

MOBILIZATION OF FOREST RESOURCES TODAY AND TOMORROW

ALAIN THIVOLLE-CAZAT – ELISABETH LE NET

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The issue of soil fertility has only recently become a major preoccupation; but this could change in the future, in association with major changes to the mobilisation of forestry resources. Several contextual elements contribute to this.

The political desire to strongly increase the harvesting of wood (from 21 million m³ between 2008 and 2020) concerns the use of both energy and wood materials, with the double aim of reaching the target of 23% for renewable energy in the national energy mix and of reducing the deficit in the trade balance for the wood sector. This issue needs to be understood in the broader context of the energy transition to renewable energy sources; forest biomass represents a major contextual element. In a still broader context, new development models, lower in energy consumption (in particular fossil), and using wood as a carbon storage, either in the forest or in wood products (construction, furniture etc.) are also envisaged.

Mobilisation of forestry resources thereby runs the risk of being subjected to growing tensions. The intensification of forest harvesting can take place in different ways, in particular through the sampling under certain conditions of small diameter wood (stems and branches, rich in minerals), or trunks, which causes a range of soil disturbance (increased mineralisation of forest litter, reduction in carbon stock).

Forest work is also currently undergoing substantial changes at the same time. In this way, due to the scarcity of the manpower and the need to improve the technical and economic efficiency of wood sector supply, the mechanisation of forest work is accelerating. Machinery is heavier and economic constraints trend to impose logging throughout the year, even when the weather conditions are not favourable (frost and waterlogged soils, see Bigot *et al.*, same issue).

The targets set for forest mobilisation largely depend on estimates of the capacity of forests to provide wood or biomass. Evaluation methods and their ability to assess the forest resources technically, economically and sustainably affect directly current and future pressure exerted on the stands.

A number of different scenarios for the evolution of supply and demand (of energy in particular) may be formulated and simulated to test their more or less long-term viability [scenarios of the IPCC (Intergovernmental Panel on Climate Change), the DGEMP (General Directorate for Energy and Raw Materials), ANCRE (National Alliance for the Coordination of Research on Energy), ADEME (Agency for the Development and Control of Energy), GRDF (Gas and France Distribution Network), SOLAGRO, Association négaWatt].

Firstly, we will therefore look at how to best evaluate the actual forest availability and thereby contribute to the setting of reasonable targets for the forest. We will then see what is the place of the forest among the other biomass sources in general and what will be the changes imagined for it in future.

EVALUATING AVAILABILITY: A CASCADE OF QUESTIONS

Expectations are substantial, in particular on the part of:

- the authorities in defining the public policies in the area of environment, energy, industry or commerce;
- industries that want to be certain that they have good visibility regarding the resource in order to invest;
- producers who have questions about the development of the markets and opportunities to invest in forests.

Studies of resources and forest availability are numerous: there are more than a dozen at national level over the past twenty years and almost a hundred carried out at inter-regional, regional or even smaller territory (Lesveque *et al.*, 2007, Biomass energy – French Rural Network, 2010). The methods used are also highly diverse and have evolved in the course of time, benefiting from improvements in the calculation and the availability of new data (Levesque, 2007). As a consequence, the figures announced are rarely directly comparable.

In the same way, there are several studies that include forest resources at European level (Biomass Energy for Europe, Biomass for Future, Refuel, Renew, EUwood, etc.)

In what follows, we will limit ourselves to national level studies. Here we will in particular refer to the following studies:

- ADEME (2012),
- ANABIO (2009),
- BIOMAP (2010),
- CARTOFA (2012),
- Cemagref (Ginisty *et al.*, 2009),
- ECOBIOM (2009),
- GRDF (2013),
- IFN/FCBA/SOLAGRO (Colin *et al.*, 2010),
- REGIX (2008),
- VALERBIO (2010).

