ENERGY TRANSITION IN RURAL AREAS

Tools and best practices

C4ET

www.citizens4energytransition.org

ENERGY TRANSITION IN RURAL AREAS
Tools and best practices

ENERGY TRANSITION IN RURAL AREAS

Tools and best practices

drafted by
Gal Molise verso il 2000

thanks to
Futuridea
for the scientific material and
"Territori che fanno la cosa giusta" project

INDEX

Introduction

Energy conservation and the use of renewable sources are currently crucial to tackling climate changes. Aware of the importance of moving towards a more sustainable energy system, the international community is committed to reviewing both emissions' and new energy sources' standards and objectives.

In line with the global trends, the European Commission has established a 40% cut of gas emissions (compared to 1990) and a 27% share of energy mix
with a consequent increase of energy efficiency by 2030. These targets were set at 20% each for 2020.

Citizens of the European Union play a fundamental role in the implementation of such policies, as well as the transition towards sustainability in general, being deemed pivotal actors of change.

Every citizen is important, and all of us bear a share of responsibility when energy, climate change and sustainable development are taken into account. Our behaviours have always effects on the environment, in particular we need to change our consumption behaviours in terms of use of transportation, procurement of good and services, or housekeeping. Moreover, as citizens, we can contribute to spreading information amongst our friends, family and colleagues, and above all we can advocate a policy change.

The Citizens for Energy Transition (C4ET) project has the following general objectives:
- Raising European citizens' awareness about energy transition;
- Contributing to a low carbon energy development;
- Enhancing knowledge on the topic;
- Supporting citizens in identifying the opportunities linked to energy transition.

The specific objectives are:
- Identifying existing good practices;
- Enhancing and spreading such practices;
- Raising the number of organisations and citizens who deal with energy transition;
- Encouraging exchanges about energy transition and the creation of networks of stakeholders;

- Strengthening the competences of organisations and stakeholders;
- Strengthening the competences of European citizens.

To reach all the objectives, the project first identifies existing educational practices at national level (in each of the six countries represented by the project). It then provides innovative and pedagogical materials designed to reach (directly or indirectly) adult European citizens, helping them to feel concern about energy transition, to reconsider their behaviour in the light of the information provided and to encourage them to move towards sustainability.
The project's beneficiaries are:

- Civil Society Organizations (CSOs) and other stakeholders active in the education of citizens;
- CSOs interested in raising awareness on general issues related to our development models (consumer associations);
- Adult citizens;
- European adult citizens as final target.

Part of the educational tools of the project, included the present e-book, is dedicated to the topic of energy transition in rural areas.

With this e-book we want to provide a practical guide to some existing good practices as well as leading innovative technologies that have been developed in Italy, particularly in the Molise Region and in the Campania Region.

It therefore aims to gather and organise documentation on climate change, policies contrasting and favouring sustainability, and energy transition.

The e-book is structured as follows: the first part consists of a general discussion about the issue of sustainability, based on most recent data and an examination of national legislation in the field of energy transition. In the second part, instead, space will be given to projects and technologies for energy conversion in agriculture.

For this section, we will partly refer to a volume by Futuridea distributed in 2014 by the LAG Molise Verso il 2000 as part of the "Territories that do the right thing" project and entitled "Repertoire of useful and sustainable innovations".

1. Global Transition and Sustainability

1.1 Global sustainability: general remarks and data[1]

According to UN data on the global population growth, in the forthcoming decades our planet will have to support a population growth of 2 billion people[2], 80% of which will reside in urban environments.
In addition, data on desertification, the increasing atmosphere pollution and the impoverishment of cultivated lands highlight a global environmental emergency. The size of the phenomenon is clearer if we take into account data provided by the United Nations: the risk of desertification affects ¾ of the lands, especially in Africa and North America[3]. The Mediterranean also faces these phenomena; in particular, it is foreseeable a negative impact of desertification on local ecosystems.
Demographic growth, rising temperatures and rainfall reduction have to be accounted in order to grasp the complexity of today's climate change phenomena.

An increasing unsustainability of urban concentrations as well as a growingly uncontrollable atmospheric pollution compel to move from conjunctural and emergency decisions to structural changes, at both global and local levels. Rethinking the urban-rural relationship without any further delays and with the necessary radicalism is a precondition to fully grasp its demographic implications, namely the realistic perspective of having 50% of the population concentrate in urban areas, as a new form of urban gigantism, and the rest of the population scatter in increasingly depopulated and impoverished rural areas.

The simultaneity between demographic growth and the desertification of soils is at the basis of a significant phenomenon known as land grabbing, meaning land acquisition by multinationals and investors. It consists of purchases or long-term use concessions by multinationals and investment funds or foreign government agencies finalised to the exploitation of farmland. Local corrupted bureaucracies facilitate the phenomenon, mostly to the detriment of resident populations.

In fact, the UN agency has estimated that the global food production will have to increase by 60% by 2050, mostly in already cultivated lands.

The first crucial concern is, therefore, to review and consequently predict food production: producing more food in urban areas and through sustainable approaches (photovoltaic hydroponic greenhouses, multifunctional farming and networks of condominium vegetable gardens), advocating a massive use of the land for the development of tree crops (which provide greater sustainability for their ability to break down CO2) and legumes (nitrogen-fixing plants).

