to the river flow. These power stations are characterized by having a practically constant useful level difference and a very variable turbine flow, dependent on hydrological conditions. In this type of installation therefore power potential is directly related to water flow in the river.

- Power stations at the foot of a dam
  Those that are located below reservoirs designed for hydroelectric use or for other uses such as water supply for consumption or irrigation. These may be used to produce electrical energy since they do not consume water volume. They have the advantage of storing the energy (the water) and using it when it is most needed. These are normally used to regulate the capacity of the electrical system and can achieve the best balance between consumption and production.

In flowing water power stations their basic set up tends to involve all or some of the following elements: a shunt reservoir or pool which channels part of the flow through a canal or tube to a charging chamber from which a tube conducts the water to a turbine.

The turbine is located in the power station building together with an electrical generator and auxiliary elements. Lastly, a discharge channel returns the water to the river.

2. *Ktoe (kilotons of oil equivalent)*

The power potential of a hydroelectric power station depends on the flow passing through the turbine and the difference in level between the water entering and leaving the power station. The choice of the most suitable turbine depends on these parameters (level difference and flow).

It is necessary to have hydrological information for at least 20 years in order to correctly ascertain the characteristics of a specific set up.

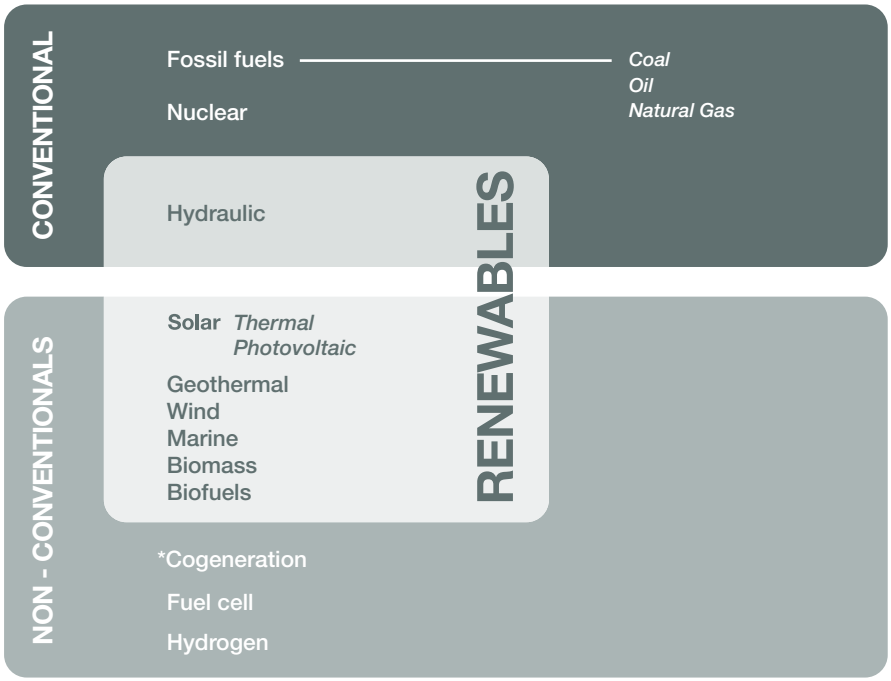
Wind energy

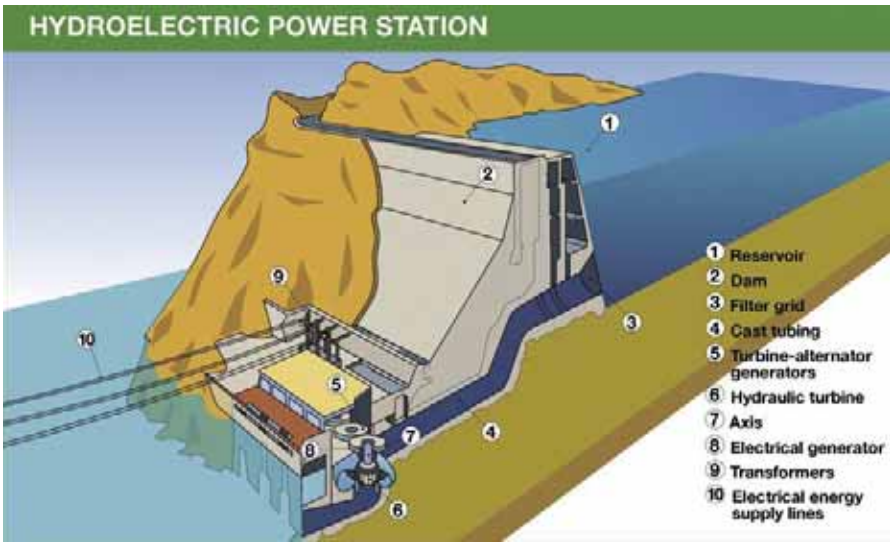
The machine used in order to convert wind energy into electricity is called an aerogenerator. These are divided into two groups: those with a horizontal axis, the most frequently used and efficient, and those with a vertical axis.