On this scale, the recent work carried out at national level may be distributed according to three subject axes (figure 1, p. 47):

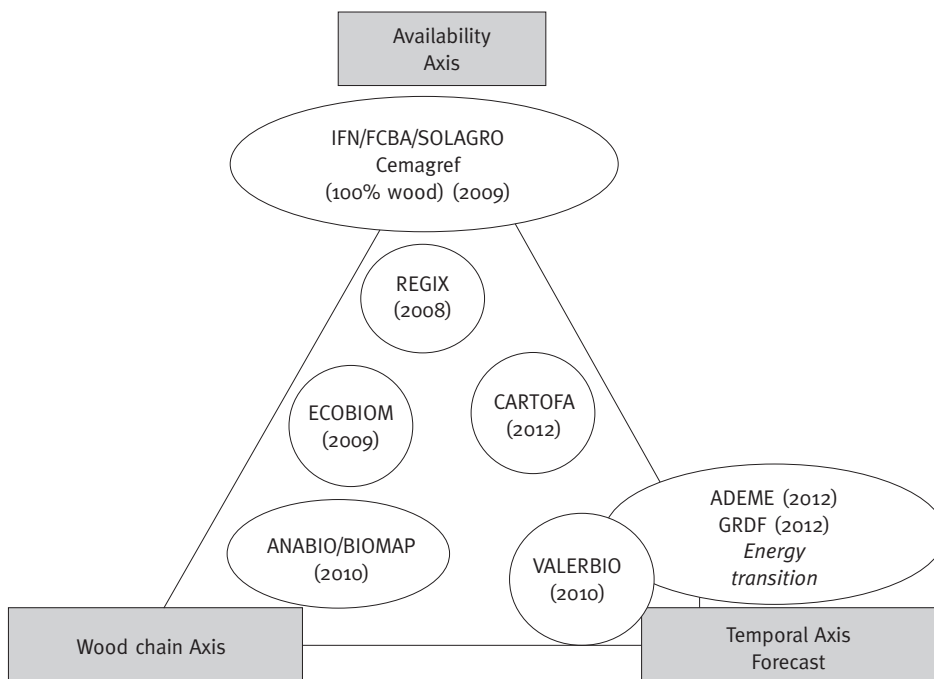
- topic “Availability”: availability in forest biomass, agriculture, industrial co-products of the wood industries, the agro-food industry and end-of-life-cycle products;
- topic “Sector”: in addition to availability, uses are integrated into the study via the economic aspects of mobilisation, rates of use and life cycle analyses;
- topic “Forecast”: scenarios for the evolution of supply and demand are put together and simulated to appreciate the impact of these scenarios on the forest or other economic sectors.

This triangular graph (figure 1, p. 47) shows that the underlying questions are different and that the systems analysed do not have the same limits: if the topic “availability” mainly concerns the resource when standing and harvestable, the topic “sector” introduces the notion of supply, demand and competition between uses of biomass, whereas the temporal axis expands the time scale. As

the delimitation of the system studied is different, the studies call on a variety of methods and tools in order to deal with them.

FIGURE 1

**DISTRIBUTION OF RECENT NATIONAL STUDIES
OF FOREST RESOURCES AND AVAILABILITY FOR THE THREE TOPICS “AVAILABILITY”,
“SECTOR” AND “PROSPECTS”**



Even in the more restricted field of availability studies, methods have evolved due to the available data, processing methods and the questions asked by sponsors. That is why an important work of explanation process is required in order to understand the various results of the studies.

It is therefore necessary to help in the deciphering of the results of the studies by specifying what are the objectives of the study, the geographical field, the biomasses considered (tree compartments), the hypotheses retained (production, forestry, exploitation, losses, etc.) and the used units (m^3 , gross or dry tons).

In short, the answers to all these questions make it possible to have the key for the proper interpretation of the results and to compare the studies between them when possible.

**BIOMASS COMPARTMENTS AND UNITS OF EXPRESSION OF THE RESULTS WHICH LIES
AT THE ROOT OF A LARGE NUMBER OF MISUNDERSTANDINGS**

Reference volume IGN

IGN expresses the volume of trees in timber wood volume (volume from the stem up to the crosscut of diameter 7 cm). This is the reference volume in which all the results of the Forest Inventory are expressed.

