A BIOECONOMY STRATEGY FOR FRANCE

Goals, issues and forward vision

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RÉPUBLIQUE FRANÇAISE

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FOREWORD

In 2015, the Ministry for Ecology, Sustainable Development and Energy, the Ministry of National Education, Higher Education and Research, the Ministry of the Economy, Industry and the Digital Sector and the Ministry of Agriculture, Agrifood and Forestry launched a project to define a bioeconomy strategy for France.

The intention was to propose a vision for the coordinated and sustainable development of supply chains based around biomass for food production, materials, biobased molecules, bioenergy and ecosystem services.

Given the vastness of the subject (from upstream to downstream in terms of supply chains and activities), this effort obviously needed to be opened up to all actors. The involvement of four government ministries testifies to this. The desire for broad involvement of the stakeholders is more evidence: a series of hearings was held for key actors in six theme-based meetings. The present document was also submitted to all concerned in order to obtain their views.

This work demonstrated the need to consider the disparity of the situations relating to the bioeconomy, along with the diversity and history of the approaches supporting it in terms both of public-sector measures and the involvement of the private sector. These discussions also established the need to continue the dialogue.

For all these reasons, this document is one stage in the implementation of an acknowledged, concerted approach in favour of the bioeconomy. The aim is to define by consultation between the parties the domain, the issues and the vision for a future that has a bioeconomy. In particular, the task is to define together a framework for ambitious and sustainable development of the bioeconomy consistent with our country's resources and needs.

In conjunction with this, there is a need to raise awareness of the measures already in place. And lastly, it is essential to lay the foundations of long-term governance.

This document therefore sets out to define the fundamentals of a holistic French strategy on the bioeconomy shared by all private- and public-sector actors. It will be supplemented by a second chapter describing the milestones and proposals for the operational deployment of the bioeconomy in France. The task will be to define an action plan to apply, once again adopting an open approach.

1

THE BIOECONOMY IN FRANCE: A REALITY, A GOAL FOR TRANSITION

The Paris Conference on Climate Change (COP21) led to a universal agreement on the climate with the objective of ensuring, for the whole planet and by the end of this century, that the average rise in temperatures is well below 2°C, and endeavouring to limit that rise to 1.5°C.
That agreement also acknowledges the crucial issue of global food security and the particular vulnerability of food production systems. The outlook is for a human population of over nine billion by 2050 with dietary regimes showing ongoing changes, in particular increases in protein consumption.

In order to cope with these challenges and avoid compromising the population's quality of life or the development capacity of future generations, it is necessary as of now to adopt new modes of production and consumption that are, at one and the same time, more efficient, resilient and compatible with the planet's limits and mechanisms. Improved use of bioresources intended for food markets, for the manufacture of useful molecules, products, materials and energy, and the maintenance of ecosystem functionalities can offer powerful leverage for the control of global warming.
The use of bioresources also offers opportunities for our economy. It can contribute to greater food sovereignty and the restoration of our trade balance, as well as creating value-added, thereby reinforcing the dynamism of rural areas and developing employment.

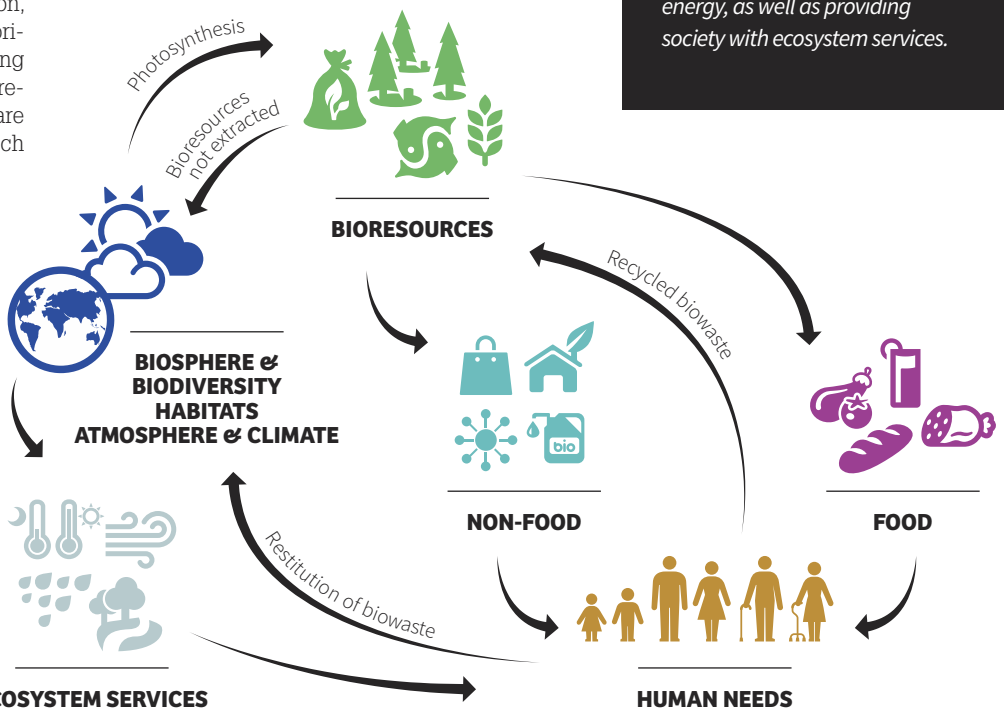
DÉFINITIONS

Bioresources – *also called* **biomass** – *are the core of the bioeconomy. This includes all materials of biological origin (with the exception of fossil materials such as petroleum or coal). Terrestrial plants, algae, animals, microorganisms and biowaste either produce or are themselves bioresources. Bioresources derive directly or indirectly from photosynthesis and are renewable.*

The **bioeconomy** *encompasses the whole range of activities linked to bioresource production, use and processing. The purpose of bioresources is to provide a sustainable response to the need for food and to part of society's requirements for materials and energy, as well as providing society with ecosystem services.*

The goal of the French bioeconomy is to respond to all these challenges by bringing together within a systemic vision all activities for bioresource production, supply and processing, product valorisation and the ensuing solutions, along with maintenance of ecosystems in regions. Human beings and citizens are central to a new vision in the French approach to the bioeconomy.

THE BIOECONOMY: FOR OUR FUTURE AND THE FUTURE OF THE PLANET



The farming, forest-wood, maritime (seaweed, fisheries) and aquaculture sectors in our country, all of which supply bioresources, have a long history and are in many cases deeply rooted in our regions. They have given rise to a diversity of supply chains for their valorisation:

Actors in the agricultural sector have put in place major industrial and financial operators backed by research and innovation in order to diversify their modes of production and expand their commercial outlets. This has enabled France to develop an agrifood sector recognised for its products' quality and diversity: a fact notably reflected in a large number of official quality signs and by the existence of innovative production systems such as organic farming, agroecology and agroforestry. France is the leading European producer and the second biggest exporter of agricultural products. Agriculture also provides ecosystem services by maintaining farmland and shaping landscapes, as well as helping retain activities in rural areas.

The actors in the forest-wood sector have developed diversified management systems for hard- and softwood woodland, as well as supply chains for primary and secondary processing with numerous commercial outlets. Forestry operators maintain woodland and produce economic services (lignocellulosic resources from the exploitation of forests and wood), environmental services (climate, air quality, water quality, soil protection, noise reduction, biodiversity) and services for society (leisure, living space, etc.).

Products from the sea (animal and plant) are also a focus for significant research and specific forms of valorisation. Innovative companies are emerging in the area of creation and production of new foodstuffs, for example.

The great diversity of the co-products of all these supply chains, the organic waste they produce and the organic waste from the urban environment, can also be used for new commercial applications or as substrates for fermentation, composting or the production of energy in programmes for recycling and the management of materials and energy flows.

These sectors are giving rise to novel sources of value. A broad range of biobased products and energy is now either available on the market or under development. Notable among them are: intermediate molecules, detergents, solvents, surfactants, adhesives, biobased plastics, construction materials, furnishings, paper and cardboard, composites for transport applications, energy in the form of liquid biofuels, heat, electricity and biomethane. In many cases, such biobased products offer technical and environmental performance equivalent to, or even better than that of their fossil counterparts and, above all, new functionalities.

DÉFINITION

Biobased products *are defined as products deriving entirely or partially from bioresources.*

The quality of natural and anthropised spaces and the landscapes that result from these production systems underpins the development of a tourism and leisure economy while at the same time providing major ecosystem functions (climate, water purification, erosion control, biodiversity, protection against natural hazards, etc.) that are indispensable, especially for the maintenance of primary production, the bioeconomy's essential foundation. Development of the bioeconomy and ensuring its sustainability also entails a need to ensure that those mechanisms continue to function.

One of the key advantages of the French bioeconomy derives from the excellence of France's fundamental scientific research as finalised and applied, along with the very many initiatives promoted by local actors. National operators in the research field, technical institutes, major programmes and collaborative research and development facilities, industrial demonstrators, transverse regional approaches such as competitiveness clusters active in this domain, or more modest initiatives relating, for example, to short distribution channels, methanisation or biobased construction materials for buildings have brought into existence and have tested technologies and innovative markets and practices that have proven their worth.

These already offer novel prospects for bioresource production, use and processing as well as valorisation.

The bioeconomy is a reality in our country; it is solidly embedded in our regions, where it already generates a high level of economic activity. In a competitive international context which is rapidly organising, leading to a need to remain vigilant with regard to competitiveness issues, its development can rely on strong investment in research and innovation in both public and private sectors. In particular, it will be necessary for it to optimise and expand its capacity to produce and make use of the available bioresources on a sustainable basis and to foster potential points of synergy between different industrial sectors. If it is to be viable and productive over the long term, that development must be part of an approach involving the linking up of different uses of biomass and the sustainability of production and processing methods.

Specifically, there is a need to take account of the fact that use of bioresources assumes that materials are extracted from the natural cycles of carbon, nitrogen and other nutrients, water, and so on. This in turn means that it is necessary to close the loop of these cycles, in particular by preserving the biological processes that form the basis of all production in the living world (soil life, pollination, etc.). Public policy already incorporates a series of measures to ensure the sustainability of bioeconomy development by combating food waste, developing renewable energy and bio-based materials, sustainable extraction and rational use of raw materials, and so on.

In addition, the French approach to the bioeconomy sets out to be participatory: the major social, environmental and economic issues are matters of concern for all citizens and they should therefore be in a position to understand what is at stake in the balance between value creation, allocation of wealth across the regions and the quality of life there. For that reason, it is essential that all stakeholders (economic actors, academics, elected representatives and the general public) should be associated with the policymaking processes and the execution of practical projects.

Finally, coherence and synergy are imperative for national policies, regional applications of policy and European integration in terms of the economy, the environment, agriculture, forestry, and research and development in the regions. Closer cooperation not only with our European partners but also internationally is another objective in the implementation of this strategy.

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The bioeconomy in Europe

In 2012, the European Commission put forward a strategy for the bioeconomy entitled *Innovating for Sustainable Growth: A Bioeconomy for Europe.* Various initiatives have been engaged in this context:

▶ Formation of several working groups in the Standing Committee on Agricultural Research (SCAR) in DG Research.

▶ The setting up of the European Bioeconomy Observatory, backed by a panel of experts.

▶ Formation of an expert group on biobased products as part of the LMI (Lead Market Initiative) in order to underpin their development.