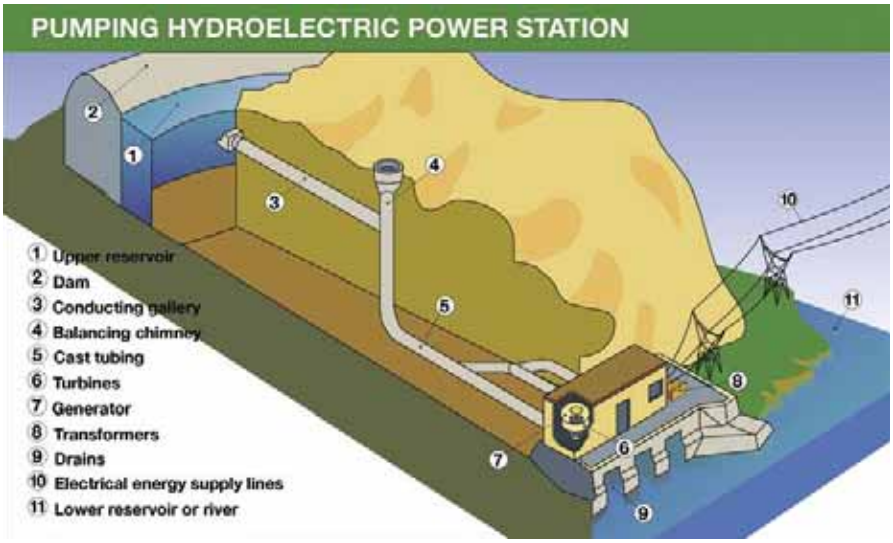
The aero generator with a horizontal axis, the most frequently used in Spain, has three basic parts:

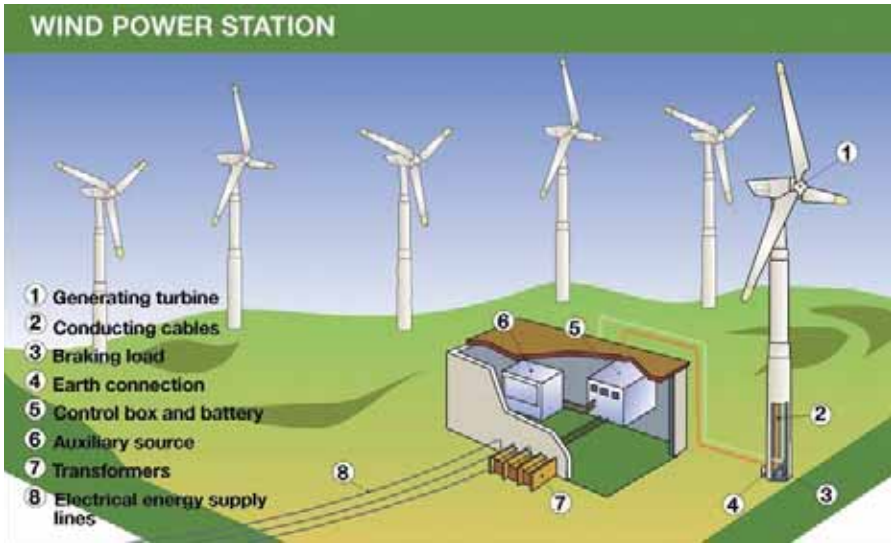
- **The rotor,** which includes the axle housing and the blades, normally three.
- **The gondola,** where the electrical generator, the multipliers and hydraulic control, orientation and braking systems are located.
- **The tower,** which will be tubular, since latticed towers are not used at present.