1. Cf. Futuridea Sustainable and useful innovations (2014)
2. Cf. UNRIC (2015), Urban development Report.
3. Cf. United Nations Convention to Combat Desertification (2011), available online at http://www2.unccd.int/news-events/2011-world-day-combat-desertification

In practice, a deep process of simultaneous urban and rural rebalancing. Less energy consumption for transport by bringing production sites as close as possible to places where food is eaten; reducing energy consumption in agriculture; reducing the use of fertilisers and soil improvers.
By "Sustainable Development" we mean to meet the needs of current generations without compromising the ability of future generations to manage their own.
Sustainable energy translates into the need to adopt technologies for the conversion and utilisation of highly efficient energy sources, bearing in mind their economic, social and environmental consequences.

1.2 Reduction of fossil fuel consumption and Reduction of CO_2 emissions

These goals are closely related and can be achieved by turning to energy sources other than fossil fuels, namely the so-called Renewable Energy Sources (RES), with a view to effectively meet the energy needs of production activities. The adoption of RES technologies also reduce pollutant emissions at the local level, thus increasing the quality of final agricultural products. In addition, these technologies enable businesses to save on the costs of energy supplies.

Choosing a more sustainable agriculture is inescapable to feed both the existing population and the other five billion people who are going to impact global demographics over the next decades.

Increased sustainability can not be achieved without revising the "carbon cycle", the extraordinary mechanism that destroys the organic matter by breathing and regenerates it through photosynthesis.

Food production, therefore, will no longer be sustainable given the growth in both population size and urban concentration, the depletion of the agricultural surface which is increasingly exposed to desertification as well as the generalised loss of organic matter, the rising use of resources (water, energy, fuels) in areas with water shortage and pollution problems.

One of the ways to concretely rethink the overall conditions of food production is to produce food also in urban areas through agro-housing, urban regeneration, eco-greenhouses etc.

Modern architecture is at the forefront in responding to this need, by building metropolitan greenhouse architectures all around the world, supporting a short-distribution-chain approach, and rationalising the use of renewable and non-polluting energy sources. Creative hypotheses of vertical architectures also emerge, where skyscrapers are transformed into indoor farms capable of producing food for the inhabitants.

1.3 Energy autonomy

Over the last few years, agro-energy has been spreading throughout Europe and in the world. Photovoltaic fields have been very successful. Farmland has been used for the installation of medium to large plants, but the "use" of agricultural and rural land is no longer sustainable. Rather, we should "integrate" plants with crop systems in every respect and not see them as "separate plants". Rather, we should see them as a coordinated set of activities where the production process rationalises the use of resources (electricity, water, etc.), self-produced on-site (photovoltaic, mini-aeloc, water purification), to allow farming without soil, or improve the quality of native crops.

Many years ago, technologies aimed at cultivating plants in places other than the natural environment were launched. Since the 1960s, studies on artificial lighting of plants have been conducted in order to reconstruct the optimum environmental conditions for productive yields.

Greenhouses became the tool to grow plants in places with unfavorable environmental characteristics or in adverse seasonal times.

At the same time research and scientific studies dealt with the different aspects of so-called "off-ground", "hydroponic" and "aeroponic" crops. We speak of farming without soil, based on environments specifically built for plant production.

The most striking thing, however, is that currently even industrialized countries use energy almost exclusively derived from fossil fuels (diesel, methane etc.). This involves not only CO2 emissions, but lower food quality and high production costs.

Therefore, a reasonable proposal for a true "sustainable development" is to carry out a radical technological transformation of "greenhouse" production, pushing the whole system to virtuously combine new technologies (photovoltaic, eolic, recovery of rainwater, wastewater treatments, LED lighting, electric means, etc.).

New vertical farming companies, urban regeneration, ecological conversion of dismantled industrial sites together with the spread of agro-housing would provide a new opportunity for urban systems to eliminate or limit devastatingly polluting dynamics. Producing foods with the technologies just mentioned would mean reducing the use of pesticides, herbicides, fertilisers and drastically reducing the use of fuel for agricultural machinery. Even the reuse of water for agriculture would save a lot of groundwater resources.

1.4 The EU strategy on adaptation to climate change[4]

The European Union (EU) has some of the highest environmental quality standards in the world, developed over the course of several decades. Environment policy contributes to making the EU economy more environmentally friendly, protects Europe's natural resources and safeguards the health and well-being of people living in the EU.

Environmental quality is fundamental to our health, our economy and our well-being. However, it faces a number of major challenges, not least those relating to climate change, unsustainable consumption and production, and various forms of pollution.

EU environmental policies and legislation protect natural habitats, keep water and air clean, ensure adequate waste disposal, improve knowledge about toxic chemicals and support business in moving towards a sustainable economy.

As far as climate change is concerned, the EU formulates and implements policies and strategies, assuming a leading role in international negotiations on climate. It is committed to ensuring the successful implementation of the Paris Agreement and the implementation of the EU's emission trading system (EU ETS). In this regard, EU countries have agreed to meet several goals in the years to come. The EU aims at ensuring that climate concerns are integrated in other policy areas (e.g. transport and energy) and promotes low-carbon technologies and adaptation measures as well.

The EU environmental policy is based on Articles 11 and 191-193 of the Treaty on the Functioning of the European Union. Under Article 191, combating climate change is an explicit objective of EU environmental policy. Sustainable development is an overarching objective for the EU, which is committed to ensuring "a high level of environmental protection and the improvement of its quality" (Article 3 of the Treaty on European Union).

