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MINISTÈRE
DE L'AGRICULTURE
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DE LA PÊCHE
DE LA RURALITÉ
ET DE L'AMÉNAGEMENT
DU TERRITOIRE

PROSPECTIVE ANALYSIS AGRICULTURE ENERGY 2030

AGRICULTURE AND THE CHALLENGES OF ENERGY

SYNTHESIS

CENTRE FOR STUDIES AND STRATEGIC FORESIGHT
CEP

General Secretariat - Department of Statistics and Strategic Foresight
Ministry of Agriculture, Food, Fisheries, Rural Affairs and Spatial Planning

2010

INTRODUCTION

The present overview document contains the main results of the *Agriculture Energy 2030* prospective study, based on the work of the group led by the CEP [*Centre d'études et de prospective* / Centre for studies and strategic foresight] at the Ministry of Agriculture, Food, Fisheries, Rural Affairs and Spatial Planning.

Energy in agriculture is all too often seen as a purely cyclical problem whereas it is a major issue for the future due to its economic consequences for agricultural holdings, its links with environmental and climatic issues, and its influence on food supply chains and spatial planning.

Based on the scenario method, this analysis initially involved describing the whole range of links between agriculture and energy in France and organising them into a system of variables before going on to draw up an inventory of the knowledge available.

Starting out from this diagnostic approach, the group constructed four scenarios over the period to 2030: "Regionalisation and sobriety to confront the crisis", "Twin-track agriculture and energy realism", "Health Agriculture with no major energy constraints" and "Ecological agriculture and energy savings". These scenarios do not form an exhaustive panorama of all possible developments of the agriculture-energy system - they are rather formalised images of what the future might hold. However, quantification and comparison of the scenarios has led to the identification of major room for progress in energy efficiency in French farming.

By helping gain greater awareness of future difficulties and issues or, conversely, opportunities to be grasped, these scenarios provided input for the strategic analysis phase, the concluding stage of this exercise, and the identification of general objectives and levers for public action.

1. AGRICULTURE & ENERGY: A SUBJECT FOR STRATEGIC FORESIGHT

1.1 Energy at the heart of French agriculture

The energy issue is of major importance for the future of agriculture in France, although it receives relatively little analytical attention. To begin with, control of energy consumption is an economic issue for agricultural holdings, which consume energy both *directly* (fuel oil, electricity and natural gas) and *indirectly* (energy for the manufacture and shipment of farm inputs). All in all, French farming consumes around 11 Mtoe a year (5.3 Mtoe directly and an estimated 5.4 Mtoe indirectly[1]). Taking all French holdings together, expenditure on fuel and lubricants represents 8.3% of intermediate consumption[2], fertilisers 13.1% and livestock feed 21.6%[3]. The share of this consumption in production costs varies widely according to the type of farming (TF): 23% for intermediate consumption relates to fertilisers and soil improvement for cereal and protein crops; 67% in the case of feed purchased for granivorous livestock holdings[4] between 2005 and 2008. For an identical TF, there are also wide variations between production systems. The prices for these inputs may vary widely, reflecting that of fossil fuels. A high oil price can for this reason have major consequences for the economic balance of holdings and it is impossible to rule out a difficult situation due to the "double whammy" of low farm prices and high energy prices.

The energy issue also involves logistics, the organisation of agricultural supply chains and the pattern of distribution of farming activities across regions. This is so because the distances separating production areas, consumption areas and sources of input supply are reflected in energy consumption.

Moreover, energy and climate are intertwined issues. Agriculture is indeed in a position to contribute to national targets for combating global warming by reducing its emissions, producing renewable energy and sequestering carbon in the soil. In addition, it is possible that ambitious climate and environment policies may increase fossil fuel prices.

1.2 A collective and systemic approach

The links between agriculture and energy are complex and their evolution will not be linear. The CEP has therefore chosen to address this subject using a collective approach based on the scenario method. The *Agriculture Energy 2030* group brought together around forty participants with a wide range of skills and backgrounds from concerned ministries (Agriculture and Fisheries, Sustainable Development), public agencies (ANR, ADEME, FranceAgriMer), technical

institutes (CTIFL, IFIP, *Institut de l'élevage*), the farming world (FNCIVAM, FNCUMA, SAF), research bodies (CEMAGREF, INRA), civil society (FNE) and the private sector (Total, ANIA).

The present exercise is centred on agriculture, that is to say the conditions and detailed procedures for the production and primary processing of agricultural resources on the farm, including agriculture's social, economic, cultural and environmental functions. It leaves both fisheries and forestry out of account. The agrifood and retail distribution industries are also excluded as core components of the exercise. In addition, a decision was taken to take climate change into account only insofar as it has a direct link with energy: greenhouse gas (GHG) emissions caused by direct and indirect energy consumption and renewable energy production. Issues relating to the production of biomaterials and bioproducts have also not been subjected to detailed analysis. And lastly, it was decided to restrict the analysis to metropolitan France given that France's overseas territories have very specific agricultural and energy features.