In just a few years, aero generators have gone from 25 KW to 1,500 KW power, which is the power rating at present installed in our wind farms, although Spain is due to see the introduction of the next generation which increase their power to 1650 KW.









Wind energy is currently primarily used for the generation of electricity which is then sold to the national supply grid, this is done by installing a number of windmills in what is known as a wind farm.

The wind farms that are currently being set up normally have a power capacity of between 10 and 50 MW.

Each wind farm also has a central control room which regulates the functioning of the aerogenerators, controls the energy which is generated at any time, receives meteorological information, etc.

Biomass

Biomass is an abbreviation for "biological mass" and includes a wide variety of fuels which are obtained directly or indirectly from biological resources. Biomass encompasses an extremely large range of organic materials which are used and transformed by the animal kingdom, including man. Man also transforms it using artificial procedures in order to obtain consumer goods. This process gives rise to elements which are usable directly and also sub products which can be used in the field of energy.

Each type of biomass has a different technology applied to it, in this way solid biomass, such as wood, is burnt or gassified, whilst liquid biomass, such as vegetable oil, is used directly in motors or turbines and wet biomass may be biologically converted into fuel gas.

Biomass is the renewable energy which may expect the greatest growth in the promotion plan, but expectations are decreasing on the part of promoters and investors due to the lack of an acceptable return on investment for the projects.
A revision is currently being drafted (R.D. 436/2004) which will be an improvement with regard to forest prunings and energy crops.

Types of biomass

The energy derived from biomass is indefinitely renewable. Unlike wind and solar energy, biomass energy is easy to store. On the other hand enormous volumes of fuel are involved, making transport difficult and providing an argument in favor of local, and above all rural, use.

Forests and woodland

The only biomass that is currently being used for energy purposes is that deriving from forests. However the systematic use of biomass from woodlands in order to satisfy energy demands can only be a reasonable option in countries where territorial density and population density is very low in relation to demand (Third World). In Spain (which has a wood deficit) it is only reasonable to make use for energy purposes of byproducts of forest maintenance (firewood, branches, foliage, etc.) along with the residues deriving from the wood industry. The underlying wood energy supply has been estimated at 2,500,000 toe[3] starting from the supposition that the production of wood in t/ha is approximately equal to one quarter of the figure for annual growth of wood in m^3/ha

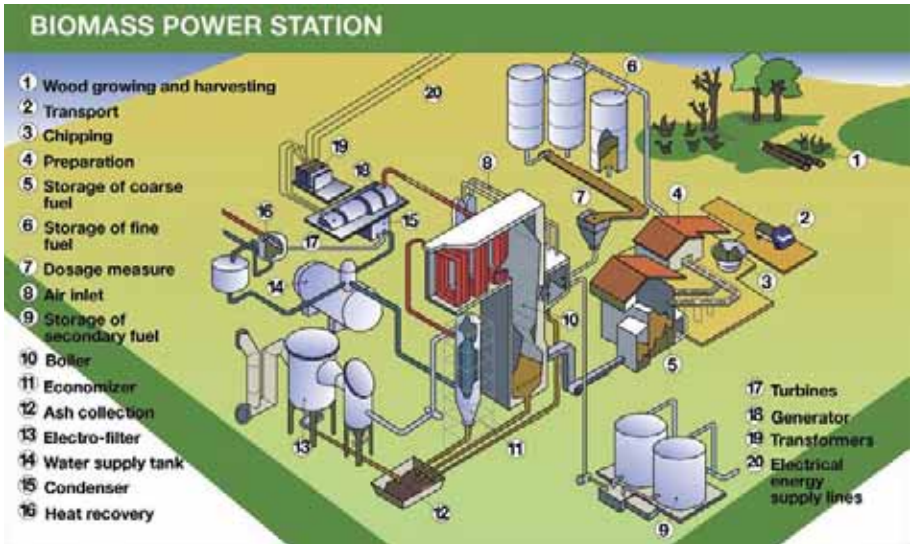
Agricultural residues, excrement and livestock bedding