▶ The launch of a public-private partnership associating the European Commission with a consortium of manufacturers in which French players are closely involved, involving €1 billion of public money and €2.7bn in private-sector funding.

Member States are encouraged to take part in these various projects and to adopt a national strategy aimed at covering the whole range of issues pointed up by the European action plan. Germany, the Netherlands, Denmark, Finland and Spain now have strategy documents. France has had numerous projects take shape in the direction of the bioeconomy, making it a major actor in the European bioeconomy. The definition of a national strategy will enable France to play a full part in forthcoming discussions and especially those relating to the evaluation and revision of the European Commission's strategy.

For our future and the future of the planet, France has taken a strategic decision to encourage and support the development of a sustainable bioeconomy:

1.

TO GUARANTEE FOOD SECURITY AND ACCEPTABLE LIVING STANDARDS FOR PRESENT AND FUTURE GENERATIONS BY PRESERVING NATURAL RESOURCES AND ECOSYSTEM FUNCTIONS IN HABITATS

2.

EFFICIENT, RESILIENT AND CIRCULAR, PRODUCTIVE FOR THE LONG TERM

3.

FOCUSED ON ITS CITIZENS AND WITH LOCAL ROOTS, A BIOECONOMY THAT CONTRIBUTES TO THE DEVELOPMENT OF ECONOMIC VALUE AND JOBS

4.

PROVIDING INNOVATIVE, EFFECTIVE AND AFFORDABLE SOLUTIONS ABLE TO MEET THE DIVERSITY OF HUMAN NEEDS

France’s bioeconomy: a major advantage for the country, the economy and the climatee

The bioeconomy is a major sector in the French economy and the country as a whole. For all industries, both those already in place and those only now emerging, it is a sector that contributes to our country’s socioeconomic dynamic.

Production of bioresources

AGRICULTURE

28 M hectares (51 % of total land area).

936,000 jobs on 450,000 holdings.

€72.8bn in annual revenue.

FORESTRY

16 M hectares (28 % of total land area).

3,3 million forest owners.

FISHERIES AND AQUACULTURE

A 10.2m sq. km. Exclusive Economic Zone.

7,200 ships and 3,300 aquaculture firms.

37,000 headcount.

€1.8bn in annual revenue.

Looking beyond these contributions to the economy and the country, the bioeconomy's value chains offer key benefits for mitigating climate change. In France in 2013, approximately 500m CO_2 equivalent tonnes were emitted, taking all activities together, and it is planned to reduce this figure to around 325m CO_2 equivalent tonnes by 2030. The bioeconomy could contribute significantly to this:

▶ replacement of products of fossil origin by products derived from bioresources could offer potential reductions in emissions of approximately 40Mt of CO_2 per year by 2030 and storage of 5Mt of CO_2 per year;

▶ the potential emissions reduction in the farming industry considered achievable by 2030 (notably by encouraging changes in farming methods and energy self-sufficiency based on methanisation, for example) would be in the region of 10-15Mt;

▶ a 20 % reduction in food waste by 2030 would avoid emissions of 10Mt CO_2eq/year.

Source : CGAAER report no. 14056 – *Potential contributions of agriculture and forestry to combating climate change – 2015* [in French].

Valorisation

AGRIFOOD

16,200 firms employing 435,000 people (not including craft enterprises).

€169bn in annual revenue.

FOREST-WOOD INDUSTRY

Pulp/paper/board.

Lumber/furnishings/ woodworking.

Wood construction.

440,000 jobs in the forest-wood industry as a whole.

BIOBASED CHEMICALS & MATERIALS

Approximately 25,000 direct jobs.

5-10% of supplies to the chemicals and materials industry are biobased.

BIOENERGY

Around 60% of renewable energy production.

>**Methanisation** : 694 biogas production facilities. (including 267 farm and local area methanisers) representing installed capacity of 355MW and injecting over 80GWh/year of renewable gas.

>**Biofuels** (not including biogas): around a dozen operators and an estimated 16,000 direct jobs.

>**Energy wood & solid biofuels**: almost 10Mtoe consumed per year.

WASTE MANAGEMENT

The waste management industry employs 120,000 people in France and generates approximately €17bn in annual revenue (ADEME 2015).

Of these, around 15,000 workers are employed specifically for bioresource-related activities (by-products, biogas, etc.).

2

THE KEY ISSUES FOR THE BIOECONOMY IN FRANCE

2A

MAKING BIOECONOMY PRODUCTS A MARKET REALITY

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The bioeconomy meets a very diverse range of needs with widely differing issues and leverage:

➔ Food markets are supplied virtually entirely by the bioeconomy. Those markets facing with the challenges of increasing global demand and transitional changes in diets. By 2030, the demand for protein is likely for this reason to grow by 40%. Additionally, France and Europe suffer from a high level of dependence on imported protein due to a deficit in the animal feed sector, a fact that points to an opportunity for additional growth. More generally, commercial outlets for food are characterised by innovation and are a major vector for growth.

➔ Renewable forms of energy include the use of wood and waste, organic residues or co-products in direct combustion or for the production of biogas. These uses are generally coupled with other value chains and reinforce the generally circular and robust nature of these sectors. Biomass accounts in total for around 60% of renewable energy in France. In the renewables category, the biofuels industry is highly dependent on regulations and evolving demand for fuels (diesel/petrol(gas)). First-generation biofuels are already present in the land transport market. Advanced biofuels are under development in major R&D projects directed at the use of lignocellulose and the creation of new supply chains for fuels derived from waste and residues. Energy biomass (wood in particular) is already used for the production of heat and electricity; biogas is the smallest component of the energy mix but is showing promising growth. The use of these forms of energy in markets is the focus of multiyear energy programming that defines levels of bioenergy production and percentage inclusion in conventional fuels.

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EXAMPLE

Methanisation, the production of energy and fertilisers from local materials

Methanisation is a process whereby organic matter is broken down in the absence of oxygen. The result is biogas and a residue, the digestate. Biogas can be converted into electricity and heat (cogeneration) or biomethane (injected into natural gas supply networks or used directly as a fuel for example). The digestate has fertilising properties. The minerals it contains can be directly taken up by plants, distinguishing it from raw effluent (manure for example), and its organic fractions can improve soils.

Reduction of greenhouse gas emissions from farm effluent, waste management, continuous production of energy storable in a number of different forms and renewable fertilisers, generation of additional value-added for biowaste producers … projects are being set up to obtain one or more of these benefits, depending on local needs.

▶ **Geotexia** (22 France) was formed by farmers, agrifood companies, elected representatives and an energy company. This collective facility can convert excess nitrogen for use outside the local area, while at the same time producing electricity and heat. Discharged water irrigates plantations for a local wood-energy centre. http://www.ccmene.fr/accueil_menerpole/route_des_energies/lusine_de_methanisation_geotexia

▶ **AgriBioMéthane** (85 France) is a facility run by four farms. It digests slurry and manure from their holdings and by-products and waste from agrifood. The biogas this produces is purified to make biomethane with a composition equivalent to that of natural gas and this is injected into the GrDF distribution network or used for trials as a fuel in school buses – http://www.agribiomethane.fr

▶ In the case of **Biovalsan**, it is sludge from Strasbourg's urban wastewater treatment plants that is methanised to produce biomethane which is then injected into the Strasbourg general supply network – http://biovalsan.eu

▶ **Trifyl** (81 France)is a public/private entity at the level of the département. Household waste remaining after recycling is sent to a bioreactor (a form of landfill facility where waste is broken down more rapidly). The biogas produced there is valorised in three different ways: cogeneration, biomethane fuel and hydrogen. Thirteen utility vehicles, a tractor and a skip loader all run on biomethane fuel. Trifyl is also running a project for biogas processing trials for the production of hydrogen. http://www.trifyl.com/actualites/actualites-liste.phpX

Methanisation projects are therefore highly diverse in terms of the raw materials used, the operators involved and the forms of biogas valorisation.

France has set itself ambitious goals for the development of the biogas sector. For this, facilities can be supported in several ways:

▶ subsidies can be offered for feasibility studies and investment, notably via ADEME, the French Energy and Environment Agency, and regional authorities;

▶ a regulated purchase price for the electricity produced using biogas and biomethane can offset differences in production cost compared with conventional sources of energy;

▶ EU funds can be allocated to innovative projects.

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Where the markets for formulated products and materials are concerned, French policy on support for innovation has resulted in the market placement of numerous biobased industrial products: polyols used in formulas for paint, coatings and adhesives; polyester resins used in composites for applications in the automotive, construction and leisure industries; up to 100% biobased lubricants for the metal cutting and stamping industry; agrosolvents for industrial degreasing, surfactants for detergent markets; packaging for food markets; construction and insulation products, and so on. Many regulatory provisions in favour of the environment and health at EU level and in France have led to the development of biobased products, but these have been one-off measures (e.g. regulations on reduction of volatile organic compounds encouraged biobased paint development, the plastic bag ban for fruit and vegetables, etc.). The work currently under way on standards for biobased products (work at EU level in the CEN TC411 group mirrored in France in that of the AFNOR X85A group) is likely to ensure recognition of the positive externalities of these products, aligned as they are with environmental and sanitary objectives, enhancing their market competitiveness.

Other forms of valorisation of bioeconomy products and services, as well as the associated production areas, must also be taken into account: fertilisation, landscapes, tourism and leisure in rural areas, water purification, and so on. Such activities and resources must not be left out of socioeconomic models, even if the details of how to include them are as yet unclear.

In order to expand the share of French bioeconomy products in all these markets, it can be seen to be necessary to pursue and extend the approaches already adopted in order to heighten awareness of biobased products and their benefits on the part of those that consume them, whether manufacturers, end-users or public-sector procurement managers.

FOCUS

Agrobiobase: a showcase for biobased products

Agrobiobase is a website focused on biobased products and their markets. It is published by IAR, the French bioeconomy cluster.

Acting as a facilitator for supplier-user contacts, this website describes itself as a B2B platform directed at accelerating the market integration of biobased products.

Presenting nearly 300 products, the website covers around twenty markets for applications ranging from cosmetics to sport and leisure, from construction to transport.

This enables over 90 European American, Asian and African suppliers to communicate on their products.

The site is bilingual, in French and English, and is consulted internationally (30,000 annual visits); it has democratised the use of biobased products by providing key information on aspects such as environmental benefits, plant origins and technical data, as well as supplier contact details.

The bioproduct universe is just a mouse click away, with thousands of details on biobased products in product datasheets plus a series of articles and studies.

These articles and studies provide additional information on bioproducts, markets for their applications and product families: market data, use benefits, applications, technical characteristics, etc.

You can find out more at www.agrobiobase.com

Raising the profile of innovative bioeconomy products

Certain biobased products can now be integrated into market offerings thanks to the new functionalities they provide. As innovative solutions, their profile nevertheless needs to be raised for operators likely to make use of them if they are to win significant shares of the target markets. It is also important to assist and train users to enable them to make such solutions a part of their own production as effectively as possible and to take user feedback into account to make changes to the solutions they are offered. For that reason, it is important to bring downstream actors fully on board when developing the bioeconomy.