The choice of timeframe, 2030, stems from a compromise between the desire to set aside cyclical effects on the one hand and, on the other, the necessity of working with a timescale sufficiently close to the present to be manageable.

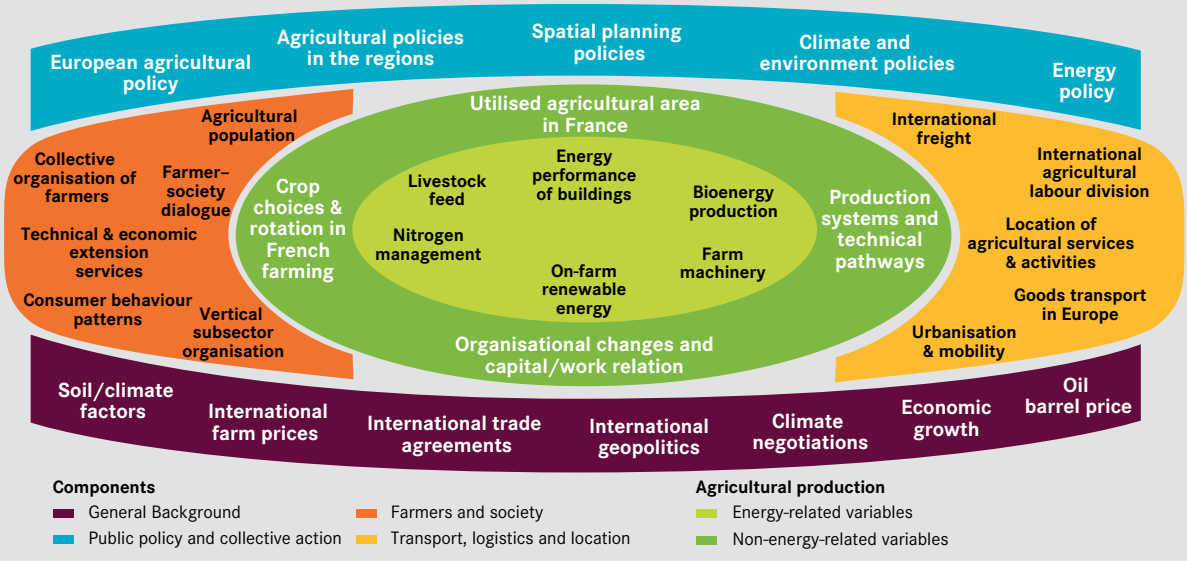
Starting out from this basic framework, the *Agriculture Energy 2030* group identified 33 variables relevant to an understanding of the development over time of the agriculture-energy system, these being categorised in five component groups. At the heart of the system are, quite naturally, the variables for agricultural production, with a distinction between those with a direct link to energy and those that are more agronomic in character. Another component, termed "Farmers and Society" is positioned upstream of this core. The component "Transport, Logistics and Location" is better positioned downstream of agricultural production. The system in its complete form includes two more general components: "Public Policy and Collective Action" and "General Background".

A study card was created for each variable[5] containing a number of hypotheses as to its future development. This exploratory work was based on an identification of past trends, emerging trends and the main areas of uncertainty to be considered when looking forward into the future. Proceeding very conventionally, these hypotheses were combined for each component to produce micro-scenarios and those micro-scenarios were then themselves combined in order to arrive at general scenarios. For greater consistency and to cast a more informative light on the issues surrounding agriculture and energy, the general scenarios were quantified using Climagri[6], which enabled the estimation of French farming's production, energy consumption and GHG emissions in 2030. These scenarios are not predictions of the future, and are even less an expression of the preferences of the *Agriculture Energy 2030* group or the French Ministry of Agriculture. They are formalised conjectures, the purpose of which is to alert actors and decision-makers. They are presented here very succinctly; the complete versions are to be found in the full report.

1. According to a report by the French energy agency, ADEME, to be published in 2011.
2. Not including household consumption.
3. National agriculture accounts 2009.
4. FADN: averages over the period 2005 to 2008.

5. Eleven cards have been published on the Ministry of Agriculture website: http://agriculture.gouv.fr/agriculture-energie-2030#2
6. "Climagri" is an experimental calculation tool created by the French energy agency, ADEME, and was used for this study.