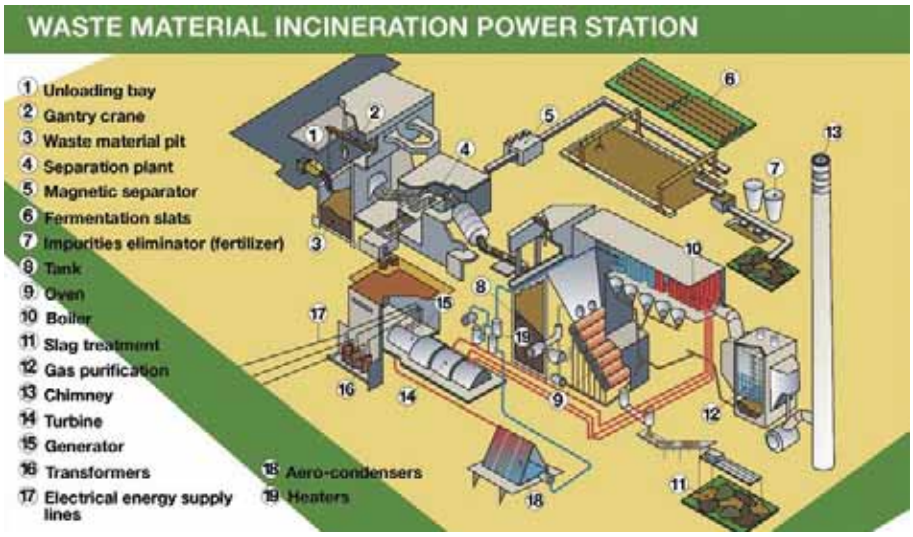
These constitute another important source of bioenergy, although it is not always reasonable to put them to this type of use. In Spain this use would only seem advisable in the case of straw derived from cereals in the cases where its removal from the field would not substantially affect the ground's fertility, and in the case of excrement and livestock bedding where if they were not systematically used as manure this would not prejudice agricultural productivity. It has been estimated that in Spain there would be a hypothetical energy supply of 3,700,000 toe[3] from cereal straw.

Energy crops

There is a certain amount of debate as to the advisability of crops or plantations for use as a source of energy, not only in terms of their own profitability, but also due to their competition with foodstuff production and other necessary products (wood, etc.) These doubts are even greater in the case of temperate regions where photosynthetic assimilation is lower than

3. *toe (tons of oil equivalent)*





in tropical areas. Special studies have been carried out in Spain into the possibility of certain energy producing crops, especially sweet sorghum and sugarcane, in certain regions of Andalusia where there is already a tradition of growing these plants which have a high level of photosynthetic assimilation. This problem of competition between classic crops and energy producing crops would not arise in the case of another type of energy producing crops: aquatic crops.

Solar energy

Solar energy includes both photovoltaic and thermo electrical. This latter type of energy has the greatest possibility to substitute wind energy in the short-term. This technology involves the concentration of solar energy at a point where fluid circulates and which then increases in temperature, its thermal energy is then able to be recovered in a ranking cycle[4] where this energy is transmitted to an electric turbine. As is the case with the other renewable energies, photovoltaic technology which involves directly converting solar radiation into electricity is a decentralized source of energy that is clean and inexhaustible.

At the present time it is already economical to use photovoltaic energy to supply electricity to locations that are relatively distant from electrical supply lines for uses such as rural dwellings, water pumping, signaling, public illumination, emergency equipment, etc.

In Spain, as in many places in the world, there are still segments of the population that do not have an electricity supply. Photovoltaic technology is a competitive and reliable solution, as has already been shown in many projects carried out in this country.

Photovoltaic energy is undergoing expansion now that its promotion has been favored with the new framework (RD 436/2004) and with the adjudication of new funds for the ICO-IDEA financing scheme.

As is the case with wind energy, Spain is at the cutting edge of technological development and manufacturing of these types of installations, and it is therefore an industry with possibilities for the creation of employment and export opportunities.