This means that the treetop (stem less than 7 cm diameter) and the branches (regardless of their size) are not counted in this volume despite the fact that they can represent 30 to 100% of the total aerial volume depending on the species and diameter of the trees (Vallet *et al.*, 2006).

Branches of more than 7 cm in diameter have always been the object of harvesting for hardwood (pulpwood or log wood), whereas the harvesting of the crown and small branches is once again envisaged for the production of energy, or is even already being carried out (harvesting of entire trees in first thinning or in coppice).

In this way, the volume usage of reference IGN for calculations of availability and the expression of the results lead to an underestimation of availability compared to the physical reality. It is therefore indispensable to convert the timber volume of reference IGN into the total aerial volume of the trees. Calculation of the total volume is carried out using the tables produced in the Carbofor study (Vallet *et al.*, 2006) for 6 major species. The EMERGE project (Deleuze *et al.*, 2013) generalised these tools of total volume applied to all species of metropolitan resources, as well as stem volumes by cuttings (Longuetaud, 2013). Whilst this objective has not been fully achieved, the advances in methodology that have been acquired in this project should be able to allow IGN to better estimate the potential volume of lumber.

Biomass compartments

An estimation of total availability is not sufficient. This must be broken down between its different potential uses, for example with a view to not considering the share allocated to more noble uses as usable for energy.

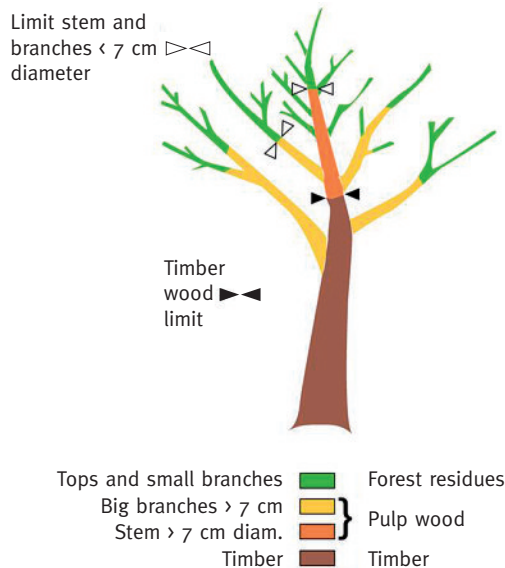
We generally distinguish between three uses represented in figure 2:

- lumber (LUM): basal portion of the lower trunk. The diameter of the section is *on average* 20 cm for coniferous wood and 30 cm for hardwood. It may be bigger or smaller depending on the case;

FIGURE 2

REPRESENTATION OF THE VARIOUS COMPARTMENTS OF POTENTIAL USES TAKEN INTO ACCOUNT

(Colin *et al.*, 2010)



- the wood industry/wood energy (WIWE): all parts of the tree of over 7 cm in diameter that are not lumber;
- wood residue (WR): crown and branches of less than 7 cm in diameter, generally used for energy.

Each category may be downgraded into the lower category in function of quality and demand: wood with a potential use as lumber may for example be used as wood for energy.

However, regardless of the specification of the volume tables used for the calculation of volumes of potential uses, a share will always be downgraded into the lower category, either due to the quality of the wood or of the demand. We have then recognised the expert appraisals to estimate the percentage of wood in a given category that is really used in this category.

Units to express the results

Whilst in most cases forest availability is expressed in m³, there is a need to be more specific if this is a volume on or under the bark, if it is expressed standing or if it takes into account operating losses.

But the results may also be expressed in gross tons (without specifying the degree of humidity), or dry tons and even in energy content (Watt x hour, gigajoules, toe) in availability studies for fuelwood or where a number of different sources are studied (forest products, sawing residue, end-of-life wood).

As the water content of the wood at the time of cutting down is 50%, and the density of the dry wood that can vary from simple to double depending on the species, we can see that we should pay the utmost attention to the means of expressing the results.

CALCULATION OF FOREST AVAILABILITY BY SUCCESSIVE REDUCTIONS

Calculations of forest availability are calculations by successive reductions – and this is also true for all biomasses.