Clarifying and highlighting the positive externalities of biobased products

The list of the potential positive externalities of bioeconomy products is long: climate change mitigation, preservation of regions, local jobs, reduced dependence on fossil resources, resource sustainability and renewability, reduced sanitary and environmental impact, protection against natural physical hazards, water resource conservation, waste recycling, among others. The use of quality labels and standards appropriate to companies and market demand can highlight the value of these advantages in comparison with non-biobased

products. The proven benefits linked to the biological origins of these products must be highlighted. This will make it possible, firstly, to describe correctly what it means for a product to be "biobased", and progressively to fine-tune the definition and the methods for the evaluation of biobased products. Clear answers to environmental questions will provide information for understanding their environmental performance (cf. 2D). Communication efforts directed at the general public and buyers at all these levels is also necessary. In addition, in many cases precise determination of the benefits will require work on methods and validation. In addition to commercial communication, there are numerous public-sector tools that can be considered for supporting biobased products and promoting their positive externalities: taxation (as used for biofuels), regulations (used for biobased, compostable plastic bags, and for building performance), market control (energy feed-in tariffs), and others. Such approaches need to be thought through systemically, identifying the instruments to be favoured and verifying the capacity for the chain of value as a whole to respond on a sustainable basis, avoiding possible negative effects (prolonging sector dependence on public subsidies, slowdown or cessation of innovation, impacts upstream, etc.) and justifying them in light of the advantages described above.

FOCUS

Industry rules for hempcrete use in construction: a tool for biobased product market access

Drafted in 2007 in partnership with the government ministries responsible for national infrastructures and agriculture, alongside the non-profit association Construire en Chanvre (building with hemp), these rules are regularly improved and validated by Agence Qualité Construction (construction quality agency).

By providing security for the use of hemp in construction, the rules make it possible to obtain cover under 10-year construction warranty insurance, which in turn opens up the markets for newbuild and major renovation. They require the use of a validated combination of a standardised mineral product and a quality-labelled plant granulate (hemp chaff) by builders who have attended approved training in application techniques.

Making possible the use of hemp in construction means getting the benefit of a large number of positive externalities for the annual equivalent of one thousand new buildings:

▶ promotion of an exemplary plant for sustainable development: no plant protection products, no irrigation and the possibility of longer crop rotations;

▶ reduced pollution due to building activity, with a positive differential of 26t CO_2 for a standard 100 sq. m. housing unit (total net floor area) and a unit in hempcrete plus hemp wool insulation;

▶ development of reservoirs of qualified jobs in farming and industry that cannot be moved offshore;

▶ provision of exceptional thermal, acoustic, seismic, hygrothermal and sanitary performance;

▶ utilisation of healthy, renewable materials (hempcrete and hemp wool).

Further information at:
www.construire-en-chanvre.fr

Making use of public procurement to promote the use of biobased products

The roadmap of the "Green Chemistry and Biofuels" industrial plan contains measures to support the use of biobased products in the public procurement context. This approach is consistent with Article 144 of the French law on energy transition for green growth promulgated on 17 August 2015, which amends the code of environmental law: *« Art. L. 228-4. – Public procurement shall notably take into account the environmental performance of products, and in particular their biobased character »*. The use of demonstration tools for product sustainability and overall cost can provide an effective means of consolidating and targeting such use.

PUBLIC MEASURES ALREADY IN PLACE

Strategic frameworks

✱ **The Energy Transition Law for Green Growth (LTECV): multiyear energy programming, an approach directed at environmental high performance for newbuild, a prohibition on plastic bags unless biobased and compostable in Article 75; Article 144 on the obligation to take biobased characteristics into account in public procurement.**

✱ **Renewable energy policy (EnR): (energy feed-in tariffs, call for competitive tenders by the French Energy Regulation Commission (CRE), biofuels, etc.).**

Operational and knowledge tools

✱ **Work on standards for biobased products (AFNOR X85A and CEN TC411 standardisation committees).**

✱ **A study by ADEME (French Energy and Environment Agency) of current markets for biobased products and ongoing changes to 2020 and 2030.**

✱ **An economic watch programme pooled with the forest-wood sector.**

2B

SUPPORTING THE TRANSITION TO A HIGH-PERFORMANCE, INNOVATIVE AND SUSTAINABLE BIOBASED INDUSTRY

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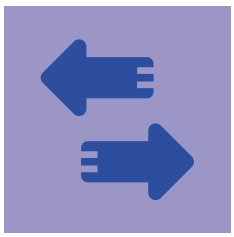
The industries producing these products must meet the needs of consumers and society (cf. 2A) and can rely on one of France's key advantages: its possession of abundant and diverse resources. By processing raw materials, those industries also contribute to generating value-added at local level. However, if the development of an innovative and sustainable "biobased" industry is to be fostered, it will be necessary:

- to know precisely what the needs of the target markets are in the short and medium terms;
- to develop systems of production favourable to industrial ecology, i.e. synergies in the use of biomass and energy resources;
- to design processing methods that are flexible and capable of accommodating different types of biomass;
- to support and foster synergies between research and industrial development in order to encourage innovation;
- to coordinate supply from upstream sectors and demand from the processing industries and also to improve knowledge of the technical quality of the bioresources.

Fostering industrial ecology through **synergy in uses** of bioresources and the factors of production



The development in local regions of new activities linked to the bioeconomy will allow new forms of synergy to emerge in order to optimise the use of bioresources and respond competitively to market requirements. Such synergy, which will develop over time, can be encouraged through balanced dialogue at local level between those involved. It must be based as far as possible on existing activities, strengthening but not destabilising them. The public authorities at the appropriate regional level, depending on the nature of the project, can support such alliances by facilitating discussions between stakeholders.

There are already a number of trials in France that are seeking to address these issues. Between upstream and downstream, valorisation of processing industry effluent as fertiliser is naturally a widespread typical application. Biorefineries are among the keystones of the bioeconomy, using local biomass resources as raw material and maximising the exploitation of all fractions of the resource for both food and non-food applications.

Other models can also be considered: smaller-scale production systems, possibly mobile and capable of adjusting to high levels of biomass variability, can also be appropriate solutions. Such systems could enable bioresource production to be adapted to the consequences of climate change and strengthen the development of a local economy.

FOCUS

Grape spirit distilleries: valorisation of the industry's by-products and improvement of its environmental footprint

Grape spirit distilleries based in France's winegrowing regions collect, process and recycle the by-products of winegrowing (grape pulp and wine lees). In the main, they make alcohol for human foodstuffs, biofuels and the chemical industry, but they also produce colorants, tannins and polyphenols, grapeseed oils, tartaric acid (for wine acidification, food conservation, etc.), pulp for animal feed, fertilisers and biogas. These distilleries also have commercial outlets in the food, farming, industrial and energy sectors.

The processing of grape pulp and wine lees by these distilleries constitutes the main method for valorisation of these by-products. A life cycle analysis conducted by IFV and FranceAgriMer has shown that processing these by-products in the distilleries is more virtuous that any other currently available treatment. These distilleries are therefore effective environmental tools for the winegrowing industry, forming part of the bioeconomy approach in that they maximise the valorisation of organic products.

The sector is constantly evolving: in less than a century, traditional itinerant distillers have given way to innovative enterprises operating in permanent premises. For example, 2011 saw the birth of the MARCSIF project thanks to the help of FranceAgriMer and grape spirit distilleries. This research and development programme is aimed at extracting condensed tannins from dealcoholised grape pulp for the development of biobased adhesives. Trials are ongoing and the tannins could replace the formaldehydes in glue, molecules responsible for emissions of volatile organic compounds.

Developing novel, flexible production systems suited to the resources used

Non-food activities in the bioeconomy make use of increasingly diverse biomass (e.g. crop residues, forestry and wood industry co-products) and organic waste. The use in the same recycling facility of waste and co-products from farming, the agrifood industry or urban areas, or even mixtures of these, requires a viable technical and economic model based on straightforward but robust processes for the production of commodity products. Models focusing on the production of high value-added, low-production volume speciality molecules from more specific bioresources also constitute a further promising way forward for development.

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Rolling out industrial activities

The industrialisation phase can face various hurdles: difficulties in obtaining supply, difficulty in finding finance, occasionally complicated or inconsistent market regulations and product standards, a lack of local acceptability for industrial projects and the associated logistics flows, complex and in some cases lengthy supply chains, and a lack of attractiveness in local areas.

With regard to sectors that are strategic for France but still emerging, subject to the unforeseen contingences of the living world and facing strong international competition, the public authorities must endeavour to support the creation or further development of such activities. The funding of projects for the initial innovative industrial or experimental facilities can be assisted by the authorities. Revision of provisions in standards or regulations unsuited for this new context are also to be considered in order to encourage the industrial roll-out of bioeconomy activities.

Given the dependence of biobased products on a variety of business models, a sector-by-sector approach will be necessary when considering public policy measures for the various uses, and those measures should be defined in conjunction with all the links in the value chain, especially the sectors for product application.

FOCUS

Tembec in Tartas: transformation of a cellulose pulp plant into a lignocellulosic biorefinery

In 1994, the forest product group Tembec decided to acquire a cellulose pulp plant in the Landes region of France. The plant was the property of the Saint Gobain group at the time.

Twenty-two years later, this industrial facility has been totally transformed and provides an example of industrial diversification in the area of sustainable, profitable bioeconomy.

The company began with an overhaul of its business model to position itself as a supplier of speciality products: high

›

value-added cellulose for chemical applications in the pharmaceutical and food industries.

The other components of wood – the biorefinery's raw material – are also commercialised in the chemicals market: industrial lignins and tall oil soaps (resin).

Such biorefinery operations are particularly energy-intensive: due to recent changes, the fuels burned by the plant are now exclusively of plant origin (forest non-paper biomass and black papermaking liquor).

The thermal energy generated is converted into green electricity sold on to the national operator, with the plant having been successful in the second call for competitive tenders launched by the Energy Regulation Commission (CRE) in 2008.

All these changes have resulted in a very significant reduction in the plant's environmental footprint.

Such a coherent industrial complex has been possible only due to the very significant investments made by the Tembec group (more than €150m over 20 years), an uninterrupted R&D effort and financial support from institutional partners at the national, regional and département levels.

PUBLIC MEASURES ALREADY IN PLACE

Strategic frameworks

- **Transposition of the methods in the UK's National Industrial Symbiosis Programme (NISP) to four French regions by ADEME.**
- **Call for proposals for industrial programmes for the future (PIAVE) and a call for proposals under the programme for structural organisation for competitiveness (PSPC) by Bpifrance.**

Existing programmes in various sectors

- **Food: food industry agreement; smart food supply solution for a new industrial France; national food programme.**
- **Energy: European and national policies for biofuels and a solution for new resources for a new industrial France; energy methanisation plan for nitrogen self-sufficiency; heating fund; multiyear energy programming.**
- **Materials: strategic wood industry agreement; national forests and wood programme; sustainable city solution for a new industrial France; Directorate for Housing, Town Planning and Landscape (DHUP) biobased construction materials action plans 1 and 2.**
- **Chemicals: new resources solution for a new industrial France.**

Fostering dialogue between farming, forestry and fisheries upstream and processing industry operators

The design and development of innovative, effective and efficient processing tools require forward visibility of raw materials supplies. Such visibility is all the more necessary in the case of radically new partnerships (between the chemical industry and upstream farming and forestry activities, for example).

Information on available resources is imperative ahead of project implementation (cf. 2C). Throughout the life cycle of a project, coordination arrangements need to be put in place by upstream and downstream operators in order to secure supplies. Balanced contractual relationships can be solutions for better management of volumes, quality, prices and encouragement of collective innovation. Such relationships must enable downstream activities to take into account the variability intrinsic to upstream production (weather, disease, changes in production systems, etc.) in terms of both volume and quality, especially in the case of highly disparate materials such as biowaste. Logistics issues between upstream and downstream must also be among the questions to be addressed.