Photovoltaic technology

An isolated photovoltaic installation is composed of equipment designed to produce, regulate, accumulate and transform electrical energy as follows:

- Photovoltaic cells:
  this is where the photovoltaic conversion occurs. The most commonly used cells employ crystalline silicon. When light radiation strikes the cell this creates

4. *ranking cycle: the thermodynamic cycle for the obtaining of mechanical energy from steam*

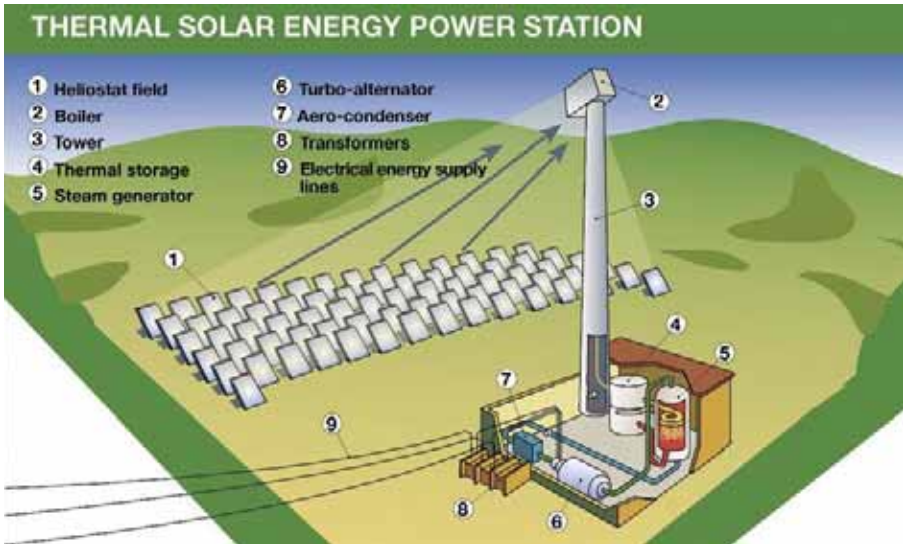
a voltage differential and produces a current.

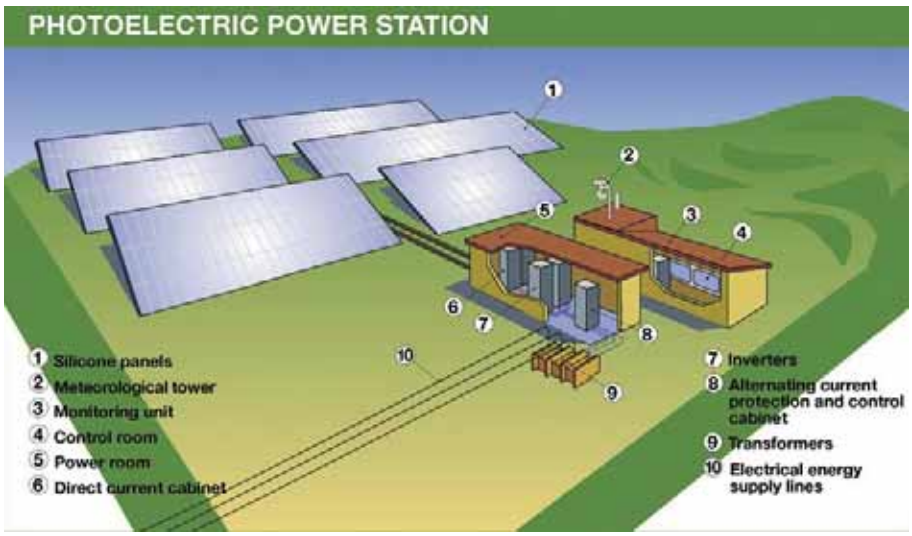
- **Photovoltaic modules:** these are a number of photovoltaic cells connected together. The cells are encapsulated in order to form a stable and resistant module.

- **Regulator:** its purpose is to regulate the charging and discharging of the batteries and protect them from over-charging.

- **Batteries:** these store the electrical energy that has been generated. These types of applications normally use stationary batteries that do not only allow the supply of electricity during the night and at times of low sunlight but provide a supply of electricity for various days.

- **The inverter:** this transforms the direct current (at 12, 24 or 48 v) generated by the photovoltaic modules and the energy accumulated in the batteries to alternating current (at 230 v and 50 Hz).