First we calculate *total availability*, i.e. the maximum harvesting potential allowed by the forest. For annual harvesting, this more or less closely corresponds to the organic production of the parcel of land. In the forest, due to a length of production cycles of several dozen years, there is a need to take into account the initial status of the forest stands (surface areas, species, distribution of age categories, fertility, upright volumes) and of the management method (forestry). In addition, we generally make sure that the sustainability of the system is ensured by choosing forestry rules that do not take the capital of production.

And then there is a need to successively reduce the following:

- operating losses (given the current state of technology);
- parcels where operations are not profitable under the current economic conditions, owing to operating conditions or the quality of products generated by cutting;
- parcels where the products cannot be harvested through regulatory constraints (biological reserves, water catchment areas) or environmental constraints (poor soil quality, sensitivity of the soil to compaction).

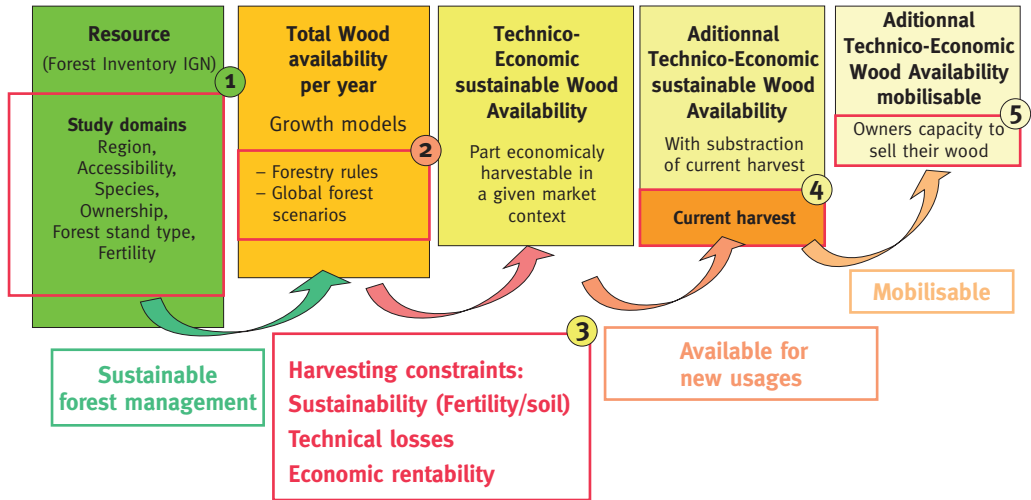
We thereby obtain the *technico-economic sustainable availability*.

If we reduce current harvesting for current uses, we obtain the *additional technico-economic sustainable availability*.

Lastly, taking into account the landowner’s capacity to offer, we define the *mobilisable additional techno-economic sustainable availability*.

Figure 3 shows these various stages.

FIGURE 3 STAGES IN THE CALCULATION OF MOBILISABLE ADDITIONAL TECHNO-ECONOMIC SUSTAINABLE AVAILABILITY



Estimation of total availability

A good knowledge of the resource (species, stands structure, etc.) makes it possible to define the forestry itineraries that allows a continual production of wood, in a sustainable management context, with the main aim being to produce high quality wood (mainly lumber). We can then calculate total availability, i.e. the quantity of wood that can be produced by the forest without any constraints of any kind.

The taking into account of other criteria, whether or not measured by the IGN forest inventory (FI) makes it possible to adapt the forestry itineraries to calculate a total availability that is as accurate as possible for the land management.

In this way, by superimposing the geographical layer of the inventory points with the other geographical layers (water catchment, biological reserves, national parks, Natura 2000 areas, forest properties subjected to the Simple Management Plan, etc.), we can qualify the points according to their belonging or not to these zonings. For some of them, forestry constraints may be linked (increase in rotation periods, removal of clear cuts); this can therefore change the forestry itineraries to be applied to the points concerned, up to the deletion of harvest (forestry stockpiling) (Thivolle-Cazat, 2012).

Estimation of sustainable availability

This is a question of estimating the availability which allows for the sustainability of forest production.