4. Cf. Communication of the Commission, "Winning the Battle against Global Climate Change" (2005)

1.5 Climate and Energy Package 2020[5]

The climate and energy package includes complementary legislation aimed at guaranteeing the achievement by the European Union (EU) of ambitious climate and energy targets for 2020. The package sets three key objectives:

- 20% reduction of EU greenhouse gas emissions as compared to 1990 levels;
- 20% improvement in the EU's energy efficiency;
- 20% of the EU energy from renewables (wind, solar, biomass, etc.).

At the heart of the package is the revision of the EU Emissions Trading Scheme (ETS), which accounts for about 45% of total EU greenhouse gas emissions. The system includes all EU countries as well as Iceland, Liechtenstein and Norway. It seeks to cut greenhouse gas emissions from the power sector and the main industry cost-effectively by allocating a market price to emissions through the application of a "cap and trade policy". The ETS system applies to approximately 11,000 power stations and other large-scale industrial facilities. In 2012, the system was expanded to include aviation.

The ETS system is based on the Emission Trading Directive, which was significantly revised and strengthened. The review came into force in 2013, at the beginning of the third trading period of the ETS, and introduced into the system:

- a single EU-wide cap on emission allowances (reduced by 1.74% each year) replacing country-level cap systems, so that by 2020 emissions will be 21% below 2005 levels;

5. Cf. European Commission, DG CLIMA, Climate and energy package: https://ec.europa.eu/clima/policies/strategies/2020_it (as of 15 may 2017).

• auctioning (for the purchase of emission allowances) to gradually replace the free distribution of allowances, starting from the energy sector;
• broader coverage in terms of sectors and gases (carbon dioxide, nitrous oxide and perfluorocarbons).

1.6 National targets for non-EU ETS emissions

The second legislative act of the package is the Effort Sharing Decision. It sets binding annual targets for each EU country to reduce its greenhouse gas emissions in non-ETS sectors such as housing, agriculture, waste and transport (excluding aviation).

National targets, covering the period 2013-2020, are differentiated according to the relative wealth of each EU countries. They range from a 20% reduction in emissions (compared to 2005 levels) by the richest EU countries to a 20% increase by the least wealthy ones. However, all countries must strive to limit their emissions. They must also report emissions annually, under the EU monitoring mechanism.

1.7 National renewable energy targets

Under the Renewable Energy Directive, the third legislative act of the package, EU countries are given binding targets to raise the share of renewables in their energy consumption by 2020. These targets, ranging from 10% Malta to 49% of Sweden, depend on each country's use of renewable sources and on the potential to increase their production.
National targets will enable the EU as a whole to meet its 20% renewable energy target for 2020 (more than twice the 2010 level of 9.8%) and a 10% of renewable energy in the transport sector. The targets will also contribute to reduce greenhouse gas emissions as well as its dependence on imported energy. At least 10% of transport fuel in each country must be renewable (e.g. biofuels, hydrogen, "green" electricity). Biofuels must comply with agreed sustainability criteria.

1.8 Carbon capture and storage

The fourth part of the 'climate and energy' package is a directive establishing a legal framework for the environmentally safe use of the carbon capture and storage (CCS) technologies. CCS technologies envisage capturing carbon dioxide emitted by industrial processes in order to store it in underground geological formations and preventing it from contributing to global warming.
The directive covers all CO2 underground storage sites in the EU and lays down requirements applicable to the entire life cycle of storage sites.

1.9 Energy efficiency

The energy efficiency target is being implemented through the 2011 Energy Efficiency Plan and the Energy Efficiency Directive.

2. Energy Conversion Tools

The following section of the e-book has been redrafted from a previous publication by LAG Molise Verso il 2000, as part of the "Territories doing the right thing" project. The publication entitled "Useful and Sustainable Innovations" was created by the Futuridea Scientific Committee in collaboration with NRC - IAFSM to classify innovations and good practices in the Campania and Molise Regions. The selection of the practices included in the volume was made on the basis of their relevance for the project partners and territories, and on the basis of the actual demand for innovation. For this e-book, the identified practices have been described by skipping most technicalities and focusing on the latest developments.

2.1 Zero-emission eco-greenhouse

In order to realize and favour the birth and development of high quality native agricultural productions, and to create additional conditions for zero-km farming, we suggest the creation of "Eco-greenhouses"; the innovative nature of this proposal is based on the characteristics of their production and, above all, of the final product in terms of:

- eco-sustainability;
- healthiness;
- t raceability;
- authenticity.

The Eco-greenhouse is an eco-friendly hi-tech greenhouse, having an aesthetic design, and, with a view to a low environmental impact, capable to integrate all the technologies useful to sustainability.
By virtue of its characteristics, it is able to pursue the following objectives:

- to implement vertical agriculture within urban centers;
- to produce renewable energy, rationalising its use;
- to recycle rainwater and purify irrigation water;
- to use only electrical means (reducing pollutant emissions);
- to ensure the optimum environmental conditions, thereby reducing water waste and plant protection treatments;
- to guarantee the quality of products, and their tracking and tracing.