Agriculture Energy 2030: system structure



Source: CEP, 2009

2. FOUR SCENARIOS TO 2030

Scenario 1: Regionalisation and sobriety to confront the crisis



This scenario has two drivers: a profound energy crisis undermining conventional business models and rising importance for regional governmental authorities. The international context is tense and focused on protection of domestic markets. Around 2020, the management of public policies is entrusted to a greater extent to regional authorities, which are seen to be closer to the development issues of their territories. The image that results from this in 2030 is that of a profoundly changed agricultural world which, faced with a series of external constraints (energy prices at sustained high levels, a budget crisis and loss of legitimacy for central government, a withdrawal into home regions and a contraction in international trade) adapts as a matter of urgency by adopting a strategy focused on the local level, this being necessarily accompanied by major institutional reform.

The growing self-sufficiency of production systems inevitably involves a reduction in inputs, more extensive livestock farming and diversification of production. The search for complementarity between crops and livestock or between types of crop across holdings and regions becomes a general reality. By 2030, this transformation is not harmonised across the whole of France and there are major regional disparities. Despecialisation and lower production lead to limited export capacity. French farming makes major reductions in its energy consumption (down by 32%). Renewable energy produced on the farm supplies additional income but its development depends on local potential and dynamics. Extensive use is made of biomethanation and wood-for-energy, but expansion of biofuels continues to be held back by high agricultural prices.

THE MAIN STAGES

2010-2015
Gradual rise in oil barrel price

2016-2020
Difficulties in obtaining supply of liquid fuels and nitrogen fertiliser

2020-2030
Diversification and relocation of production systems

2010-2015 → 2016-2020 → 2020-2030

2015
Very high levels of pressure on the oil market (barrel price above $200)

2018
Chambers of agriculture assimilated into regional government authorities

2020
Institutional reform in France, agricultural capacity transfer to the regions

2025
A Europe–Regional Authorities "New Deal" focused on energy diversification and modal transfer.

AGRONOMIC AND ENERGY-RELATED CHARACTERISTICS

- Expansion of area under grass to the detriment of major field crops
- Major expansion of areas under protein crops (threefold increase)
- Major reduction in mineral nitrogen inputs (–40%)
- Significantly reduced yields (–20%)
- Major development of biomethanation and pure plant oils (PPOs)

WEAK SIGNAL[7]

Regional authority investment in agriculture

The regional government authority for Poitou-Charentes provides support for up to 40% of the cost of investments and collective projects mobilising farmers wishing to increase their energy and protein self-sufficiency: plant oil presses, filtration equipment and storage facilities for the production of unprocessed plant oil for use as vehicle fuel or for combustion, equipment for adding value to by-products (cattle cake) and products derived from biomass for animal feed. http://www.poitou-charentes.fr/files/guide_aides/agri-agroressources-reglement.pdf

On 1 March 2010, the regional government authority for France's Centre region formed "SelfBioCentre", a SCIC (multi-stakeholder cooperative addressing collective interests in a territory). This will be responsible for supplying organic products to the 120 canteens in the region's high schools and vocational training centres. The target is 1.5 million organic meals served by 2013. Alongside this, the region has opened a fund to speed up farm conversion to organic methods. http://www.bio-centre.org/index-3-106.html

7. A "weak signal" is a fact (e.g. an event, an announcement, a decision) that has occurred recently and seems to confirm the scenario described. It is a warning or an indication that seems to herald certain new realities. Nevertheless, not all advance symptoms turn into future trends.

Scenario 2: Twin-track agriculture and energy realism

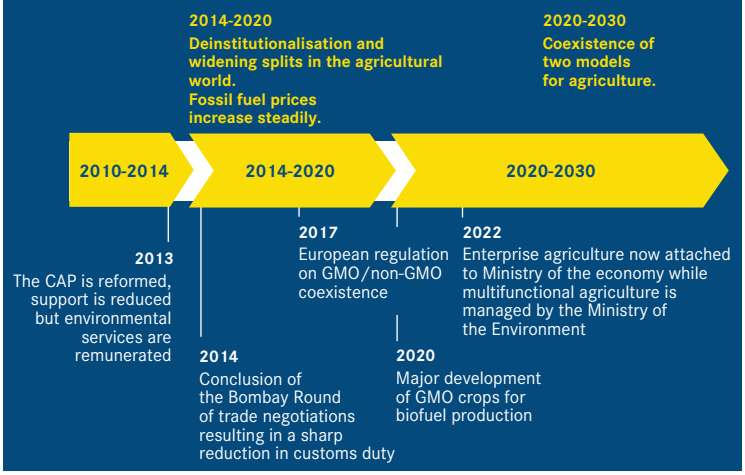


Against a backdrop of high energy price volatility and further trade liberalisation, a reduction is observed in public support for agriculture and a refocusing on remuneration for the public goods provided by agricultural activities. These changes have very different impacts on holdings according to whether or not they gear themselves up to meeting local demand for local supply and provision of public amenities. In 2030, two forms of agriculture exist side by side:

- "Enterprise agriculture" (mainly on the plains in France's north, centre and west). These farms seek to be competitive and position themselves on export markets. Intensification and restructuring result in a high-precision, high-input model of farming. Energy optimisation on these farms is a response to economic logic and is benefited by private-sector market supply of technology and advisory services.
- "Multifunctional agriculture": these farms diversify their activity and receive remuneration for the environmental services they provide (water, biodiversity, landscape, carbon storage). Their main activities are extensive livestock, organic and mixed crop-livestock farming. Such holdings adopt strategies focused on self-sufficiency and low energy use close to those in Scenario 1.