In this way, depending on the richness of the soils estimated with the IGN readings (soil and floral observation), we can distinguish between the cases in which the harvesting of wood residue can be

carried out without constraints, only once or twice in the life of the stand or even not at all (Colin *et al.*, 2010; CARTOFA, 2012; Thivolle-Cazat, 2012).

Estimation of technico-economic availability

In order to calculate technico-economic availability, we proceed the same way as a forest operator who determines his capacity to buy timber cutting (Colin *et al.*, 2010; CARTOFA, 2012; Thivolle-Cazat, 2012).

He evaluates the harvestable products, he knows their value on the market and can therefore estimate the total roadside value of products from the cutting. In addition, he estimates the cutting operating costs. The difference between the two should allow him to achieve a margin and to buy the wood on the stem from the owner. Lastly, the purchase price offered by the operator to the owner must be accepted by him (price offered higher than the withdrawal price).

The calculation of technico-economic availability is carried out in the same way according to the species, the diameter, the type of cutting, and operating difficulties, we determine the price of the standing timber and the operating costs on the one hand, and the volume and the price of the products produced on the roadside on the other hand.

If the price of the products produced covers the costs for the placing of the wood on the roadside (buying from the owner and operating cost) thereby providing a margin, the margin is operable, otherwise it is not.

Using this method, it is possible to modulate operating costs according to the management or operating constraints (for example cable skidding on soil with very low lift), to introduce the cost of compensatory fertilisation in the event of harvesting wood residue on poor quality soil, to take into account a number of different operating methods with their associated costs, and to be able to estimate the economic cost of the choice of which who has the lower environmental impact, etc. There again, taking account of the characteristics of the parcel makes it possible to improve the estimation of availability that is actually accessible under the technical and economic conditions defined.

Estimation of additional availability

Additional availability is the share of technico-economic availability that is not harvested. It therefore requires an estimation of current harvesting levels. Prospect studies add trend scenarios for future harvesting.

The estimation of the harvesting is currently carried out based on a number of different data sources (Annual Survey for the Sector "Forest exploitation and Sawmills", Housing Survey INSEE/CEREN on the consumption of firewood by households). Through their different nature, the comparability of the results of these surveys with the availability calculations is far from being optimal, in spite of the precautions that have been taken to make them coherent (estimation of operating losses, compartmentalisation of trees, etc.). As a result, the estimation of additional availability comes with a high degree of uncertainty. In the near future, new measures carried out by the IGN will allow for a direct assessment of the cutting work in the forest and will give a precise estimation of the samples of the trees (species, cleanliness, size, geography) and consistent with the estimation of the standing volume carried out by the IGN (Colin *et al.*, 2011). Whilst these data do not take into account the use of the harvested wood, they do allow for a high degree of accuracy on the harvested volume and consequently on the additional availability.

In addition, as these measures will make it possible to better characterise the current harvesting, they will consequently enable a better characterisation of the stands that are not currently harvested (geographical areas, stand types, species, etc.).

Estimation of mobilisable additional availability

Consent to offer is not limited to the sale decision. Depending on the objectives pursued (hobby, firewood for own consumption, stewardship, production of wood, etc.), the practised forestry or more or less strong constraints imposed on the operator, owners are led to place more or less wood or biomass on the market.

Unfortunately, whilst a large number of studies have been carried out with forest owners (ECOBIOM, 2009; AFO, 2011), thereby making it possible to draw up behaviour typologies, it has not yet been possible to link them with resource estimates.

The possibility of characterising the points of the inventory according to the size of the parcel or property would allow a study of the relationship between this criterion with the actual harvest and to progress in the estimation of the capacity to offer owners.

A few conclusions concerning the methods for estimating forest resources

Since the 1990s, the methods for evaluating forest availability have changed a great deal, thanks in particular to the availability of new data and to processing methods. Among the recent advances, we can cite the new inventory method which, thanks to its systematic sampling, allows a cross-referencing of inventory information with cartographic data, thereby making it possible to enrich the information available on the points of the inventory (management or operability constraints, characteristics of forest property, etc.). The contributions of techniques that are still at the experimental stage in the forestry domain – such as the land or air LiDAR – will in the coming years make it possible to better characterise resources on the inventory points (volume standing according to various cuttings, Deleuze, 2013) or to spatialise current resources and their availability to reach the parcel scale (ANR FORESEE project).