The idea underpinning the proposal is to develop "green islands" so as to realize and encourage in the identified territories the birth and development of high quality native agricultural productions; its innovativeness is linked to the characteristics of the production and, above all, of the product in terms of: eco-sustainability, healthiness, traceability and authenticity.
The Eco-greenhouse is an eco-friendly hi-tech greenhouse, having an aesthetic design, and, with a view to a low environmental impact, capable to integrate all the technologies useful to sustainability. The island, therefore, is able to achieve sustainable agriculture: it produces energy from renewable sources and rationalises its use; it recycles rainwater and purifies irrigation water; it uses only electrical means and, therefore, does not pollute; it is able to guarantee the optimum environmental conditions and consequently it reduces the waste of water and phytosanitary treatments; it guarantees the quality of the products, as well as their tracking and tracing.

The development of such products will be implemented by using a series of highly innovative tools, ensuring compliance with the identified quality criteria. The "islands" will be produced following precise processes and using tools developed to create them, and will be identified on national and international markets with a "signature" designed as a part of the project. Below are the technical characteristics of the productive tools to be realised in the various regions.

2.2 Photovoltaic roofing and brise-soleil

The Eco-greenhouse is a self-sufficient energy structure, powered by specifically designed photovoltaic modules. Once the supporting structure has been modified so that it can withstand the static load without any risk of collapsing and destabilising, a proper ratio between light and habitat is guaranteed. The basic criterion is the ad hoc integration of innovative photovoltaic modules with a protective and shadowing system where shade density is modulated according to the specific culture. This innovative structure is able to integrate, besides the use of photovoltaic technologies, any form of automation for agricultural production (irrigation, lighting, aeration, etc.).

Even the island’s facades can become energy generators by installing special photovoltaic panels called “brise soleil”.

2.3 Creative Micro-aeolian

Wind is undoubtedly another available energy source. Small vertical rotor blades, designed according to both efficiency and aesthetic criteria, can contribute to the generation of energy to be invested in agriculture.

The use of this system strongly depends on both the environmental conditions and the specific characteristics of each single production unit. Remembering that there is an ongoing research for the production of highly-performing and cost-efficient micro-aeolian turbine models, also providing the necessary assurance of safety and durability, it should be emphasised that the market already guarantees absolute reliability.

The use of micro-aeolian also allows access to a number of advantages linked to the newly introduced regulatory framework, which provides simplified authorization procedures up to a maximum power of 200 KW, and further simplifications for systems with maximum power of 60 KW.
Among the most interesting researches, a FX18 wind aerogenerator with a power of 60 KW was produced by the University of Padua and the R&D department of the ESPE group.

An important recommendation is the choice between vertical or horizontal axis generators. The first represents a technology with lower environmental impact, capable to exploit the wind generated by turbulences, with almost negligible noise output. The drawback is in its current cost that, the power capacity being equal, is higher than in horizontal systems. For these reasons, we wait for the new generation of vertical systems.

2.4 Water Tanks and Water Purifiers

Rainwater can be collected inside special containers to be buried or installed in unused spaces, and can then be used for a variety of purposes, from washing the vehicles and structures up to irrigation of plants not intended for food use. Once properly purified, the waters can also be used for hydroponic crops and, in general, for irrigation of crops.
To this end, the greenhouse roofs will be suitably equipped with a drainage system connected to underground containers.

2.5 Tractors and zero emission operating machinery

It is well known that carbon oxides, aldehydes and aromatic polynuclear hydrocarbons (APH) cause damage to both humans and agricultural products (in the case of greenhouse production). Beyond the rules for the adoption of air extraction systems guaranteeing sufficient air circulation, there are real possibilities to adopt environmental-friendly, zero-emissions electric operating machinery and tractors. Futuridea, in collaboration with some of its associated companies, has already developed prototypes of several zero-emission electric machines: from tractors, to multipurpose transporters, to machines for harvesting or cutting vegetables. All machines are able to guarantee continuous use for a full shift; simplicity in replacing and/or recharging batteries; effective performance up until the total discharge of the charge.

2.6 Electronic environmental control systems

The whole crop can be monitored by means of electronic tools. A system of sensor detects a series of environmental parameters (air temperature, air and soil humidity, brightness) on the basis of which an electronic system, previously customised on the specific cultivation, runs some actuators to perform normal operations such as: humidification or dehumidification, aeration, irrigation, fertilisation, lighting. In order to facilitate the programming of the production process, an software developed ad hoc enables the configuration of the control panel via a user-friendly interface.
The collected sensing data will be used for research purposes and to integrate information for intelligent labelling. This type of environmental control allows to monitor crops and prevent critical situations while always ensuring the optimal situation. This is particularly useful in avoiding plant curative health treatments and planning them effectively.

2.7 Rural Eco-wharehouses. Wood and straw constructions.

Introduction

The proposal of rural eco-warehouses has been formulated with particular reference to the European Convention on Landscape, in our case, rural landscape.
In the light of the European Landscape Convention, we identify the 'landscapes', in our case the rural ones, and set quality standards in order to then define different levels of protection based on specific needs.
As Ian Chambers writes, in recent years "the world has shattered in different geographies, each with its separate senses and directions". Rural areas, which do suffer disadvantages in terms of infrastructure, services, technical know-how and opportunities, provide strongly connotative characteristics such as sustainability and cultural identity. In times of crisis, we are beginning to consider the "emergence" of new cultural values, hoping that they can lead to profound consideration as to socio-economic issues. If "artists can be sparkles of a future interaction between culture and society" (Yukiko Shikata), to experience rurality through art and new technologies can help us "redraw" the rural territory with an innovative and sustainable approach.