Reciprocally, upstream activities must, within the limits set by their unavoidable constraints, implement solutions to move closer to the requirements of the tools for valorisation. This search for the right fit between upstream and downstream activities requires more precise collective knowledge of the resources and products concerned in order to confirm the relevance of the proposed solutions in technical and economic terms.

The effort to establish such intensified dialogue can lead to a consolidation of approaches for the organisation of value chains and those driving them (inter-branch bodies, trade federations, etc.).

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FOCUS

Bazancourt-Pomacle biorefinery

Bazancourt-Pomacle biorefinery is located just a few kilometres from the city of Reims and is the outcome of a long-term, collective effort initiated and driven by farmers in the Cristal Union and Vivescia cooperatives.

Today, this site is host to industrial units, R&D organisations, pilot trials, a demonstrator dedicated to industrial biotechnologies and an academic "campus" funded by local government. The BRI (Biorefinery, Research & Innovation) innovation platform which has established itself at the heart of this agroindustry complex was the first innovation centre to be awarded government validation under its competitive cluster policy in 2009, in conjunction with the IAR bioeconomy cluster.

The complex forms an ecosystem in which various types of synergy have been exploited to optimise the site's overall "metabolism" and ensure total use of the agro-resources processed in the biorefinery (mainly wheat and beet). This is a frequently cited model in the industrial ecology context. The relevant markets relate both to this sector and chemicals, cosmetics and bioenergy.

This ecosystem has expanded further with the addition of an experimental farm on what was originally a military airbase a few kilometres away, with the objective of improving the sustainability and performance of the agricultural production, in addition to a business park intended for new bioeconomy enterprises.

The Bazancourt-Pomacle biorefinery has been recognised by the DGE (General Directorate for Enterprises at the French Economy Ministry) and the UIC (Union of Chemical Industries) as one of France's leading chemical platforms.

2C

PRODUCING BIORESOURCES SUSTAINABLY TO MEET THE NEEDS OF ALL BIOECONOMY VALUE CHAINS

Bioresource production allows the needs of the bioeconomy's value chains to be met. The way in which this production is conducted determines in large part the quality of the resulting raw materials, the quantities available and, obviously, their initial geographical location. Additionally, bioresource production and harvesting is mainly carried on in natural or semi-natural areas, and are therefore activities for which control and monitoring is imperative with regard to their environmental impacts (not only habitats, landscape, climate, air quality, but also the ecosystem services rendered) and their social impacts.

Conditions in France are conducive to primary bioresource production: it has the largest Utilised Agricultural Area (UAA), the third largest area of woodland in Europe if French Guiana's forests are included, the world's second biggest maritime area, a wide diversity of distinct local regions ranging from large cities to overseas territories, and more. This situation permits high production in terms of variety and volume. However, underneath this general picture the picture is more uneven: certain reservoirs of biomass are already exploited at the present time while others offer major development potential for using sectors. Added to such primary resources are biowaste and co-products, available in large volumes, a significant part of which is already exploited.

FOCUS

SCIC Argoat Bois Énergie: a tool for farmers, forestry operators, local government and local enterprises

SCIC Argoat Bois Énergie markets, produces and processes energy wood, mulching materials and products of agricultural and forest origin. It involves actors from upstream and downstream in the supply chain working within a single organisation of cooperative type in building a local network of producers and small- to medium-sized heating plants, the aim being to fully master the resource and obtain a decent income for the producers (the target is €2,000 to €3,000 in extra revenue per year and per kilometre). It also provides advice and assistance to the owners of wood-burning heating plants.

The SCIC (collective cooperative company) is positioned as a reference supplier for small- to medium-sized heating plants locally: it sells nearly 2,500 tonnes to 20 customers, mainly wood from stands on farms purchased from the 50 farmers who are members and who have adopted a sustainable management plan for their woodland. Maximum transportation distance between storage centres and heating plants is 30 kilometres. After screening, the wood is delivered directly to the storage facility or stored on the producer's farm, and is transported by pneumatic truck for easier delivery to plants with tower or underground silos (it is important to note that the collective does not own either the chipping machinery or the storage facilities). Non-forest woodland covers nearly two million hectares in France (Pointereau, Solagro) and a fine-grained network of such organisations will allow this resource to be exploited more efficiently.

This collective was set up thanks to funding from LEADER, Brittany's energy wood plan and municipal cooperation bodies in the Pontivy area.

©Samuel Le Port

It is generally the case that development of the bioeconomy will lead to increased demand for biomass or reconfiguration of its uses. Competition between potential users may arise, depending on the economic context and supply from bioresource producers. For this reason, measures for the structural organisation of the bioeconomy must take fully into account upstream production in conjunction with its valorisation downstream and the biomass it is necessary to keep in the environment to meet the ecosystem requirements.

FOCUS

The combined technology network (RMT) for biomass & local regions

The RMT (combined technology network for biomass & local regions) is a national network formed under an agreement signed by the actors in various R&D and training organisations working in biomass research and development at every stage from local area to industrial plant. It is headed up by the Regional Chamber of Agriculture for the Hauts-de-France region (lead contact: e.nguyen@hautsdefrance.chambagri.fr). Its aims are to collect, capitalise and disseminate knowledge already acquired in its field, to define priority focuses for investigation to match the needs of ongoing biomass projects and to build specific shared R&D projects.

It maintains and strengthens a network of 70 multidisciplinary members at national level that has been in place since 2008. Its founding partners are: the Normandy Regional Chamber of Agriculture, Arvalis Institut du Végétal, AgroTransfert Ressources et Territoires, COOP de France Services, Bergerie nationale and Troyes University of Technology.

Its goal is to facilitate and support the development of sectors for the valorisation of local biomass from agriculture, taking into account the specific features and resources of the local area.

The three priorities for 2014-2018 are:

▶ to clarify, objectify and disseminate knowledge of production and exploitation of the agricultural biomass resource and its present and future uses;

▶ to optimise the deployment of sectors across the country: competence, technology, economics for leveraging the "post-production" cost of agricultural biomass;

▶ to characterise and assess the environmental and social impacts and positive spin-off from biomass supply chains in local economies and natural habitats in order to promote it.

Like all RMTs, in recognition of its coordination work it receives its own funding from the special allocation account for agricultural and rural development (CASDAR) manged by the Ministry of Agriculture.

To find out more, please go to the website pages at: www.rmtbiomasse.org

That is why a national strategy for the use of biomass (SNMB) (rolled out in regional versions, SRBs) is planned for 2017 to develop biomass production and exploitation on a sustainable basis in order to secure supplies for using sectors. The SNMB will make it possible to avoid or reduce pressure on access to bioresources by ensuring the maximum possible convergence of requirements and availability. It will be based on a systemic vision of the relevant resources and the possibilities for their exploitation, adopting an approach to guarantee the renewable character of primary resource production. Such convergence will be sought at national level and if it cannot be completely achieved with French resources alone, the SNMB will assess the volume of biomass to be imported. Resource evaluation will also be conducted at regional level under the regional biomass schemes.

The SNMB will in this way improve our knowledge of the resources and their uses, encourage increased mobilisation and link up users more effectively.

Improving and sharing our knowledge of the resources and their uses

Detailed knowledge of bioresources and their uses is an important means for facilitating convergence between products and needs, building the capacity to evaluate the various options for valorisation, constructing long-term economic projects, applying sometimes far-reaching industrial decisions, verifying the sustainability of those decisions and, lastly, for ensuring the right fit between local and general requirements. The development of the bioeconomy must therefore be founded on robust, shared scenarios themselves based on data allowing the inclusion of sufficiently consolidated and regionalised quantitative and qualitative analysis, giving due consideration to the heterogeneity of the resources by using means already available such as ⊙

the national biomass resource observatory (ONRB). Such reflection must include and cross-correlate the whole range of bioeconomy activities insofar as all biological materials include fractions whose uses have a range of applications relating for foodstuffs, chemicals or energy. This requirement for founding scenarios points to the necessity of improving evaluation methods and information transparency, relying on research and strategic foresight analysts, and making use of innovative information systems that include, where relevant, the opportunities offered by digital technology and big data.

Producing and using more bioresources

Preservation of the environments on which the bioeconomy is founded is an imperative precondition: farmland, woodland and aquatic or marine habitats must be preserved in terms of both quantity (notably by combating soil artificialisation) and quality (maintaining their functional mechanisms) with an approach based on renewal rather than consumption of natural capital.

Initial efforts to increase resource production and use will need to target regions where the sustainable potential remains underutilised. The requirement may be for improvement in the means for harvesting, agronomic or forestry performance, crop genetics, logistics systems, or other aspects. Such optimisation must be economically viable.

It is also necessary to consider forms of supply that until now have been exploited little if at all: this may involve the valorisation or revalorisation of certain areas or components of the landscape (e.g. uncultivated land, abandoned farmland whose productive capacity needs to be preserved, maritime or aquatic areas), proposing crop systems that include new forms of production (intermediate crops in rotations, mixed crops, field hedgerows, etc. in conjunction with the application of agroecology), or possibly the invention of original forms of valorisation for unused biowaste whose production cannot be avoided. The combination with agroecology can help achieve goals for environmental sustainability and diversification of the uses for harvested fractions while at the same time producing greater quantities and improving the stability of supply. Here again, technical, economic, social and environmental assessments, both ex-ante and ex-post, will be of key importance.

FOCUS

Projects for increased use of wood, supported by AMI Dynamic Bois

In order to expand the use of wood resources, in 2015 the French Energy and Environment Agency (ADEME) and the Ministries responsible for energy and forestry launched a call for declarations of interest under the heading “Dynamic Bois” (wood dynamic) with funding of €35 million. The operators engaged in this will contribute to supplies of bioresources to bioeconomy sectors. The following are examples of winning projects.

FOCUS

The ACPDL project (coordinated action in the Loire valley)

This project is driven by Atlanbois, the regional interbranch body for the forest-wood sector in the Loire valley in a context characterised by growing demand for energy wood (heating plants planned in Nantes plus industrial processes) and limited forest resources. It is aimed at combining different resources: valorisation of urban wood for use in energy production in chipped form in areas distant from woodland and promotion of the replanting of depleted stands to contribute to the production of forest wood chips. This project has a total budget of €4.6m and is based on a partnership between companies supplying wood chips (forestry operators and recycling firms), forestry cooperatives, forest managers, the national centre for forest ownership (CRPF), the French national forests office (ONF) and the Programme for the Endorsement of Forest Certification (PEFC) West in order to promote certification and wood chip firms. The target for additional wood harvests is 280,000 tonnes of energy wood and 45,000 cu. m. of construction and industrial wood over the next three years.

FOCUS

The ERFCAL project (energy in reforestation, Franche-Comté Alsace)

This project is driven by Sundgaubois, a company producing energy wood in the southern Vosges and the Jura in northern Franche-Comté and southern Alsace, this being an area of urbanised woodland where demand is high for energy wood. The project involves the national centre for forest ownership (CRPF) in a leadership role, forest municipalities (very numerous in this region), the Chamber of Agriculture and producers of energy wood. The Ballons des Vosges regional nature park and the hunters’ federations in the départements monitor landscape preservation and forest multifunctionality. The project includes investment in equipment and forestry (machinery, supply centres, forestry operations) and leadership activities and has a total budget of €2.2m for the promotion of wood harvesting, including non-forest wood located at field margins (hedgerows), waterway bank upkeep, maintenance of areas occupied by major utility networks, and so on.