Overall, there is little change in direct or indirect energy consumption. Renewable energy production expands moderately, with investment held back by price volatility. Biofuels develop more strongly in the context of integrated and innovative industrial sectors.

THE MAIN STAGES



AGRONOMIC AND ENERGY-RELATED CHARACTERISTICS

- Expansion of 18% in areas under cereals and oilseed crops (biofuels) to the detriment of pastures
- Mineral nitrogen inputs unchanged
- Increased cereal crop yields (approx. 1% per year)
- Shrinkage of bovine herd (–17%)
- Major development of GMOs and biofuels

BREAK POINT[8]

The break-up of agricultural unionisation

The break-up of agricultural unionisation is an institutional factor that may accelerate the emergence of twin-track agriculture as envisaged in this scenario. The growing impossibility of maintaining unity of representation and interests within the farming world is indeed leading many observers to predict a gradual weakening of agricultural unity. The refocusing of support following the 2008 CAP Health Check has thus led to great tension within the majority farm union.

"Agricultural unionisation: from proclaimed small farmer unity to pluralism" [in French], Transrural no. 310 (2006).

"Union representation might need to see things a little differently" [in French], interview with Jean-Michel Le Métayer, AgraPresse, 15/02/2010.

8. A "break point" is defined as an unexpected fact (e.g. an event, an announcement, a decision) that might occur and take the relevant scenario away from its expected course. Its level of probability depends on period and domain. A break point may be negative and lead to crisis or it may well be positive and lead to accelerated change in a given system.

Scenario 3: Health Agriculture with no major energy constraints



In 2030 urban consumers, more numerous and more influential, with the backing of the large retail chains, have succeeded in imposing a major reduction in the use of pesticides by agriculture on the grounds of protection of human health rather than protection of the environment. In the absence of major energy constraints, and against the backdrop of weak environmental policies, urban sprawl, dominance of road transport and competition between large cities all continue. Agricultural supply chains are shaped by their downstream components, with labels and mandatory specifications becoming highly prescriptive with regard to reduced pesticide use. Producers adjust more or less well, with some sectors being impacted negatively by this new constraint. The most isolated rural areas experience significant abandonment of agriculture. Conversely, the major cities invest in periurban farming to meet demand for green space and local food supply. An agricultural model involving integrated pest management has developed, specialised and technically sophisticated, and aiming at high levels of production while at the same time making significant reductions in pesticide use. Alongside this, organic farming develops significantly. In the absence of any major constraint in terms of policy or energy pricing, the result is a slight fall in overall energy consumption, since the decrease in inputs is partially offset by an increase in use of agricultural machinery. Biofuels expand strongly, driven by the early arrival of second-generation technologies.

THE MAIN STAGES

2010-2020
Sharp rise in food and health concerns

2020-2030
Movement in fits and starts in the direction of an integrated production model

2010-2020 → 2020-2030

2013
The CAP is reformed, and support reduced

2014
Publication of disappointing mid-term results for the Ecophyto plan; a Zero Pesticide label is launched by a large retail chain

2016
National food & health plan: lower VAT on fruit and vegetables, tax on high-fat/high-sugar products, reduction in pesticides

2019
Rapid industrial deployment of 2nd generation biofuels

AGRONOMIC AND ENERGY-RELATED CHARACTERISTICS

- Sharp reduction in the use of pesticides and moderate decline in nitrogen deliveries (–15%)
- Crop choices unchanged, oilseed and protein crops expand
- Yields unchanged
- Decrease of bovine herd (–10%) but increased milk yields
- Major development of 2nd generation biofuels and PPOs

WEAK SIGNAL

The big retail chains play a prescriptive role in agricultural production

In the UK, chains such as Tesco and Sainsbury's have recruited agronomists to inspect farms and organisations storing basic agricultural commodities and make sure consumers are aware of this through the messages on supermarket shelves.
See for example http://www.pleinchamp.com/article/detail.aspx?id=39061

The Bonduelle group has recently launched an experimental programme for the reduction of pesticide use for open-air growing of vegetables. This should lead to lower use of synthetic chemicals, thanks notably to sophisticated mechanical weeding techniques.
The programme also emphasises decision aids, crop diversification and genetics. Good practices of this kind have been implemented on eight pilot farms in Picardy. After the end of the trial period, duration five years, the programme will be extended to all land farmed by the Bonduelle group: 100,000 hectares under vegetables, one-third in France, one-third elsewhere in the EU and the remaining third around the world.