In order to exploit agricultural waste, especially straw, innovative architectural techniques have been developed to build rural warehouse structures out of wood and straw only. Such techniques consist of the construction of prefabricated buildings, with a wooden support structure, prepared in some establishments and subsequently assembled on site. The walls of the structure are filled with renewable insulating materials and coated with wooden panels. The use of straw guarantees

the following characteristics:

- Adequate mechanical strength;
- Thermo-hygrometric insulation;
- Breathability;
- Living comfort;
- Reduced costs;
- Low energy consumption for the production of components.

Taking advantage of this technology in building rural warehouses where agricultural products can be stored provides the following advantages, as compared to traditional warehouses:

- High energy efficiency, resulting in a reduction in the energy needs of the warehouse itself, with consequent lower costs;
- Effective thermal insulation (transmittance = 0.12 W / m2K);
- Costs of implementation reduced by 50%;
- Fire resistance (90 minutes at 1000 ° C);
- Ecocompatibility of the entire life cycle of the structure.

Air conditioning of passive warehouses by means of geothermal heat pumps

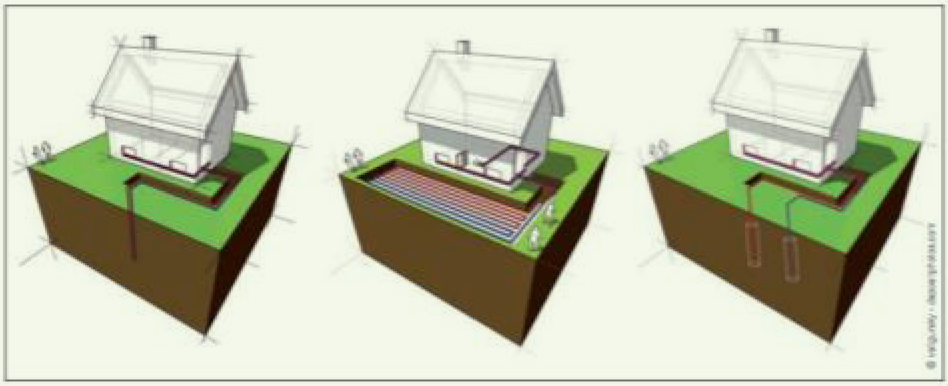
In order to meet the energy needs of passive warehouses in terms of controlling temperature and humidity for the proper preservation of the products, geothermal heat pumps are used. These have the following economic, technological and environmental characteristics:

- Annual economic savings;
- Return on the initial investment in 10 years;
- High Energy Efficiency (COP 4-6);
- Reduction of CO_2 emissions up to total elimination, if coupled with photovoltaic panels;
- No combustion;
- Use of "zero km" energy;
- Elimination of the architectural and acoustic impact of traditional air conditioning systems;

These features allow to maintain the same levels of quality of preserved products. The installation of a geothermal system involves earth drilling procedures specific to the probe pipes installation. A preliminary assessment is required to verify site suitability and a technical-economic feasibility assessment. As compared to "traditional" solutions (simpler and less expensive), the installation of geothermal systems implies greater initial expenditure, even if its management is easier.

It is obvious that the convenience of such a choice must always be analysed and evaluated according to usual cost-benefit criteria. It can be estimated that the overall cost for drilling, supply, geothermal probes and hole filling is around 40-50 € / m.

Once installed, the geothermal plant is virtually self-sufficient. The very nature of the



heat pump makes the heat generator very reliable and no maintenance is required. A regular periodic inspection of the operating system by specialized personnel is advised. A geothermal probe has an average life of about 20-25 years.

2.8 Mini-wind

Mini-wind is one of the technological solutions that can be adopted to:

- Meet electrical needs (self-consumption);
- In economic terms, have profits by supplying the possible surplus of energy produced in the market;
- Achieve greater energy autonomy.

Mini-wind power is a system capable of converting wind energy into electric energy with a power of 1 up to 20 KW.
In order to increase the energy autonomy of passive warehouses, an additional element is the creation of photovoltaic roofs. This system provides electric energy generated by the geothermal heat pump and allows partial or, in optimal conditions, full autonomy from the electricity distribution network. The installation of photovoltaic panels allows to cover the electricity needs of the warehouse (driving of the heat pump, lighting) and it is also possible to assess the possibility to exchange the excess electric power.

2.9 Biomass

Introduction

The term "biomass" refers to a series of biologically-derived materials, generally agricultural waste, which can be processes so to obtain fuels or even electrical and thermal energy. Biomasses include: firewood, residues from agricultural and forestry activities, food industry waste, wastewater from farms, marine algae.

Plants specifically cultivated for energy production and urban organic waste are also included.
The transformation process depends on the final product. Farms can reuse production waste for energy recovery (valorisation) and as fertilizer. Fundamental in this process is the integration of agricultural waste and vegetation rehabilitation of marginal lands along watercourses and generally of the tree barriers for soil conservation. The common policy is to favour indigenous plant species and to prevent the risks linked to the introduction of alien species into local habitats, so that there is an increasing focus on the functions of soil defense and the simultaneous valorisation of a plant which is commonly known in the history of our territories: the common reed (Arundo donax). The development of a new approach to plant nursery such as the production of rapidly growing plant species (poplars, willows and reeds) allows to deploy a noteworthy and competitive vegetation rehabilitation strategy. Below some uses of biomass within rural agricultural realities are illustrated: biogas production; mini-pelletising; on-farm composting.