FOCUS

The Foredavenir project

This project is promoted by the centre for forest ownership (CRPF) in France's Aquitaine region. It covers the Gironde area, whose forest resources, consisting largely of softwood, is underexploited; it is aimed at reducing the pressure on energy wood supply from the Landes forests. The project is founded on a partnership with forestry businesses, the Alliance Forêt Bois cooperative, the forestry entity of the Caisse des Dépôts and the national institute for geographical and forest information (IGN). Its goals are the take-up of an extra nearly 160,000 tonnes of wood over three years and the restoration of depleted stands on almost 1,400 hectares. It has a total budget of €4.50m.

These participants are engaged in a common approach to the operational implementation of the programme, pooling their information in order to ensure both a properly balanced value chain in the sector and sustainable forest management, based on the following principles:

▶ intensified mutual consultation and information-sharing, speaking the same language;

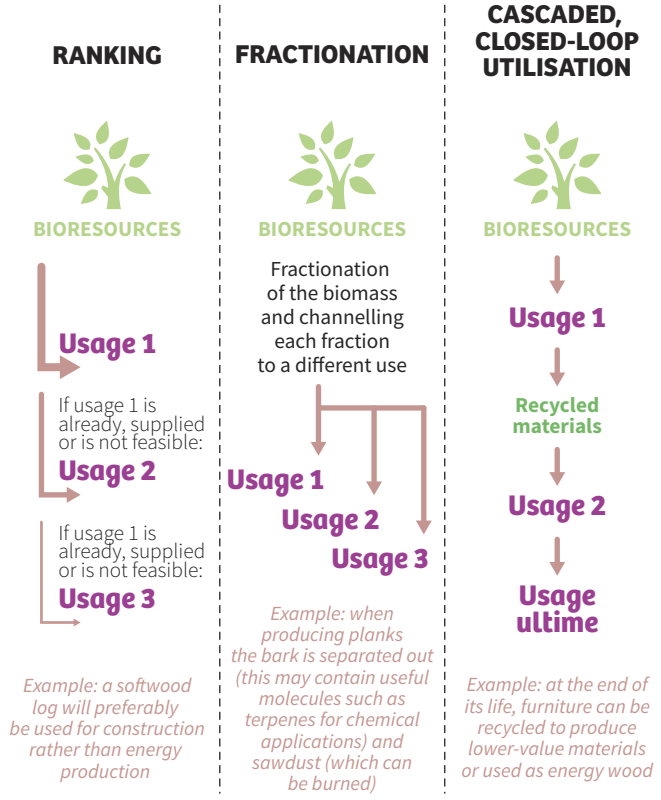
▶ take-up of extra volumes of wood and a regrouping of market supply;

▶ affirmation of an economic balance between sector operators;

▶ communication of sustainable management criteria for greater value-added from forests.

ORGANISATION OF THE USES OF BIORESOURCES: APPROACHES TO BE COMBINED ACCORDING TO SITUATIONS AND DESIRED OBJECTIVES

The bioeconomy does not necessarily give priority any one of these approaches. They can be combined and evolve to match the context.



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Using bioresources, seeking the best possible organisation

It cannot be ruled out that market pressures on long-term access to raw materials will arise or intensify. Such pressures will affect either the conditions for access to the factors of production (soil, water, etc.) or the types of use for the bioresources (supply chains).

The primary importance of the food security issue is a principle generally shared at international level ("food first"). However, the scope of application of this principle and the societal needs within that scope may vary (between local and global levels) and evolve over time (dietary role and importance of plant proteins, new commercial technologies, etc.), all of which tends to shape the analysis (and therefore the choices) according to the situation.

Non-food uses are however also legitimate for meeting other human needs (e.g. clothing, housing, energy) and ensuring the proper functioning of ecosystems (e.g. soil fertility by composting, mitigating the greenhouse effect with carbon storage, longer crop rotations for non-food plants). Among such non-food uses, valorisation as materials or in the production of useful molecules can often be considered preferable to immediate use in energy production, in order to store carbon in biobased products and maximise value-added generated per unit of biomass produced and harvested. Wherever feasible, reuse or recycling of biobased products must also be encouraged, based on a circular-economy philosophy.

It is also important to support the optimisation of material yields as far as possible in order to limit resource requirements, cascaded applications (reusing the co-products or waste from an activity) and synergy between applications: in many cases the various possible forms of valorisation are not mutually incompatible and their combination can in fact be considered. Combating loss and wastage at the various stages in supply chains is also a way of increasing usable and used volumes of materials, thereby limiting potential pressure on resource access.

However, those principles must remain flexible where their application is concerned and they must take account of economic and regional realities, and in particular the existence or absence in each biomass category of expressed demand for biobased materials or biomolecules, in light of current or upcoming market conditions. The aim is not to establish a strict rule for priority between different options for valorisation of a given category of biomass; conversely, it is legitimate to ensure, for example, that the development of an energy biomass sector is in fact compatible with maintenance of supply to existing operators producing biobased materials, something that will be enabled by the preparation and implementation of the national strategy for the use of biomass (SNMB) and its regional versions (SRBs).

Finally, upstream, the preservation of production systems must be given very high priority in order to maintain production capacity over the long term. It is for example necessary to retain a sufficient quantity of organic matter and nutrients in soils and to achieve this by not extracting the totality of the biomass produced or degrading the soil's biological mechanisms.

Multicriteria evaluation studies (covering employment, the environment, economics, local and global contexts, existing supply chains) and modelling of the short- and long-term effects of projects will for example be essential to allow informed choices to be made between the various options (and, by the same token, between the various public policies and measures impacting the activities concerned).

PUBLIC MEASURES ALREADY IN PLACE

Strategic frameworks

- National strategy for the use of biomass (SNMB) and its regional versions (SRBs).
- National plan for the development of agroforestry.
- National forest-wood programme (exploitation aspect).
- The agroecology project.

Operational and knowledge tools

- National biomass resource observatory.
- Activities of biomass units at regional level.
- Combined technology network (RMT) for biomass & regions.
- Scientific Interest Grouping for CAS (modified land assignments).
- IGN forest inventory programme and the ADEME-IGN-FCBA study of forestry resource availability for energy and materials over the period to 2035.
- "Dynamic Bois" call for proposals.

2D

GUARANTEEING A SUSTAINABLE BIOECONOMY

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Bioresources stem from complex, unceasing living processes and the bioeconomy will lead to increased extraction of products from the carbon, nitrogen, phosphorus and water cycles, etc. It is vital to ensure that these cycles are protected and closed for the long-term viability of the living processes that regenerate the basic resources, enabling adaptation to climate change, the aim being to guarantee the long-term viability of the bioeconomy.

A competitive bioeconomy works in synergy with natural mechanisms

Soil renewal, soil quality, robust trophic systems, the presence of biological auxiliaries of micro- and macro-fauna and flora, resilience in the face of adverse natural events (biotic and abiotic) notably guaranteed by biological diversity, are all important preconditions for a sustainable bioeconomy.

Synergies between the maintenance of living processes and the supply of bioresources must therefore be sought and exploited, for example in order to address the issue of phosphorus requirements, or to foster synergies between plants and animals (e.g. association of crops, trees, rotations, pollinating insects) capable of enhancing productivity, reducing input

consumption and improving the quality of soils and aquatic habitats. Sustainable management of farmland, forests, the sea and bodies of freshwater, along with industrial processes sparing in their use of materials and generating little or no pollution, together form the essential basis for the French bioeconomy.

The development of the bioeconomy has a major regional component

Stronger synergy between economic activities and biological mechanisms would make it possible to maintain the ecosystem services provided to operators in local regions by natural and exploited areas (water quality and circulation, pollination, protection of soil against erosion, fish nurseries, landscape and tourism, etc.). Like the environmental processes to which they must adapt, bioeconomy activities are governed by many rhythms and spatial scales ranging from the national and beyond down to local farmland, water catchments and maritime areas. Managing them must be approached at the appropriate geographical level in light of existing knowledge and methods. Spaces for regional exchanges between actors mentioned in 2C will also need to take these issues into account, in line with local infrastructure policies. Just as it requires a panoramic overview of all the skills and methods applied in the socioeconomic sphere, the sustainability of the bioeconomy therefore demands the construction of a panoramic overview of the channels for materials and processes in the biological sphere. That overview must also take account of the diversity of economic and social uses, market trends and all the components of regional development. This transverse approach may in fact involve, in conjunction with the national strategy, interregional cooperation at EU level.

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FOCUS

An integrated multi-trophic aquaculture project in Brittany

The purpose of the CIMTA project promoted by the Centre for Algae Studies and Valorisation (CEVA) based in Pleubian in Brittany is to set up a pilot aquaculture unit based on the principles of Integrated Multitrophic Aquaculture (IMTA), a first in France in an open marine setting.

The project combines a salmon farm, a mussel farm and brown seaweed crops on a single site, all of which creates an artificial ecosystem that takes advantage of the high degree of mutual complementarity between these different species. This concept offers numerous benefits: it reduces aquaculture's environmental impact, improves economic performance, enhances resilience in the face of the variability of the marine environment and occupies less maritime area, among other advantages.

A productive and competitive bioeconomy is founded on sustainable production

In order to take account of both the growth in demand for bioresources and the planet's biological limits, consumption of basic resources must be as sparing as possible and process efficiency optimised. That is why a viable and competitive bioeconomy is founded on four principles:

+ effective and efficient use of inputs, including energy, as well as the stages and processes involved in obtaining and processing bioresources;
+ optimum use of resources, exploiting fractions that are currently lost, little used or destroyed, such as organic waste or the utilisation of polluted land for non-food purposes and decontamination, applying an approach based on industrial ecology and integrated, regionalised biorefining (cf. 2B);
+ a switch, wherever feasible on a sustainable basis, to the biological synthesis of useful molecules in confined environments as a substitute for extraction from ecosystems, in order to reconcile sustainable extraction with desired production;
+ organisation of the different uses of the types of organic production extracted, raised or cultivated on land or in aquatic media, without exceeding the system's capacity for sustainable production and notably taking into consideration the needs of the ecosystems themselves.

FOCUS

Practical recommendations for the environmental assessment of biobased chemicals

Since its creation in 2008 in the Association Chimie du Végétal (plant chemistry association) (ACDV) the expert group on Life Cycle Analysis (GE ACV) has endeavoured to encourage operators in the plant chemistry sector to use LCA in support of dual use of this resource.

With the support of the French Energy and Environment Agency (ADEME), this group led the production of a manual to help users of biobased raw materials assess the environmental impacts of their products pragmatically and responsibly. This document offers a novel combination of state-of-the-art LCA and the experience acquired by five manufacturing companies in evaluating their own products. Its recommendations address around twenty frequently asked questions on the specific characteristics of biobased products and comparisons with their fossil counterparts.

This approach took practical form in March 2016, when the French Union of Chemical Industries (UIC) held a one-day event dedicated to the use of LCA, attracting over 50 attendees. A second day will be organised in Paris this year to offer a practical introduction to LCA; it will probably be followed by another event in the Lyon area.