Scenario 4: Ecological agriculture and energy savings



Towards 2015, the need to make sharp reductions in the environmental impact of human activity and the opportunities opened up by this new challenge lead to a consensus in the developed world and begin to make their mark in the emerging countries. European and French households adapt their patterns of consumption out of concern for preservation of the environment and in response to prices that now include the environmental cost of products. The implementation in 2016 of a common EU-US CO_2 market with carbon offsets against leakage at their borders triggers a massive movement towards ecological modernisation. In this context, agriculture, like every other sector of the economy, evolves in the direction of new production models with smaller impacts on the climate and the environment, supported by reformed agricultural policy. This change in model is however both difficult and gradual. There is initial resistance to it in the farming world and it requires major changes in the whole agri-food system. From 2020 on, French agriculture moves in the direction of an ecologically intensive model on the wide cereal-growing plains of the country, making use for example of crop diversification, general use of nitrogen-fixing crops at the beginning of rotation sequences, and zero-tillage. In hilly and mountainous areas, farmers receive remuneration for environmental services and are encouraged to seek greater self-sufficiency at the level of the individual holding (diversified systems based on mixed-crop-livestock farming) or across whole regions (complementarity between holdings). Biomethanation and renewable energy production develop strongly.

THE MAIN STAGES

2010-2015
Rising levels of environmental concern in Europe and the United States

2020-2030
A transition in agriculture in terms of energy and environment

2010-2015 | 2015-2020 | 2020 -2030

2013
Food crisis after three years of very poor harvests due to drought

2016
EU–US Climate Alliance is signed

2017
A major refocusing of the Common Agricultural Policy on a goal of ecological intensification

2021
Creation of the World Environment and Climate Organisation

2025
The oil barrel price stabilises around $60 (excluding carbon tax)

AGRONOMIC AND ENERGY-RELATED CHARACTERISTICS

- Very significant increase in protein crop area (sixfold) and yields
- Zero-tillage sowing on 30% of cereal crop area
- Very sharp reduction in mineral nitrogen inputs (–60%)
- No change in yields or herd sizes
- Very strong development of renewable energy production, especially biomethanation

BREAK POINT

Major changes in conceptions of progress and wealth

Looking beyond the greening of our modes of production and consumption, it is possible to imagine a more thorough-going change in conceptions and aspirations where progress is concerned. The idea of prosperity without growth, no longer based on individual economic wealth and responsive to a need for a slowing of the pace of society, could emerge and lead to a break point in terms of economic functioning and collective organisation.

"Prosperity without Growth? - The transition to a sustainable economy", report by the UK Sustainable Development Commission, 2009.

SCENARIO OVERVIEW AND COMPARISON

	SCENARIO 1 Regionalisation and sobriety to confront the crisis	SCENARIO 2 Twin-track agriculture and energy realism	SCENARIO 3 Health Agriculture with no major energy constraints	SCENARIO 4 Ecological agriculture and energy savings
General Background	**Energy and climate crisis** Contraction in trade Oil prices at sustained high levels	Conventional growth and market-based regulation **High volatility and upward trend in oil barrel price**	Defensive strategies, competitive specialisation **Oil prices stabilise**	Increased international cooperation **High carbon price**
Transport and agricultural sector organisation	Relocation across regions Rebalancing of major production areas	Regional specialisation and widening disparities Increased flows	Growth and innovation in transport **Very strong influence of downstream components on supply chain organisation**	Refocusing on Europe and modal transfers Ecological modernisation of sectors
Public policies	**Major rise in power of regional authorities** Mosaic of energy, agriculture and environmental policies	Contraction in public action **Sharp cut in agricultural support but remuneration for environmental services**	Metropolisation and moderate efforts on energy and climate Ambitious policy focus on healthy food	High priority for the environment Integrated, ambitious public policies
Farmers and society	**Diversification and multifunctionality** Attachment to local area, local development	Deinstitutionalisation of farming Twin-track agriculture	**Focus on nutrition and health issues** Restructuring and productivity	**Strong environmental consensus** Mobilisation of farmers, consumers and public authorities
Emblematic model for agriculture	Mixed-crop and livestock farming	**Twin-track agriculture: enterprise agriculture vs. multifunctional agriculture**	**Integrated, very technically sophisticated agriculture**	High environmental value agriculture
Agriculture and energy	**Energy self-sufficiency and sobriety:** Protein crops, PPOs, farm consumption of renewable energy (inc. biomethanation), exchanges of co-products between neighbouring farms	Enterprise agriculture: economic optimisation, major biofuel development Multifunctional holdings: search for self-sufficiency (see scenario 1)	Moderate reduction in inputs, major development of 2nd generation biofuels	**Ecological intensification:** Biomethanation, pulse plants, varietal innovation, zero-tillage, trade in co-products 2nd generation biofuels and high production of renewable energy
Changes in utilised agricultural area from 2006	Expansion in areas under grass to the detriment of major field crops Threefold expansion in areas under protein crops	Increase of 18% in areas under cereals and oilseeds (biofuels) to the detriment of pastures	No change in choices of crop but expansion in oilseed and protein crops	Very sharp expansion of areas under grass and protein crops
Variation in production of French farming compared with 2006	Forage crops: –3% Cereals and protein crops: –37% Meat: –12% Milk: +6%	Forage crops: –22% Cereals and protein crops: +28% Meat: –6% Milk: –5%	Forage crops: –7% Cereals and protein crops: ±0% Meat: –3% Milk: +25%	Forage crops: –6% Cereals and protein crops: –17% Meat: –12% Milk: +4%
Energy consumption by French farming	7,226 ktoe **(–32% compared with 2006)**	9,797 ktoe **(–8%)**	9,414 ktoe **(–12%)**	7,325 ktoe **(–32%)**
GHG emissions by French farming (including soil sequestration)[9]	76 MTeq CO_2 **(–35% compared with 2006)**	117 MTeq CO_2 **(±0%)**	100.8 MTeq CO_2 **(–14%)**	45.9 MTeq CO_2 **(–61%)**