Production of biogas

Biogas is one of the most widely used sources of renewable energy production.
It is a mixture of several gases derived from the fermentation in the total absence of oxygen (a process called anaerobic digestion) by some bacteria that digest organic waste and vegetables coming from the urban area (bio-waste collection, animal slurries, rotting carcasses).
Energy in chemical bonds is then released and stored mainly in methane (CH_4), which together with carbon dioxide (CO_2) is the main constituent of biogas. Other substances present in lower percentages are carbon oxide, nitrogen, hydrogen, hydrogen sulphide.
Biogas has a high calorific power and can be converted into electricity and heat.

Biogas is indicated by EU among the non-fossil renewable energy sources that can guarantee not only energy autonomy, but also the gradual reduction of the current levels of air pollution and hence of global warming.
Biomethane, instead, is derived from a biogas purification and its transformation allows it to be used as fuel for vehicles other than petrol and diesel.

Technologies that produce biogas from waste and drain waters have been improving steadily over the last few years. In this regard, reference is made to a research by NRC Ibimet (Institute of Biometeorology of the National Research Council), which deals with a gasification procedure that allows to produce biogas and simultaneously a useful solid compound (biochar), which has been authorised by the Ministry of Agriculture as soil improver. Biochar is therefore a vegetable charcoal that is achieved by pyrolysis of the most various types of biomass.
It is very suitable for carrying out the energetic exploitation of agricultural waste: pruning, straws, corn stalks, dried fruit shells, dried foliage, etc.).
Currently, there are 1,555 biogas plants operating in Italy with a total installed power of 1,196.6 MWel and an average plant power of 752 kW. As a result, Italy is confirmed to be a leader in Europe and worldwide, representing the second biogas market in Europe after Germany, and the third in the world after Germany and China.
The most common type of plant in Italy is still agricultural: 80% of biomass sent to anaerobic digestion plants, in fact, comes from agriculture.

Mini - pelletizing

Quality fuels can be obtained through a mechanical process called “mini-pelletizing”, by exploiting waste from wood-based cellulose biomass, such as wood waste and tobacco stalks. The pellet, also used for self-consumption, can be produced by small commercially available machines for the processing of even small quantities of residual biomass. A mini-pelletizer is characterized by an hourly production that ranges from a minimum of 20 kg/h to a maximum of 90 kg/h, depending on the biomass (softwood, hardwood or cereals/

fertilizer), for an installed active power of 4 kW. A technical constraint consists of the characteristics of the input raw material, in terms of Morphology (granulometry between 0.5 and 1.5 mm); Degree of humidity (less than 14% (MAX)); Pure material (free from ferrous material and other pollutants).

On-farm composting

Compost is the result of the natural process of decomposition and humification of all organic waste: it forms naturally thanks to microorganisms, oxygen and specific chemical reactions.
In particular, it can be described as a biochemical process used to produce biomass with carbon/nitrogen ratio below 30 and humidity above 35%. Microorganisms in the environment demolish organic molecules, from simple to complex, into organic waste. By means of the appropriate aeration and periodic tedding of biomass piles, in the final stage a dark coloured and bio-stabilized compost is obtained, with no unpleasant odour.
The use of compost as soil fertiliser is a very effective solution for the recovery and maintenance of soil fertility and to encourage carbon sequestration.
European compost production has been steadily increasing over the last few years, thanks to the diffusion of organic waste separation as a priority of integrated waste management systems.
There are many initiatives aimed at the creation of composting plants that give optimum results for an economical and quality compost.

2.10 Precision farming technologies

Introduction

Farms specialised in arable crops have a two-fold choice to contribute to climate change mitigation: (a) reducing their carbon source, namely reducing its CO2 emissions; and (b) increasing their carbon sink potential, namely strengthening their ability to absorb atmospheric CO2 and storing it in more or less stable way within the agricultural system. Farming is the source of both direct and indirect carbon dioxide emissions.

Emissions are essentially related to the direct and indirect consumption of fossil energy. A common example of direct consumption is the use of fuel for the operation of tractors. Forms of indirect consumption, instead, include the use of fertilisers and chemical synthesis products along with the wear of machines and tools, mainly among those used in the preparation and processing of the soil. These consumptions contribute considerably to amplifying the carbon footprint stemming from the production process of many primary products such as grains. Land cultivation, however, has also a potential carbon sink function (b). By this we mean the possibility of storing carbon dioxide underground in the form of organic matter (e.g. humus).

In this sense, agricultural soil can be considered as a real carbon reservoir that can be replanished or emptied according to the type of tenure: a land which is exploited and deeply disrupted by farming processes generally becomes a source of CO2, on the contrary, under specific agronomic regimes, it can become a carbon storage point.
Basically, therefore, a farm that intends to become more virtuous from the point of view of the overall carbon balance can undertake two different pathways: to reduce its (direct and indirect) energy consumption and to increase its ability to store carbon underground. These two paths can even cross thanks to a particular agronomic technique called no-tillage seeding.