As a complement to this, a "sustainability" expert group was set up in ACDV in 2014 with the aim of providing operators in the plant chemistry sector with a clearer overview of the relevant state of the art for sustainability criteria in this sector, in addition to recommendations for responsible communication on biobased products.

Since its creation, this group has analysed and combined existing reference criteria for the assessment of the sustainability of renewable raw materials and has published a flyer for ACDV members setting out the relevant key messages.

In 2016, the group published a "*Guide to Responsible Communication on Products of Biobased Origin*" [in French] for ACDV members containing general recommendations and more detailed information in sectoral datasheets.

Generally speaking, a sustainable and competitive bioeconomy requires the development and use of the most advanced knowledge where our understanding of biological systems is concerned. Moreover, it is imperative to gather together, apply and perfect the production systems and practices that are most sustainable and compliant with the principles described above. An inventory of the current situation and objectives, including the influence and application of general frameworks (e.g. the CAP, forest management, aquaculture and fisheries) will make it easier to identify and share good practice.
Involvement of the actors in disseminating this good practice may involve pooling the risks associated with the new techniques by adding value to them (e.g. with certification and/or quality labels), and by giving official recognition and rewards to the pioneers.

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The bioeconomy must make use of environmental impact assessments

The fact that a product has a biological origin does not in itself guarantee either its sustainability or its quality, even if its declared primary purpose is to mitigate certain environmental impacts. That is why assessments are essential in order to be sure that the bioeconomy's very objectives are actually being achieved. While remaining accessible to all operators, such assessments require indicators and therefore measurement, traceability and verification, and criteria that must evolve along with advances in knowledge and differences in situations.
Life Cycle Analysis (LCA) provides a holistic approach and can in principle enable comparisons to be made. While LCA has been successfully mastered and applied for industrial processes, its application upstream (in farming, forestry, aquaculture, etc.) has limitations insofar as it yields results that vary extremely widely according to the locations and periods studied, a fact which demands further work on the methods. This type of assessment should be applied on a multiyear basis in order, for example, to take account of crop rotations, and long-term balances must be established for forest cycles, as is beginning to be the case.

FOCUS

Agribalyse: supplying the data for applying life cycle analysis to products from farming

The French Energy and Environment Agency (ADEME) coordinates the Agribalyse® programme in partnership with the French Agricultural Research Institute (INRA), other agricultural technical institutes, the French International Centre for Agricultural Research for Development (CIRAD), agricultural cooperatives and the Ministry of the Environment, the aim being to construct a uniform, transparent database to provide information on the environmental impact of agricultural products. The programme sets out to provide a harmonised method suited to the forms of production in France, along with robust indicators calculated according to the international framework for life cycle analysis (LCA). Since the first version of the database was placed in the public domain in 2013, the data have provided input for numerous projects linked to the environmental improvement of supply chains (eco-design), the study of food-related practices and the environmental protection of consumers, for example. Both data and methods are regularly updated and enriched. This tool thus contributes to the establishment of environmental balances for bioeconomy products from agriculture.

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Assessments of the bioeconomy's effects on the environment need to take the following into consideration:
1. Greenhouse gas balances.
2. Efficient, sparing resource use (direct and indirect consumption of energy, water, phosphorus, rare earths, production areas and systems and the bioresources themselves).
3. Maintenance of ecosystem services (biological aspect) and landscape (cultural aspect).
4. Management of waste, co-products and the recyclability of the finished products.

This system of assessment should be shared at EU level and could be implemented in the context of more operational measures. This qualification is important not only in local contexts but also internationally.

It is also necessary, in the interests of avoidance of distortion of competition and progress generally, firstly, to apply the methods for environmental impact assessment irrespective of the origin of the raw materials and, secondly, to extend them in sectors dependent on non-organic or fossil resources. Such equality of treatment is a major factor for the roll-out of a bioeconomy able to offer competitive solutions. In this way, in the specific case of organic resources the bioeconomy illustrates the desirability of parallel development tracks in the economy as a whole, which, if it is to be viable over the long term, must be generally compatible with the planet's resources and natural regulatory mechanisms.

PUBLIC MEASURES ALREADY IN PLACE

Strategic frameworks

- National strategy for an ecological transition to sustainable development.
- National low-carbon strategy.
- The agroecology project for France.
- National plan for the development of agroforestry.

Operational tools

- National pact against food waste.
- CAP tools: cross-compliance for support payments and greening, agro-environmental and climatic measures, competitiveness and adaptation plan for agricultural holdings.
- Sustainability criterion for biofuels – system of voluntary schemes.
- Criteria and indicators for sustainable forest management and associated management documentation.

2E

BUILDING A DIALOGUE WITH SOCIETY FOR A SHARED BIOECONOMY

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The development of the bioeconomy is likely to lead to major changes in certain activities, involving new jobs and skill requirements, as well as modifications in local areas and daily life. Looking beyond the economic and technical issues, the bioeconomy thus points to societal change. This is so because the goal is to engage significant change in lifestyles by promoting sustainable modes of bioresource production and processing, responsible modes of consumption, with significant reductions in the use of fossil carbon and limits on the global negative impacts of agricultural systems on the environment. While certain aspects of such societal change are imposed by current or expected developments at planetary level (e.g. increasing scarcity of resources, especially petroleum; climate change entailing action to counter its progress; damage to biodiversity due to modes of production and consumption and climate change; urbanisation and a growing lack of farmland, etc.), others on the other hand must be chosen if they are to be implemented effectively (e.g. preference or incentivisation for purchases of biobased products, their economical use, attentiveness to their end-of-life phase).

The inclusive approach of the bioeconomy thus brings with it thinking that can be debated and assimilated by society as a whole. Similarly, the reluctance – or indeed the rejection – sometimes expressed with regard to certain changes associated with the bioeconomy (for example, competition for land use between food and non-food production, modes of production, biotechnologies applied in open or confined environments, the exploitation of the living world, consequences for neighbouring populations, logging operations), raise legitimate questions that it is important to listen to and take into consideration.

This means that the construction of a sustainable bioeconomy must bring on board the vast majority of stakeholders so that ultimately it can become a genuine societal choice. This major objective requires that the debate should be informed by cross-correlated, multidisciplinary and multi-actor expertise, outreach, consultation and transparent decision processes.

Informing and engaging the actors

An initial objective is to inform those involved (including the general public) on current issues and developments in the bioeconomy both in France and around the world, giving due consideration to the diversity of situations across the population (professionals, students, the public at large, European institutions and European partners, etc.). It is an objective that demands a framework for the production of relevant and legitimate knowledge for all actors.

An initial, fairly general level of information is intended to help explain the core principles of the bioeconomy, the advantages of sustainable biobased products and how the different uses of the resources are mutually complementary (in line with the "circular economy" concept).

FOCUS

Ambassadors for biobased materials: engaging and advising the construction industry

In 2010, the French General Directorate for Development, Housing and Nature (DGALN) put in place an action plan to eliminate obstacles to the economic development of supply chains for biobased building materials. To achieve this, various measures were adopted for the training of industry professionals, among them the national roll-out of training for the creation of a network of ambassadors for biobased construction whose core task is to engage, reassure and convince public-sector project owners.

Two initial courses were organised in 2015 and 2016 by the Regional Directorate for the Environment, Development and Housing (DREAL) for the Central/Loire Valley region and the Centre for Human Resources Development (CVRH) in the city of Tours. This training was intended for various public and quasi-public organisations possibly in contact with development project owners and providing advisory and support services for construction projects. To date, around 35 ambassadors have attended three days of training. All have signed the ambassadors' charter and are in possession of a sample kit.

Encouraged by the success of this pilot training programme, the DGALN set out to reproduce the model in other regions. Seven CVRHs declared themselves ready to organise eight training sessions in 2016. The scheme will be renewed in 2017.

www.centre.developpement-durable.gouv.fr/les-ambassadeurs-des-materiaux-biosources-a2171.html

A second, more specialised, level of information relates to statistics on the various bioeconomy sectors, the results of research work and information from actors in the economy and the public (non-profit associations).

All of this could be brought together in specific tools and passed on through vocational education, provision of information and socioeconomic channels. Lastly, these informational efforts will need to be reviewed and adjusted on a regular basis.

Organising debate to ensure informed decisions

The creation of a space for debate with society at large meets the demand for environmental democracy and is crucial to the emergence of a bioeconomy compatible with the aspirations of the French public. This dialogue must set itself a collective objective of ranking the arguments for advocacy.

The arrangements and forums for the debate must match the questions to be addressed. For example, the criteria for objectification of sustainability require debate at EU or even international level; questions of ethics and bioethics, and governmental investment decisions require debate at national level; support for industrial conversions, local economic development and control of undesirable effects at the local neighbourhood level can be dealt with most appropriately at regional, municipal or intermunicipal level. Conversely, some topics, such as changes in designated land use and choices of modes of valorisation of the various natural environments, along with impact assessment, require specific arrangements for public discussion.

While building a consensus is always a possibility at the outset in any debate, it is not necessarily the primary objective insofar as not all involved may share the same hierarchy of values. Due to this, the procedures for addressing disagreements collectively will be an important issue to be dealt with in the course of the discussions.

The outcomes of the debates must inform decision-making, and where disagreement or opposition continues to exist, the responsibility for the relevant choices will fall upon political representatives at the appropriate level of subsidiarity depending on the matters or issues concerned, with accompanying explanatory arguments.

2F

INNOVATION FOR A HIGH-PERFORMANCE BIOECONOMY

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There are very many research and innovation issues relevant to the bioeconomy that relate to more than one discipline; those issues call therefore for systemic, transdisciplinary approaches.

Understanding and assisting changes in global food systems

Food supply systems are fundamental to our societies. They support life and are vital to the health and wellbeing of all citizens; they also have a strong cultural dimension. The bioeconomy must take those dimensions into account.

The proportion of animal products and plant products in the global diet is changing, driven by ongoing demographic and economic shifts. These transitions will therefore have a quantitative and qualitative influence on the residual bioresources available for non-food uses. The factors determining food-related practices and behaviour and their feedback effects on production systems must for this reason be examined in research with regard to their physiological, social, cultural and economic components. Lastly, excessive consumption of inputs in production, processing and food conservation processes, in addition to loss and wastage along food supply chains, demand an overhaul of those systems.

IMPROVE

FOCUS

Valorisation of plant proteins

By 2030, due to an expanding population and rising living standards, world demand for protein is likely to increase by 40%. Alongside this, France and Europe suffer from high levels of dependence on protein imports, especially for animal feed. This means that there is an opportunity for additional growth in this sector. France, given its expertise in the farming, food and protein sectors, is well placed to achieve a leading global position in this market over the period to 2030.

IMPROVE is the first open European platform fully dedicated to the valorisation of proteins. As the fruit of a public-private partnership, it exists to bring together all players in this field.