MOBILISATION OF FORESTRY RESOURCES, BETWEEN SUPPLY AND DEMAND

Current harvesting in France

The forest inventory of the IGN estimates average annual removals of “timber” at 44 million m³ for the period 2005-2009 (Colin *et al.*, 2011). This corresponds to the total felling of timber volume (including branches) of 64 million m³ a year. To obtain an efficient harvest, we must deduct operating losses (estimated at 10%), which leads to a volume of 57.5 million m³.

The Annual Branch Study gives for the same period an average harvest of 33.5 million m³ for industrial uses (the poplar harvest which is not subject to a back ground) to which must be added the consumption of firewood by households coming from the forest, estimated at 22 million m³, i.e. 55.5 million m³. The difference of 2 Mm³ is low and corresponds to uncertainties regarding operating losses, the estimation of direct harvesting or the estimation of consumption by households.

Harvesting of wood material

The current harvesting of wood for the sawing industry, from pulp and paper and panels is currently 32.5 million m³ excluding climatic and cyclical random factors, and excluding poplars. We note that the harvesting of hardwood lumber is decreasing, whereas that of coniferous wood is slightly increasing (excluding temporary variations linked to Storm Klaus).

Forest biomass among the other renewable energy sources

Through its moderate environmental impact and renewable character, biomass seems to be important and even essential energy panel for tomorrow.

Forest biomass also has the advantage of a long previous history in its use as well as of recent technical advances. It can be used easily and efficiently for the production of thermal energy (and possibly converted into electric energy by cogeneration), and in the medium term (~2020) as biofuels referred to as 2nd generation (2G).

At present, 60% of wood harvested, i.e. 31 million m³, is used as a source of energy either directly as firewood or as a co-product in the transformation process (combustion of stationary black liquor, sawmill waste, manufacture of wood pellets, etc.) or for the production of heat in thermal power plants or cogeneration plants (heat and electricity).

In the objectives that have been set for it at horizon 2020 by the Grenelle Environment Forum, biomass has to cover over 80% of needs for the production of renewable thermal energy and a reduced share in the production of electricity and fuels (11%).

As a result, the various calls for tenders and programmes (CRE, Renewable Heat Fund, 1000 chaufferies bois – 1000 wood-fired boilers – etc.), and the installation of units that consume wood in order to produce energy, the harvesting of fuelwood (except log wood consumed by households), has almost doubled every year since 2007, increasing from 160,000 m³ to 4 Mm³ in 2013.

The National Observatory of Biomass Resources in France (ONRB) compiles the results of national or regional studies so as to place them at the disposal of State departments and regional “biomass” divisions (FranceAgriMer, 2012).

According to the Biomass Observatory, it is agriculture that produces the most biomass that can be directly used for energy (30 Mtoe), followed by the forest (16 Mtoe) and livestock manure (7 Mtoe) (FranceAgriMer, 2012). Actual availability (quantity still available after having subtracted current uses) is a lot lower, and is this time the forest that constitutes the primary potential source with 8 Mtoe instead of 4 Mtoe for agriculture (and even 0 depending on new estimates: CARTOFA, 2011).

The various studies carried out make it possible to propose a synthesis of the technico-economic supply in the coming period (with different time horizons).