No-tillage seeding

No-tillage seeding, also known as No Till or Zero tillage, is a conservative farming technique that is based on the total absence of mechanical working of the soil. For this reason, it is deemed as an alternative to conventional agronomic methods that are based on plowing and all other forms of seedbed preparation. Conceived in America in the 1970s, became widespread in the '90s thanks to the development of techniques and means. Today, it is used worldwide on some 110 million hectares to produce essentially grains and fodder (cereals, oilseeds, leguminous crops). In recent years, the area cultivated in this way globally expanded at a rate of 2-3 million hectares per year, especially in the most competitive regions specialised in arable crops, but also in developing areas where no-tillage techniques are promoted as a sustainable rural development strategy.

The benefits of no-tillage seeding for both the environment and farm are:

- *Decrease of the carbon footprint and more;*
- *60-80% cut of direct (fuel) and indirect (machinery and chemical synthesis products) energy consumption, with consequent reduction of carbon dioxide emissions;*
- *Increased organic soil carbon stock and/or lower rate of mineralisation of organic substances, resulting in increased carbon sink potential;*
- *Up to 70% restriction of water leakage due to soil evaporation by means of mulches/ manuring, to non-processing of sub-superficial soil, and to the permanent "natural" porosity created by roots and telluric microfauna (e.g. earthworms).*

The European discourse about No Till focuses on the environmental benefits that can be achieved as compared to conventional agronomic techniques. The success of this technique, in fact, is basically based on the need to maintain (or improve) the health status of soils: soils (naturally) rich in organic matter, in nutrients and biodiversity, that are well-structured, uncompressed and not diluted/eroded, are more productive and easier to cultivate than soils stressed and depleted by intensive farming practices.

2.11 Agricultural Innovation Research and the importance for rural areas.

Functional foods

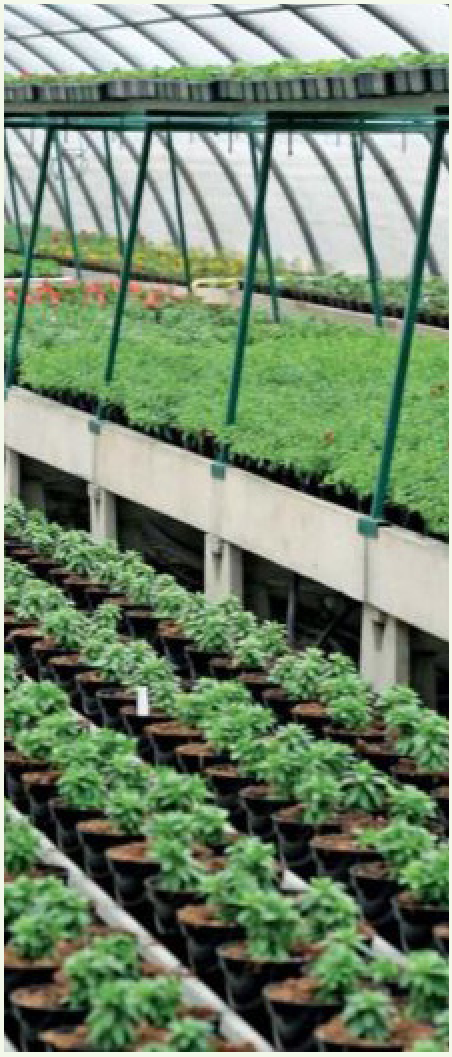
Important studies have been carried out in the field of food science.
According to the Commission on Functional Food Science in Europe, which has developed the Functional Food Science in Europe (Fufose) project, a definition of functional food could be: "a food that has beneficial effects on one or more functions of the human organism, thus either improving the

general and physical conditions or/and decreasing the risk of the evolution of diseases, which is consumed as part of a normal nutritional regimen. It is not a pill, capsule, or any form of food supplement" (EUROPEAN COMMISSION - (European Research Area - Food, Agriculture & Fisheries & Biotechnology Food).

The project has discovered a variety of strawberry rich in antioxidants, providing 27% of the substances needed to a balanced diet, and well over 60% of vitamin C recommended daily allowance. Additionally, low in carbohydrates and sodium and high in potassium, this red fruit is a major functional food, whose consumption is recommended to control hypertension problems. Peppers equally provide high levels of vitamins A and C, as well as natural antioxidant molecules.

The research in this field also lists the benefits of foods such as spelt.

Spelt is more digestible than durum and common wheat, especially, whole spelt is a good ally against problems that can affect the digestive system such as gastritis or tumors. It possesses laxative properties and helps prevent tumors of the intestinal tract, especially by avoiding biliary stasis and promoting intestinal transit. Low in fat and high in fibers, spelt is recommended in slimming programmes, as it satiates and helps to weight control. Compared to the pearl spelled, dehusked spelled has high amounts of insoluble fibers.



Intelligent vegetation management

Another important field is the valorisation of protection crops through the creation of non-productive green networks. Competent authorities should be involved more in the creation of guidelines on the choice of the right non-productive vegetation (borders, landslides, windbreaks, etc.), and, above all, on the valorisation of native species, that best meet the needs of a specific territory. To deal with this specific aspect, we must have an innovative and smart approach, taking account of: plant and animal biodiversity (extending the periods of bee pollination); soil protection (landslides, mudflows); CO_2 reduction; landscape protection; increased production of biomass energy. Even when choosing essences to be introduced, considerations should take into account the specific characteristics of the soil and the environment in general

Application of a Geothermal Plant: "Cantine d'Uva"

Cantina d'Uva, a wine farm in Larino (CB), is an example of good practice in its area. The company choose to invest in innovation and energy-efficient technologies, so to pursue the following goals:

- Obtain energy-consumption savings as applied to every manufacturing processes;
- Increase the quality of the final product significantly.