SAS PIVERT

Révéler l'innovation, du champ à la chimie

FOCUS

PIVERT: the oilseed biorefinery of the future

PIVERT (Picardy Plant Innovations, Teaching and Technological Research) develops innovative products and processes destined for use by manufacturing companies in the chemical and food industries. Set up under the PIA (investment programme for the future), PIVERT is a bridge between the research and industry worlds and is contributing to the development of a competitive French plant-based chemical industry. Its operations are based on an ambitious research programme, GENESYS, a technology centre dedicated to industrialisation, BIOGIS, and a group of manufacturers, CIP. PIVERT also runs an Institute for Energy Transition (ITE), thereby helping to promote a sector of especial excellence in France by contributing to the creation of jobs difficult or impossible to relocate offshore. The company is taking part in the development of solutions aimed at replacing raw materials of fossil origin in the chemical industry, thereby offering new commercial outlets to the farming world and actors in infrastructure technologies, while at the same time enabling chemical companies to add more renewable carbon to their production. PIVERT is also involved in training operators in the sector, identifying needs and helping to implement appropriate solutions. Selected under the PIA and given a quality label by the IAR, the French bioeconomy cluster, PIVERT's ITE receives funding of €63.9m. The ITE also benefits from support from the Hauts-de-France regional authority and the Compiegne conurbation authority (ARC), each of these providing €4m.

The scientific and technical expertise provided by IMPROVE ranges from fundamental research to market placement. IMPROVE's objective is to speed up the commercialisation of new products with comparable or better characteristics than existing products and to support breakthrough innovations. IMPROVE can add value to all European plant proteins and its innovations are essentially intended for the food and feed markets, cosmetics and materials, with six core focuses: native extraction, aggregation and cross-linking, controlled enzymatic fractionation, physiological and functional properties, protein chemistry and consumer interactions.

Awarded a quality label by IAR, the French bioeconomy cluster, IMPROVE is a pooled innovation platform (PFMI) and has been granted funding under the investment programme for the future (PIA) (€2.9m). IMPROVE is also supported by the Caisse des Dépôts (€819,000 in equity) and the Hauts-de-France regional authority (a repayable advance of €1m).

Continuing **research efforts** to develop outlets for chemicals, materials and energy

Potential and actual variations in bio-resource composition and structure are a challenge to the development of industrial processes for their use for purposes other than food.

White biotechnologies and the effort to discover innovative physical and chemical processes together represent a scientific front for opening up new ways of processing biomass from farming, forestry, aquatic resources and biowaste. There is a need to accelerate the development of efficient technologies for biorefinery and conversion into biobased building blocks, materials and products, or into energy, in addition to technologies for the enhancement of the performance of biobased products. Current technical pathways must be reassessed in light of crucial issues for the emergence of the factories of the future and eco-efficient processes (particularly, energy balances, water and greenhouse gas balances, economic balances, closing nitrogen and phosphorus loops and valorisation of co-products and waste). Combinations of physical, chemical and biological mechanisms based on progress in enzymology, nano-biotechnologies, synthetic biology and industrial biotechnologies, should be promoted. It is essential to identify precisely the scientific hurdles to be overcome, especially where microbial ecosystems are concerned, in order to understand their biological foundations, to examine their interactions with substrates and to increase yields and flexibility in use.

Supporting research for more **sustainable production systems** and biomass adaptation

Production must protect habitats or even help restore them (biodiversity, organic matter, soil structure, etc. It is necessary for that reason to design production systems that are more sustainable and to propose more acceptable change pathways. Such system redesign will demand interdisciplinarity between the agricultural and environmental sciences and technologies on the one hand and, on the other, the human and social sciences.

The new modes of production will be based less on inputs than on the use of ecosystem mechanisms which will need to be characterised and understood in order to make better use of them. Such approaches, including those collectively identified in the programme for the agroecology project for agriculture, or sustainable forest management, and which are equally valid for aquaculture, must be applied at scales larger than the individual parcel and across production systems covering entire regions, and focused on the long term.

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Such long-term focuses will depend on the efficiency of organisms (microorganisms, plants, animals) and their interactions. It will be a structurally important goal to improve their capacity to exploit resources (e.g. minerals, water), to develop in habitats where abiotic stresses are greater, more variable and more frequent, to withstand environmental stressors and pathogens and to be in synergy with the biotic environment. This requires deeper knowledge of the fundamental mechanisms (e.g. photosynthesis, metabolisms, associations of organisms, environmental interactions) in conjunction with the mapping of genomes and comprehension of the critical factors for their expression. Use of genetic leverage will contribute to overall efficiency through adaptation to climatic and environmental variations, open up new opportunities for yields, as well as the ex-ante design of harvestable products to match a variety of applications and technologies, without ever losing sight of sustainability. This relates not only to traditionally used species but also just as much to others unused at the present time, which will find a place in more diverse systems of production.

For agriculture, this new form of agronomics will be founded on precision farming that uses digital technology, robotics and decision aids on the one hand and, on the other, balanced and diversified production systems that are better integrated into natural processes (e.g. soils, interactions between species). For forestry, the endeavour will be to adapt species and varieties for climate change and new biomass applications and to develop techniques and forest management pathways that are more effective and protective of habitats, along with innovative processing methods. The development of aquaculture will raise similar issues that need to be resolved, bearing in mind the primary objective of reducing the effects of human activities on environments and biodiversity in aquatic and marine habitats. These revolutionary directions for change will respond to a number of issues of importance in terms of economics (production costs, performance), the environment (water and air quality, energy consumption, etc.) or society and work (comfort, physical stress, social cohesion). The questions of research and innovation relate to the robotisation of agricultural equipment, the optimisation of logistics, the assimilation of information and communication technologies and organisational innovation as well as energy efficiency and the water cycle.

All of the above innovations will need to be made an integral part of reflection on how to increase the use of bioresources, particularly in connection with the national strategy for the use of biomass (SNMB).

FOCUS

Agroecology farm 112: a common innovation platform heading up an R&D network for the surrounding region

Embedded in a local region with farms and agro-industrial facilities, agroecology farm 112 is located on a former military airbase. It is a locus for experimentation and transfer for and by farmers and growers. As an open-innovation platform for the implementation of collaborative, multi-partner projects, from 2017 "*Ferme 112*" will be given the means to host operators in research, development, training, etc. as well as firms active in digital technology and agricultural machinery, start-ups developing new technologies with applications in farming, among others. Farm 112 is a "trial and test area" at the scale of an individual agricultural holding, acting as a collective resource to enable successful handling of the issue of knowledge, innovation and technology transfer to farmers and, in direct conjunction with agro-industrial companies, the development of bioeconomy sectors in the region.

On the ground, in order to address the issues facing agriculture (competitiveness, sustainability, regional development), the principles of agroecology will be put into practice by six farmers working together in a formalised agricultural partnership (SCEA) "*Ferme 112*" (farming the site's 240 hectares). The project is already reality with the following in place:

- five innovative crop systems aimed at (1) improving soil fertility, (2) reducing consumption of chemical inputs and fossil energy, (3) improving crop system resilience and (4) combating climate change;
- one of five national platforms in the SYPPRE inter-institute programme, signing the first partnership agreement with bodies active in applied agricultural research. The Farm 112 project is supported financially by the *Association Agroressources et Bioéconomie Demain* (association for tomorrow's agro-resources and bioeconomy), the national fund for regional infrastructure and development (FNADT) and the national defence restructuring fund (FRED) under a contract for the conversion of decommissioned airbase BA112, the Grand-Est (Alsace Champagne-Ardenne Lorraine) regional authority, the Paris-Reims Foundation and Reims city authority (for access to the land).

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Making use of research for a regionally integrated bioeconomy and sharing value

Analysis of the availability of bioresources at the different geographical levels is a necessity for the development of the bioeconomy. Evaluation of quantities, quality levels and diversity of resources that are usable subject to a range of conditions must go hand in hand with research (cf. 2C). It will be necessary to include biowaste, seeking synergy. Account must be taken of the shift in the direction of agroecology, which broadens the range of types of production and modifies the ways in which they are shared.

The social sciences will help by studying the respective contributions and positioning of the producers, industry, the agrifood sector, bioenergy and biobased chemicals in order to identify both the hurdles and the creative potential, followed by the allocation of value-added along the chain, in addition to defining the dynamics for change. The social sciences will also help determine which support and incentive instruments are most appropriate.

The bioeconomy leads to the emergence of increased needs for representational and modelling technologies, as well as decision aids, based on a process of definition of biological and socioeconomic scenarios. Strategic foresight analyses will be imperative for informed public- and private-sector decisions. Such analyses must notably include scenarios for forward management of the local jobs produced and planning for the accompanying training effort that will be necessary.

FOCUS

Hemp, a driver for the local economy

The municipal federation of Beaumesnil canton ("3CB") covers an area dominated by farming. Seventeen farmers grow hemp, an activity that was hit hard by the termination of supply contracts with the Mauduit papermills (72 France) in 2005. The project for the region in 2009 offered an opportunity to overhaul this local activity.

In 2011, consideration of this issue, with the support of the Chamber of Agriculture and the Eure Prefecture, resulted in the award of a rural excellence cluster (PER) label for the "creation of a hemp valorisation sector". The project exploits synergies between mutually complementary local entities possessing expertise for the production, processing and valorisation of fibres and oils: the grouping of hemp producers, the Le Neubourg flax stripping cooperative and Derivery, a firm manufacturing paints.

Involvement of the above, plus funding granted under the PER (€571,000 out of an investment of €1,955,000, including co-financing from the Upper Normandy regional authority, the European Union and Eure département), provided leverage for the creation of new enterprises: CUMA Chanvrière de l'Eure for the harvesting of both straw and seed, Huiles des Terres normandes for seed preparation and milling. Addition of a production line as part of the stripping process now allows hemp defibration to be carried out locally. All of this has consolidated local agricultural activity. The partner enterprises see stronger competitive performance: a new range of paints based on flax and hemp oils, multipurpose flax/hemp processing lines and a new packaging shop. Ten jobs have been either created or made permanent.

This has allowed hemp production to be kept in the area despite difficult circumstances (major processing facilities have closed down during this period). All those involved are ready to seize new opportunities to help energise the region and protect water resources.

Successfully combining and evaluating multiple innovations in meta-systems

Innovation processes are complex in the field of bioeconomy: they have numerous aspects that relate to equipment, the biological processes used, the types of product, all of which interacts with social organisations involving large numbers of actors. Some innovations go unrecognised, and by the same token unexploited, due to the lack of any multicriteria evaluation or holistic, systemic analysis applied at a significant scale.

Due to that complexity, the bioeconomy inevitably requires a meta-systemic approach for the whole range of innovations, and this radically modifies current research and development practice. Innovations must be made an integral part of production and processing systems more aligned with economic and societal realities. This approach would make it possible to conduct more comprehensive evaluations in order to highlight potential contradictions in terms of benefits, costs and risks. It could be used in "living laboratory" projects that co-construct experimental, participatory and evaluative programmes. This would allow public and collective decisions to be built on scientific, technological and societal foundations validated at the appropriate level, as well as ensuring that support for the relevant transition is more readily accepted.

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Using research to support bioeconomy training

Development of the bioeconomy is essentially reliant on human skills. These often relate to highly specialised disciplines that our educational system takes to a high level in the theoretical, experimental, economic, human and social sciences. The skills needed also relate to abilities to integrate systems that are to a large extent transdisciplinary. Such approaches demand constant efforts to decompartmentalise and to bring disciplines together in a common melting pot. Our national vocational education apparatus still lacks any holistic, integrated approach where the bioeconomy is concerned.

Looking beyond the higher education components, which are well underpinned by research, it is necessary to include knowledge of the bioeconomy's components and issues at an early stage in general and technical training courses. Specifically, technical training in agriculture needs to familiarise future farming and forest-wood professionals with the goals and issues of the bioeconomy, enabling them to take up their roles in these expanding sectors. If the bioeconomy is to become a part of the structure of future economic and industrial activity and, beyond that, of society, it will be necessary to foster comprehension of its issues and methods through life-long grassroots education and by raising the core awareness of the general public. This involves defining the issues and points of consensus and preparing for debate and controversy. Such an approach, which stands at the borderline between education and vocational training, must be undertaken in the regions on the basis of proximity and must engage every component of society.