Prospects for the change in supply and demand in forest biomass

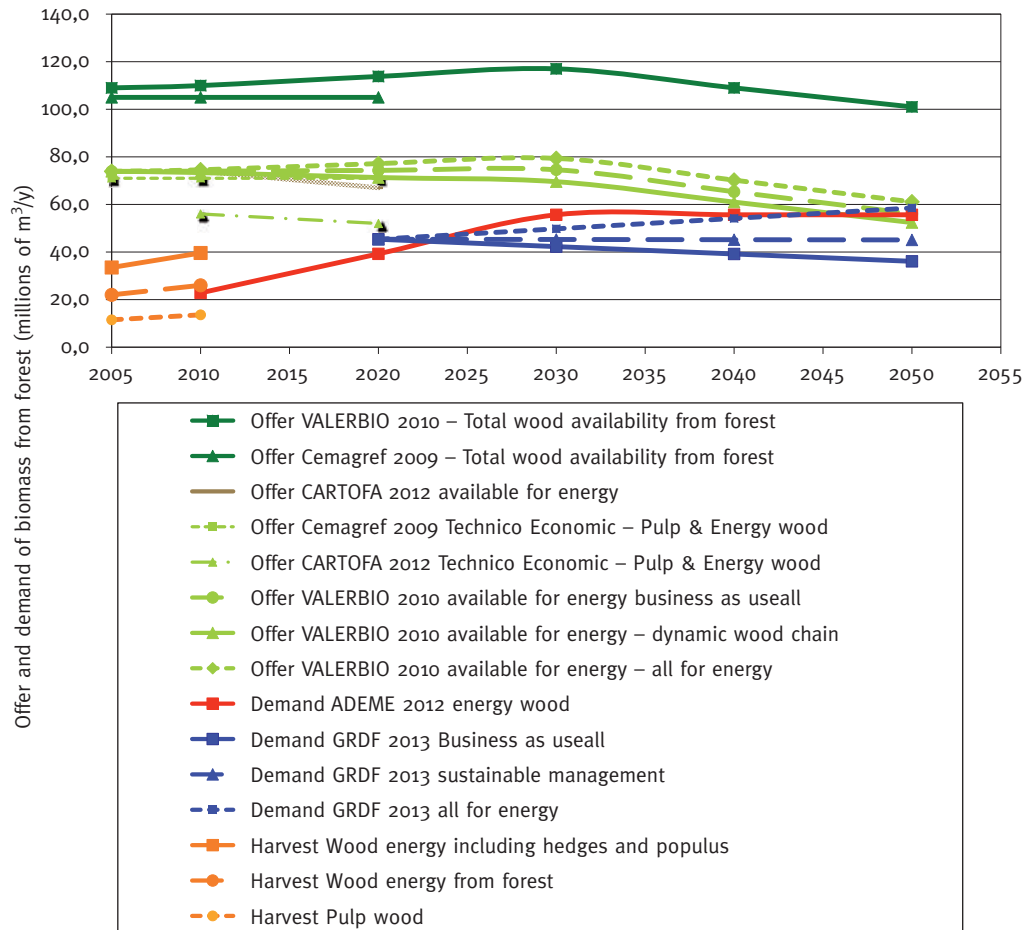
In addition, several studies have built up scenarios for changes in demand by formulating a number of different hypotheses concerning industrial and energy change. Figure 4 (p. 54) summarises these various works after adjustment for a single horizon: 2050.

It seems that total availability is currently 100 Mm³. It will decrease slightly over the next few years, after the decapitalisation of the resources not currently mobilised around thirty years. Technico-environmental availability in BIBE and WR is between 56 and 75 Mm³ depending on the studies and hypotheses retained (Cemagref, 2009; VALERBIO, 2010; CARTOFA, 2012).

Consumption of industrial wood and fuelwood is currently 36 million m³ of wood per year, including 12 million for industry. It is increasing as a result of the installation of cogeneration or wood-fired boilers.

There remains therefore a potential of over 20 million m³ of availability currently used and not marketed.

FIGURE 4 **COMPARISON OF SUPPLY AND DEMAND FOR FOREST BIOMASS**
IN FRANCE BETWEEN 2005 AND 2050



The prospective make the hypothesis that stands that have previously been under-exploited will be harvested over a period of only thirty years; this additional annual potential is not insignificant (around 15 million m³ a year in availability until 2050).

At the same time, the scenarios for changes in demand form hypotheses regarding the change in the consumption of wood material (lumber for construction and packaging, process panels, pulp) and in renewable energy of forest origin (heat, electricity, fuel), in the trade balance in constant quantities of rough lumber. These scenarios are translated into the quantities of wood that are required in order to meet needs.