9. The method for calculating GHG emissions due to changes in land use is detailed in the complete report.

Each scenario leads to energy savings compared with 2006 (the year of reference): at the very least, direct and indirect consumption of energy declines by 8%. These reductions are due to energy optimisation for farm equipment (10% less fuel oil consumption by 2030), investment as early as 2010 in low-energy and renewable energy systems (10% less energy consumed in greenhouses and livestock buildings), the spread of these technologies and improvement in the energy efficiency of certain industrial processes, especially in the mineral fertiliser industry (10% less energy consumed between 2010 and 2030).

Looking beyond these downward trends, the scenarios indicate that if concerned actors are not mobilised and if public policies are not adjusted, the dependency of French farming on fossil fuels will remain high. The Energy-Climate Package provides for a cut of 20% in energy use in 2020 compared with 1990. Agriculture is capable of achieving this target in scenarios 1 and 4 only. Energy consumption by French farming varies widely from scenario to scenario, which illustrates the wide room for manoeuvre for reductions in the consumption of fossil energy in farming. Variations in consumption of mineral nitrogen and imported cattle cake for animal feed explain these results to a great extent. Direct energy use is also a key component, and the main discrepancies between the scenarios relate to fuel consumption.

Three main areas offering room for manoeuvre are thus highlighted: reduction in inputs of mineral nitrogen, improvement in protein self-sufficiency, and reduction in fuel oil consumption.

3. STRATEGIC ANALYSIS AND LEEWAYS FOR ACTION

3.1 Four general objectives and thirteen operational objectives

Strategic foresight is not simply an exercise in pure imagination: it has a duty to be pragmatic, placing forward vision at the service of action. After exploring *probable* futures, it is therefore appropriate to think about *possible* strategies. In order to do this, the working group has chosen to refrain from ranking the scenarios in order of greater or lesser probability, feeling that such rankings, often based on shaky foundations, could be detrimental to the rich wealth of lessons to be drawn from the foresight exercise. It preferred to consider the four scenarios as offering, when taken together, a richly detailed and realistic picture of probable future developments in French agriculture and that recommendations should be made on the basis of that general picture.

The lessons of the exercise have therefore been translated into four broad, general objectives for public action by the ministry responsible for agriculture and concerned partners, and then used to define thirteen operational objectives (see box opposite). Those objectives constitute the shared vision of the *Agriculture Energy 2030* group regarding the issues and choices to be given priority over the medium term, irrespective of the scenario for the future. They relate to the reduction of energy consumption both at the level of farm holdings and across production regions, and to the production of renewable energy by the agrifood industry. Achievement of these three objectives faces major technical challenges: for this reason, a final resource-focused objective has been defined for research and development (R&D) and the dissemination of innovation related to energy issues in agriculture.