FOCUS

The *Campus des Métiers et Qualifications*: "plant biorefining and sustainable chemicals"

The *Campus des Métiers et Qualifications* (skills and qualifications campus) helps support, by dispensing training, regional policies for development of the economy and workforce. It is focused on making it easier for young people to enter employment.

The *Campus des Métiers et Qualifications* for "plant biorefining and sustainable chemicals" is an initiative of the Jules Verne University in Picardy (on behalf of Picardy Universities), the IAR bioeconomy cluster, PIVERT and the Union of Chemical Industries in Picardy Champagne-Ardenne (UIC PCA). It is promoted by Amiens educational authority, the Regional Directorate for Food, Agriculture and Forestry and Picardy Regional Council.

All the above will work in synergy across the region to promote the sectors involved in the bioeconomy and more specifically those activities that relate to chemicals and biology.

One of the main objectives will be to build collective projects driven by all players and likely to attract more young people into training that leads on to employment.

Thanks to this new resource, the actors in the bioeconomy will benefit from a comprehensive, organised menu of training courses for the bioeconomy (at levels from high school +3 years to high school +5 years), and will be able to highlight their skill requirements for all those in training or education (schoolchildren, students, individuals in retraining schemes, etc.)

PUBLIC MEASURES ALREADY IN PLACE

Strategic frameworks

- The national research strategy.
- The Agriculture Innovation Plan to 2025 and the Innovation Research Plan to 2025 for the forest-wood sector.

Operational tools

- Funding for research and innovation under the programme of investment for the future (PIA): measures promoted by the French Energy and Environment Agency ADEME (ecology transition demonstrator), the French National Research Agency (ANR) (measures for energy ransition, biotechnology and bioresources, etc.), FranceAgriMer (programme for agricultural and agrifood projects for the future).
- Bpifrance's World Innovation Competition.
- The competitive clusters programme and associated financial support (e.g. the Unified Interministerial Fund (FUI), structural projects for competitiveness (PSPC).
- GRAINE call for proposals from ADEME.
- ANR calls for proposals and specifically bioeconomy-related challenges.

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IN SUMMARY, TRANSVERSE PROJECTS FOR COLLECTIVE PROGRESS

In addition to addressing the specific goals and issues described above, the French strategy for the bioeconomy will be based on four major transverse projects:

1. UNITING, BREAKING DOWN COMPARTMENTALISATION AND CO-CONSTRUCTING A SYSTEMIC APPROACH

► Between economic actors, civil society and political leaders: to build a shared understanding of the bioeconomy and its goals and issues, constructing a project for a sustainable society.

► Between different economic sectors: to seek out and develop synergies with a view to a resilient, effective circular economy.

► Between scientific disciplines: to progress in understanding and handling systemic complexity, adapting the criteria for professional recognition of research workers and institutes.

► Between the different actors in research, development and vocational education: to cooperate more closely and more effectively for swifter innovation and inclusion of all the bioeconomy's social, environmental and economic dimensions, notably making use of interdisciplinary combinations.

2. SUPPORTING THOSE ENGAGED IN THE TRANSITION

► Support for, and evaluation of technological, social and organisational innovation on diversified pathways in order to make progress towards higher-performing systems able to meet our needs for the long term.

► Development of incentive measures for the location of new industries and activities in regions in response to the goals of the bioeconomy for the marketing of bioproducts, and public awareness of those activities.

► Encouragement and assistance for the conversion of enterprises and concerted regional projects.

► Development of tools for evaluation and forums for consultation to facilitate the settlement of possible disputes.

► Development at regional and national levels of tools for monitoring and ex-post evaluation.

3. IDENTIFYING, ORGANISING AND PROMOTING APPROPRIATE REGIONAL LEVELS

► For disseminating information, education and training, and for involving the public.

► For organising societal debate and decision-making.

► For co-constructing balanced regional projects as sources of jobs and ecosystem services in conjunction with regional strategic tools.

► For tracking the economic, social and environmental impacts of planned and completed programmes.

► For developing transnational and/or international cooperation and highlighting French accomplishments.

4. MEASURING, ANALYSING AND IMPROVING BIOECONOMY IMPLEMENTATION

► Observation and measurement of the development of the bioeconomy on the basis of shared criteria and procedures for monitoring and ex-post evaluation.

► Evaluation of the sustainability of production and processing activities for biobased products and advocacy for the methods and evaluation criteria at EU and international levels.

► Multicriteria evaluation of the impact of biobased products for the human population and advocacy for the methods and evaluation criteria at EU and international levels.

► Evaluation of the efficiency of support measures.

► Adaptation of the programme in accordance with evaluation outcomes.

3

ROLLING OUT THE NATIONAL BIOECONOMY STRATEGY

The bioeconomy strategy brings with it the idea of radical change not only in the operation of our economy but also in our society and in the management of the systems on which it is founded. The goal of that change calls for support from and for all those involved. That support must take the form of coordinated, operational application of the strategy described above.

The strengthening of the French bioeconomy must be seen in two temporal contexts, with a concern for the coherence of the measures applied on both time scales:

➔ a short- to medium-term horizon in which the aim will be to pursue existing, and trigger new innovations and changes, calling on the available resources (research, technology, finance, biomass),

➔ a medium- to long-term horizon, marking the point at which the bioeconomy will become a major component of the post-petroleum society, and where the issue will be the sustainable coexistence of highly diverse uses for bioresources.

The first of these horizons calls for practical measures to support and encourage the implementation of concrete projects.

The second requires the construction over time and in all relevant domains of a bioeconomy philosophy – economic, public, societal – that reflects the necessary changes in the economy as a whole.

Irrespective of the timeframe, long or short, the roll-out of the French bioeconomy must be in phase with the European project in order to allow France to exert greater influence over European and global choices for the ecological and energy transitions.

BRINGING TOGETHER AND FOSTERING DIALOGUE BETWEEN THE ACTORS FOR THE ROLL-OUT OF THE STRATEGY

The bioeconomy encompasses a wide variety of activities: upstream and downstream along all the value chains and involving highly diverse uses. It calls for close collaboration between the public authorities, economic agents and the population at large.
Bringing the actors together and leading collective consideration of the issues is therefore a distinct and fundamental focus for strengthening the bioeconomy. Shared governance of the national bioeconomy strategy is desirable, based on an approach that is to a great extent interministerial and includes all stakeholders and actors in society in the informational, consultation and decision-making processes on topics relevant to the collective interest.
To achieve this, the following is proposed:

➔ To establish for the long term and strengthen collective action by setting up a bioeconomy strategy committee comprising representatives of the different sectors which, while interconnected, are nevertheless scattered across a number of trades and industries. The bioeconomy strategy committee would have as members the relevant sectors, the public authorities and representatives of society. Its remit would be to ensure the coherence of public measures and policies on the bioeconomy, clarifying the interactions that may exist between them; to facilitate dialogue between official departments and economic sectors; to clarify ongoing changes in the strategy and in the action plan that flows from it and to design a procedure for the monitoring and ex-post evaluation of operations and measures.

➔ To consider regional roll-out of the bioeconomy: the strategy committee will act via the government's decentralised departments and agencies wherever necessary to build the programme for and with local authorities and especially regional councils already engaged on the subject or willing to begin consideration of it. Stakeholders are also encouraged to play a role as ambassadors to regional actors for the bioeconomy and the French strategy. Exemplary programmes in the regions can be fostered and capitalised in the national dialogue. Reflection with willing regions could be undertaken in order to work on a common framework for action at this level.

DEFINITION OF AN ACTION PLAN

In order to ensure effective development of the bioeconomy, it is proposed to set out the broad strategic lines of an action plan. The main stages in the establishment of such a plan are as follows:

Stage 1. A broad survey of measures linked to each of the six core themes, making a distinction between what has been done and what might be done. This inventory will be based on previous discussions or on new contacts if necessary. *Due: Q3 2016*

Stage 2. Prioritisation of the measures listed and preparation of datasheets for the new measures. *Due: Q1 2017*

The datasheets for measures must contain:

- a description of the measure and the timetable for its implementation;
- the targets and the means for measuring how far they have been achieved;
- an evaluation of the impacts on existing systems and the solutions for limiting negative effects;
- the links with existing measures and supplementary measures that can be added;
- the individual in charge of the measure, along with the partners and the resources deployed;
- distribution to all economic sectors of information on targets and methods;
- organisation of monitoring, ex-post evaluation and feedback.

Stage 3. Tracking the action plan based on efforts to link up with schemes already in place and contributing to it (e.g. strategic sector contracts) and specific tracking of new measures. *Due: first meeting of the monitoring committee in Q3 2017 followed by annual meetings.*

PLAYING AN ACTIVE PART AT EU AND INTERNATIONAL LEVELS

The bioeconomy is the focus of action and broad-based discussions at EU level. The Commission has had a bioeconomy strategy since 2012. A number of measures have been implemented and followed by various French players. France's active participation in EU and international policymaking, discussion and decision-making bodies in the area of the bioeconomy is a major factor in the national strategy; such participation will make it possible to advocate French views in all these bodies and, reciprocally, to enrich national thinking based on the experience of partner countries. The European Commission has planned for an evaluation and revision of its strategy as one of the measures in its "Circular Economy Package" adopted in December 2015. Given the extent of its agricultural, forest and fisheries resources, and its excellence in the area of technical and industrial innovation and the development potential of its regions, France should play an active part in this.

For this, it is proposed:

- to benchmark the various European strategies,
- to set up a network of French actors engaged in the bioeconomy at European level in close conjunction with the strategy committee,
- to play an active role in European proceedings and consultations.

At international level, the bioeconomy approach is also being organised, driven by the OECD, the International Energy Agency, the United Nations Environment Program and the FAO. France must make its contribution here also, in conjunction with European actors.

More precisely:

MAKING BIOECONOMY PRODUCTS A MARKET REALITY	*The action plan and programmes already under way should make it possible …*	…to identify the markets in which the bioeconomy can provide solutions and apply leverage (e.g. tax, regulations, standards) in order to facilitate market penetration.
SUPPORTING THE TRANSITION TO A HIGH-PERFORMANCE, INNOVATIVE AND SUSTAINABLE BIOBASED INDUSTRY		…to encourage roll-out of innovative industrial tools in the regions.
PRODUCING BIORESOURCES SUSTAINABLY TO MEET THE NEEDS OF ALL BIOECONOMY VALUE CHAINS		…to produce and use more bioresources without compromising future production capacity.
GUARANTEEING A SUSTAINABLE BIOECONOMY		…to consider the frameworks for evaluation of the bioeconomy and to encourage best practice.
BUILDING A DIALOGUE WITH SOCIETY FOR A SHARED BIOECONOMY		…to put in place a dedicated strategy for ensuring the widest possible awareness of the bioeconomy, relying on the actors involved, and to initiate a societal debate on what it can offer.
INNOVATION FOR A HIGH-PERFORMANCE BIOECONOMY		…to consolidate the underpinning of innovation that benefits the bioeconomy, to initiate transverse efforts and to link up with vocational education.


A STRATÉGIE
BIOECONOMY
FOR FRANCE