Production

Although the IDAE estimates the potential market for photovoltaic energy in Spain at 2300 MWp, the development capacity for photovoltaic installations from now until 2010 is only 150 MWp according to the Development Plan for Renewable Energies. The APPA estimates that current power output stands at 18 MWp, this shows an excessively slow trend in order to reach the objectives that have been set for the year 2010.

The production of photovoltaic energy is still very low in comparison to the rest of energy sources for the production of electricity. In the year 2001 according to IDAE it was 28.1 GWh, but the Development Plan foresees an increase in the year 2010 of 217.8 GWh and 143.7 MW of installed output.

Challenges for the insurance sector

After this review of the, until now, little explored field of energy generation from renewable sources we now go on to give some examples of what, in our opinion, will be the main challenges (due to their technical difficulty) and at the same time opportunities (due to their enormous potential demand for insurance coverage) for these new and promising energy production systems.

From the point of view of insurance, consideration must be made for the types of assets and risks which will be covered, for example prototypes will be a type of asset which is uninsurable or only partly insurable.

There are also other types of risks which are in the same category, for example: the risk of recession, changes to the law, the risk of the selling price of energy, malicious acts, terrorism, etc.

Environmental benefits of renewable energies

RENEWABLE ENERGIES	COVENTIONAL ENERGIES
Renewable energies **do not produce CO_2 emissions** and other polluting gases	Energy produced from fossil fuels (oil, gas and coal) do produce them
Renewable energies **do not produce** difficult to treat waste	Nuclear energy and fossil fuels produce waste which poses a threat to the environment for generations
Renewable energies are **inexhaustible**	Fossil fuels are finite

Strategic benefits of renewable energies

RENEWABLE ENERGIES	COVENTIONAL ENERGIES
Renewable energies are **local**	Fossil fuels exist only in a limited number of countries
Renewable energies **avoid outside dependence**	Fossil fuels increase the EU's energy imports

Socio-economic benefits of renewable energies

RENEWABLE ENERGIES	COVENTIONAL ENERGIES
Renewable energies create five times **more jobs** than conventional ones.	Traditional energies create very few jobs in comparison with their turnover
Renewable energies **contribute decisively towards interregional balance** because they tend to be installed in rural areas	Traditional energies in general are located close to highly developed areas
Renewable energies have allowed Spain to **develop its own technologies**	Traditional energies generally use imported technology

Source APPA

In terms of risks, a first classification could be that of traditional risks, amongst which are:

- Property and casualty coverage, such as those inherent in construction, assembly, machinery breakdown, fire, loss of profits and operating cover, amongst others.
- Third-party liability coverage arising from the activities of generation, marketing and distribution together with product liability, professional liability, errors and omissions (principally with respect to services), suppliers and lack of supply, directors' and executives' liability, strike, employers' liability and loss of profits (as a consequence of electrical failure or breakdown, etc.)
- Credit coverage (counterpart, default, political risks, etc.)

"Renewable energies, with the necessary and adequate coverage of their associated risks, present an excellent opportunity to change the present day energy model, which is based on sources that are clearly detrimental to the environment."

The second classification could be called new risks, amongst which, but not limited to, are:

Business risks

- Failure in the supply of fuel especifically for biomass processing plants which use this raw material for energy production and that are closely tied to agricultural or livestock production and the risks which affect these traditional sectors of activity. Supply scarcity and increased supply costs due to long

periods of drought, disease, contamination, etc. which decrease agricultural or livestock production.

- **Stoppage of the main plant** due to a failure in the cogeneration plant. A fault or accident in the cogeneration plant can lead to large losses in the primary function of the activity of an industry due to the reduction or total absence of energy.

- **Faults and difficulties** in the adaptation and interconnection of these new technologies with existing ones.

- **Necessity for high risk civil works**, due to their high economic worth and high exposure, especially in hydraulic works, geothermal works or in the sea.

With regard to the selling price of energy, in addition to the protections offered by the futures and options markets, a number of partial insurance solutions have been developed which take into consideration the price, for example of electricity, and a failure in generation not due to an insured cause, there is a requirement that the unexpected generation failure occurs at the same time as the price of the electricity which will be replaced in the system is higher than an agreed price. These types of covers are known as double cause losses.