4 GENERAL OBJECTIVES
13 OPERATIONAL OBJECTIVES

Reduce consumption of fossil fuel energy and improve farm energy efficiency
- Reduce dependence on mineral nitrogen
- Reduce dependence on imports for livestock feed
- Reduce farm consumption of fuel oil and gas
- Design and promote low-energy agricultural buildings and equipment

Reduce consumption of fossil energy and improve the energy efficiency of regions and agricultural supply chains
- Reduce waste over the entire food supply chain
- Foster complementarity and local trade between types of production at regional scale
- Optimise logistics and encourage modal transfer for agricultural inputs and products
- Guide demand for food towards products with low fossil energy content

Make French agriculture a driving force in the development of sustainable and renewable energy sources
- Ensure development of sustainable bioenergy productions
- Develop production and internal on-farm consumption of renewable energy (biomethanation in particular)

Foster research & development and the dissemination of innovation related to energy issues in agriculture
- Support innovation for energy performance and implement a dynamic system of assistance
- Develop R&D and agricultural research into energy issues in agriculture
- Train all agricultural actors in energy issues

3.2 Strategic analysis

Each of these operational objectives has been subjected to a strategic analysis involving an identification of the resources and constraints that structure the actors' field of action and the means for action available to them. The *Agriculture Energy 2030* group was able in this way to sketch out "come what may" strategies, that is to say focuses and leeways for action that remain valid no matter what the future development of agriculture and the energy context might be.

The use of fertilisers is a core element of energy balance. The technical means for reducing inputs of nitrogen are known: long crop rotation sequences and diversified crop choices, growing more pulse plants, use of organic sources of nitrogen, maximum soil cover, and so on. The group considers that their generalised implementation requires awareness-raising and educational effort directed at farmers, along with networking to permit exchanges of experience. The scale of the changes necessary will probably call for the use of strong normative or economic tools, e.g. regulatory constraints (Good Agricultural and Environmental Conditions for example) or price signals on nitrogen (duty or tax).

The work of the *Agriculture Energy 2030* group has highlighted the advantages of biomethanation as a source of fertiliser inputs, on condition that the digestates are correctly valued. The structuring and development of the relevant sector supply chains are major issues. Digestate centrifugation is among the most promising avenues because it allows an easily transported solid phase rich in nutrients (ammonia, phosphate, potassium) to be isolated, along with a liquid phase that is rich in nitrogen but which must be used in nearby areas (spreading). Official approval for the products obtained in this way can be a major boost for the expansion of such production systems.

Another advantage of biomethanation is the production of renewable energy (electricity and heat). The group considers that the existing scheme for supporting the installation of digesters on farms is interesting but should be accompanied by biogas purchase prices that offer investors greater incentives and forward visibility. There is room for progress on this in order to speed up the development of large biomethanation plants exploiting all available biomass resources and able to inject biogas directly into the distribution network. Their siting should be optimised in accordance with the quantities of biomass available for use, the proximity of a gas distribution network and the possibilities for adding value to the digestates.

Preference for local supply of protein for animal feed was seen as an advantageous strategy. The goal is to reduce the transportation of these inputs through on-farm production or local supply and to give preference to protein sources requiring low levels of inputs for their production. Grass-based livestock farming particularly deserve to be encouraged given its self-sufficiency and the numerous amenities it provides. Strategies aimed at expanding the use of grass in livestock farming and introducing legumes into pastures are of interest and should receive appropriate technical assistance.

Agricultural machinery constitutes a major area for fuel savings and a lever for change that the group felt could be easily used. Investment in proper adjustment and maintenance of tractors, replacement of machinery and reductions in machine power should be given financial support, with preference being given to pooled uses. Elimination of the need to till the soil (notably by means of zero-tillage) is also an interesting avenue to be explored for reduction of consumption of fuel for major field crops. It does however require extensive effort on training and research.

Innovations in the organisation of agricultural sectors to improve energy balances across production regions. The group recommends for this that production systems should be diversified and products traded between holdings. Support would be appropriate for farmers committing to innovative modes of production (e.g. crop-livestock complementarity, organic farming, High Environmental Value) through proactive policies on land and installations, especially in the most specialised regions. In addition, the provision of technical and financial support for the development of on-farm primary processing of water-rich products[10] would make it possible to reduce transport-related energy consumption while at the same time diversifying farmers' income sources. There is nevertheless a need to study case by case the energy efficiency and economic viability of this kind of development, which requires major investment and increases farm workload. The development of on-farm storage facilities and conservation technologies help reduce wastage and thus provide another tool for action. And lastly, there are avenues to be explored for the improvement of the energy performance of short supply pathways: delivery pooling, modal transfer, avoidance of empty return journeys, and so on.

10. Finished products (e.g. fruit compotes and yoghourts) and products for the agrifood industry (e.g. fruit preparations, cheese curd).

In the view of the *Agriculture Energy 2030* group, the development of renewable energy production must be supported and channelled. Renewable energy, other than biomass, can provide additional income, depending on farmers' investment capacity and local potential. Moderation in purchase prices should help avoid excessive speculation and the risk of unbridled development of installations on agricultural land. Where biofuels are concerned, public support should favour the most competitive and best environmentally performing sectors. Such targeting of support would help ensure that budget leeway can be found to increase R&D efforts and assist investment in second-generation technologies. Support of this kind should be made conditional on compliance with demanding sustainability criteria, which are currently being defined. The rising importance of lignocellulosic biofuels will also require sustainable management and the mobilisation of large quantities of biomass. Farm fuel taxation might also be revised in order to offer greater incentives for economic fuel use and encourage production and on-farm consumption of pure plant oils.