In particular, the technologies used to save energy are especially focused on the conditioning system, affecting the wine maturation process.

Adopted technologies: geothermal system

The aging process of wine in barrels requires constant monitoring of ambient temperature and humidity parameters. In fact, wooden barrels, being such a porous material, tend to absorb the liquids they are exposed to, including the wine contained therein. Therefore, the traditional maturation in barrel process implies that a percentage loss of the product should be expected, which can amount to 30% of the initial volume.

It is therefore necessary to avoid the infiltration of air into barrels (which would cause the proliferation of unwanted bacteria) by constantly fill the barrels with new must. Moisture control in a maturing environment allows limited absorption capacity of the barrels and exchanges humidity from the external environment by means of a special conditioning system.

To this end, in the context of the building-system's energy requalification, the company has found it advantageous to install an air conditioning system (HVAC) powered by a geothermal well. The plant consists of a geothermal well, made by three underground pipes (flow and return) at a depth of about 3 m below ground level.

The excavation is made in such a way that it does not visually affect the landscape or agricultural operations.

Underground serpentines supply the air treatment unit (UTA) of the cellars with a fluid (water) which, thanks to the thermal exchange with the soil, allows a lower temperature in summer and higher temperature in winter.
The air conditioning system of the cellars is equipped with a chiller and a combined electric boiler that covers any heat demand that the geothermal system, under particularly difficult conditions (very hot summer or very cold winter), would not be able to satisfy on its own.

Benefits of the geothermal system:

• Energy and economic savings on winter and summer air-conditioning of the cellars;
• Optimum control of temperature and humidity parameters;
• Absence of emissions (exhaust gas and CO2) thanks to the lack of combustion devices (fuel boilers);
• Landscape- and environmental-friendly impact (underground basement);
• No agricultural area subtracted to production (the area that covers the well is exploitable);
• Minor percentage loss of product during maturation due to moisture control (less wine absorption by wooden barrels);
• Improved performance and optimum preservation of wooden barrels, kept to a constant humidity.

Conclusions

The Cantina d'Uva is a virtuous example of how technological innovation matches with activities of a strong traditional character, such as Italian wine production, resulting in a significant increase in quality. The initial investment, that is higher as compared to traditional energy conversion systems, is repayable over a relatively short time span (5 years), thanks to the economic savings that the plant achieves during its operation.

Link to the virtual tour in the "Cantine D'Uva"
https://prezi.com/eqv3x7zl1owt/the-geothermal-conservation-of-wine/

Case History:
EXAMPLES OF ON- FARM COMPOSTING GOOD PRACTICES

Biocompost Project

The Biocompost Project aims to produce high-quality compost production facilities at a low cost.
The project, supported by the Campania Region through measure 124 of the RDP, aimed at achieving two results: to eliminate the problem of crop waste disposal and to produce a quality soil improver to be reused on farm.
The innovation is in the introduction of "active air intake" by using rubber tubes that allow the ventilation of the organic mass, thus eliminating the need to turn it. In this way, the compost is produced within 4-5 weeks.

Link to the project www.progettobiocompost.it

Bibliography and Web References

Bartolazzi A. *Le energie rinnovabili,* Ed. Hoepli, Milano, 2006.

Bompiani A., Brovedani E., Cirotto C., *Nuova genetica nuove responsabilità*, Ed. San Paolo, Cinisello Balsamo (Mi), 1997.

Borghesi C., Vercelli A., *La sostenibilità dello sviluppo locale*, Ed. Carocci, Roma, 2005.

Borghi C., Cicero A. ,(a cura di), *Nutraceutici a alimenti funzionali in medicina preventiva*, Ed. Bononia University Press, 2011.

Ciaravino R., Sequino V. (a cura di), *Biomasse e agro energia. Un modello di governance regionale attraverso l'analisi del caso Campania*, INEA,2011.

Futurudea, Innovazioni utili e sostenibili, 2014

La Camera F., *Sviluppo sostenibile. Origine, teoria e pratica*, Editori Riuniti Roma, 2003.

Liberti S., *Land grabbing. Come il mercato delle terre crea il nuovo colonialismo,* Minimum fax, Roma 2011.

Matassino D., *Bioterritori intelligenti*, Workshop: "L'officina dell'ingneno" nell'ambito del Progetto "Territori che fanno la cosa giusta" 24 luglio 2013, Petrella Tifernina (CB).

Nardone C., *Crisi e sostenibilità*, Ed. Il Bene Comune, Campobasso, 2010.

www.ambienteterritorio.coldiretti.it/Documents/COMPOSTAGGIO%20E%20AGRICOLTURA_2008.pdf
www.enea.it/it/comunicare-la-ricerca/documenti/quaderni-energia/agricoltura.pdf
www.fareverde.it/blog/wp-content/uploads/FV_compost_guida_agronomi.pdf
www.ibimet.cnr.it/
www.iesbiogas.it/it/cos%C3%A8-il-biogas/69
www.isaac-project.it
www.progettobiocompost.it
www.tuttogreen.it/biomasse-cosa-sono/

This project has been funded with support from the European Commission.
Project code: 2015-1-FR01-KA204-015349