In general **damage, detriments and claims as a result of lack of technology and development**. Including losses due to incompetence, oversight or lack of knowledge on the part of operators both in the phases of construction and assembly and operation.

The area of wind energy has seen some multiannual multiline coverage against risk transfer with financing of the risk of guarantee increase against annual availability of the aerogenerators of a windfarm in accordance with the operating and maintenance contract held by the construction assembly and operational company of the windfarm and after passing the pertinent tests and the owners having signed a certificate of acceptation. The factors that were taken into consideration were: annual power output at installation, average efficiency, average price of Kwh, annual average of hours of functioning and guaranteed average availability, setting an annual power limit and a maximum price for each Kwh. The way that natural hazards are handled by markets exposed to them should be taken into consideration.

Strategic risks

- **Failure of strategy**, technology, incorrect market or performance, etc. Nontransferable risk.
- **Loss of market share or reputation,** as a consequence of defined events. Basically a nontransferable risk.

Economic risks

- Long periods of inactivity due to lack of technology or qualified installers and high repair and maintenance costs.
- High loss of profits due to high operating costs (for example biomass).
- The risk of the prices of supplies, commodities and fuels etc. These can be protected against relatively efficiently using the futures and options markets.
- The risk of recession or insufficient demand, which is not insurable.

Environmental risks

- In mini hydraulic power stations, both excessive rainfall which can cause flooding and damage due to abnormal river courses, and the absence of rainfall and availability of water supply which can put these installations out of action for very long periods.
- Specifically the significant increase in loss frequency and intensity for natural catastrophes - to a large extent influenced by global climatic change - poses an enormous challenge for the technical handling of these covers.
- Lack of rainfall and an increase in production costs, cover which protects the policyholder against an increase in costs which result directly from a reduction in the production of hydroelectric energy, compared with the production in an average year, with the condition that this reduction has been caused solely by meteorological conditions that reduced the supply of water to the hydroelectric generation turbines of the policyholder. A lack of hours of sun or wind may be included in the cases of solar and wind energy.
- Product liability (for example for little tried biofuels).
- "Nonconventional" damage to the environment. A priori some types of energy production considerably decrease conventional environmental pollution (the presence of pollutants in the atmosphere, water, etc) but in the medium term may give rise to new forms of pollution. An example of this would be the visual impairment of the countryside which may be caused by the large wind farms which are currently being installed. Also "conventional" damage to the environment may be caused by faults in gas control systems, for example in urban solid waste treatment plants.
- Losses in agricultural crops (harvests) and livestock due to atypical climatic conditions (frost, snow, drought) or due to disease (including the uncontrolled effects of genetic manipulation), fire, in energy production installations and biomass fuels.

Other relevant risks which we mention but do not cover in-depth would be the following:

Risks of changes in the regulatory framework

- Changes in the law
- Delays in deregulation or re-regulation.

Legal risks

- In service agreements with suppliers and/or clients.
- Unfair competition.
- Mergers and acquisitions (guarantees and representational risks).

Operating risks

- Supply failure.
- Limitations in energy transmission.
- Network and information security.
- Information technology risks (liabilities arising from website content or personal information, data protection).
- Internet crime.

Social and human risks

- Malicious acts.
- Terrorism.

Accounting risks

- Valuation of liabilities.
- Valuation of assets.

A strategy in order to achieve profitable business

Given the advantages provided by these new technologies, especially environmental benefits brought about by their use and governmental promotion of their use, there is a clearly favorable commercial environment for worldwide insurers.

But in order to safely handle this attractive challenge - in the form of many new risks - with the necessary technical rigor it is necessary to strictly apply the general principles of risk management, especially with regard to the identification and assessment of the risks associated with these new technologies, the estimation of the consequences in case of accident and the correct calculation of associated costs.

This in-depth and complex analysis should be carried out by suitably qualified and multidisciplinary personnel that insurance companies should include in their underwriting teams.

In any case, and despite all the above-mentioned difficulties, renewable energies, with the necessary and adequate coverage of their associated risks, present an excellent opportunity to change the present day energy model, which is based on sources that are clearly detrimental to the environment. This is a change which humanity is presently in great need of in order to guarantee a sustainable legacy for future generations. ■