Reduction of the energy consumption of buildings is a necessity for those sectors that are major direct consumers of energy. Large-scale investment should be provided for the modification and effective insulation of buildings, the installation of heat economisers or biomass boilers, optimisation of lighting, and so on. Financial support in the form of grants or loans on favourable terms would seem to be essential and this could be provided in support of an obligation to carry out work to upgrade buildings to meet thermal standards in a wide-ranging scheme along the same lines as the PMPOA (French programme for the control of pollution of agricultural origin).

Lastly, the *Agriculture Energy 2030* foresight exercise has highlighted priorities for agronomic research and the dissemination of innovation in agriculture. Indeed, considerable uncertainty remains and more knowledge should be gained on indirect energy consumption (especially for animal feedstuffs), end-to-end energy balances in agricultural supply chains, the logistics of agricultural and food products and the energy content of those logistics. In particular, current work on the development of short marketing chains for agricultural products should not neglect this aspect. Generally speaking, comparisons of the energy balances of different agricultural holdings must be continued and improved in order to arrive at a better understanding of discrepancies in levels of consumption and energy efficiency in different production systems.

Varietal improvement should focus on the development of protein crops offering high yields and cereals and oilseeds requiring less nitrogen. Alongside this, research into production systems should pay particular attention to low-energy systems (e.g. integrated production, grass-based systems) or possibly alternatives to tillage. Support for organic farming should go hand in hand with research into increased yields and methods for reducing direct energy consumption (fuel oil, electricity).

Dissemination of innovation is the keystone of any successful strategy. Governance of R&D should be broadened, for example by setting up "innovation committees" involving actors in R&D organisations. It is also essential to develop a network of experimental farms for the definition and dissemination of innovative techniques and technical benchmarks. Lastly, several factors are holding back initiatives aimed at sustained improvement in the energy efficiency of agricultural holdings and agricultural supply chains: energy price volatility, low taxation on energy products in agriculture, lack of knowledge of the issues and levers for action. Action must be accompanied by efforts to communicate, raise awareness and provide training.

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The *Agriculture Energy 2030* foresight exercise invites us to abandon "short-termism". Indeed, energy in agriculture is all too often seen as a cyclical issue that can be ignored when the economic constraints appear less pressing or other issues more urgent.

In reality, energy is a structural issue for agricultural holdings. It affects their competitiveness, their sustainability and their capacity to diversify their income sources and meet new demands from society. The present exercise therefore leads to a view of the future as open and ready to be shaped. It throws light on the challenges and opportunities that flow from the energy issue in agriculture and for that reason it sets out to be a tool for raising awareness and stimulating debate in order to allow all concerned actors to define a coherent and ambitious strategy to cope with the challenges of energy.

Energy in agriculture is all too often seen as a secondary or cyclical issue. In reality, it is an issue that is of key importance for the future due to its economic consequences for farmers, its links with environmental and climatic issues and its influence on the organisation of agricultural supply chains and the development of regions.

Based on the work of a group of around forty experts and led by the Centre for Studies and Strategic Foresight (CEP) at the Ministry of Agriculture, Food, Fisheries, Rural Affairs and Spatial Planning, this *Agriculture Energy 2030* prospective study invites to abandon "short-termism", informing the actors concerned of the challenges and the opportunities raised by the energy issue in agriculture. Following a comprehensive diagnostic analysis of current issues, this overview presents four very different, quantified scenarios for future developments to 2030 and defines strategic focuses to guide public action.

Formed in 2009, the Centre for Studies and Strategic Foresight (CEP) produces analytical reports on complex public problems of national and international dimension. Its core tasks relate to monitoring ongoing developments, providing expertise and methodological support and driving networks. Its observations and work are made available to the public in a range of publication formats: observation memoranda, analytical memoranda, articles in the journal *Notes et Études Socio-économiques*, working documents and reports, among others.
http://agriculture.gouv.fr/prospective-evaluation

The report *Agriculture Energy 2030* does not necessarily represent the official positions of the Ministry of Agriculture, Food, Fisheries, Rural Affairs and Spatial Planning. The views it contains are those of the authors.

If you wish to quote this report, please use the following reference:

Vert J., Portet F., (coord.), *Prospective Agriculture Énergie 2030.* L'agriculture face aux défis énergétiques, Centre d'Études et de Prospective, SSP, Ministère de l'Agriculture, de l'Alimentation, de la Pêche, de la Ruralité et de l'Aménagement du Territoire, 2010.

Graphic design: Clémence Passot

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