As of 2020, these scenarios foresee a demand of 35 to 56 Mm³ which, when the consumption of pulpwood is added (11 Mm³), leads to a level of demand that would need to be compatible with the resources available, since the additional availability has not yet been completely harvested and will remain available over the next few years.

The difference between the potential of the supply and demand however is not very important and the satisfaction of the needs foreseen by the demand scenarios presupposes a rate of resource mobilisation higher than today, which will be difficult to fully achieve because of the unknown factor weighing on the possibility of modifying the owners' disposition to sell.

BALANCE AND PROSPECTS

Studies of forest resources also aim to establish as accurately as possible the availability of wood and biomass in forests. Changes in the data available and in the processing methods have made it possible to gradually refine the results. Taking into account of new criteria makes it possible to approach more effectively mobilisable availability.

The scenarios for changes in demand lead us to believe that the forest will be very highly mobilised in order to meet needs in the area of renewable energy. Pressure on resources consequently runs the risk of being accentuated, which would lead to an increase in the resources taken, in particular for wood residue, in a changing forestry context (reduction in rotation periods, development of dedicated cultures etc.). Maintaining the fertility of forest soil will probably become an increasingly major preoccupation in this context.

Climate change risks bringing with it further modifications to the growth and management of stands.

In the near future, an analysis of the harvest observed by return in the field will make it possible to refine its characterisation and consequently the characterisation and location of the availability that has not yet been harvested. The control of new tools such as the LiDAR or photogrammetry will allow for the spatialisation of resources and perhaps also the production of supply schemes that are more detailed than is presently the case.

However it remains to better understand and model the behaviour of forest owners and to put them into contact with the parameters that can be used in resource studies so to get closer to the mobilisable potential.

Whilst research makes it possible to have a better knowledge of the functioning of ecosystems, it also needs to be able – in a dynamic economic and social context – to offer solutions that make it possible at once to exploit resources and to retain production potential.

In order to further advance knowledge and to anticipate the expected changes, initiatives do already exist such as the Pilot Scheme for the mobilisation of wood in Auvergne and the ECOFOR Economic and Social Sciences Network. In more general terms, the mobilisation of forest biomass for energy and also for other uses, request a coordination of the efforts made, a roadmap and a collective work.

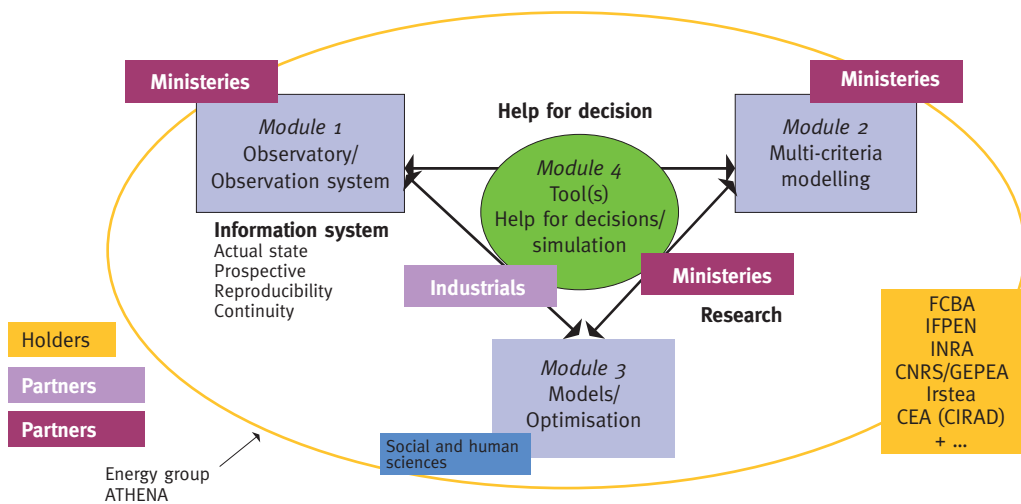
This observation is made for all biomass and lies at the basis of an initiative/a concept, Bio-oSMOSE (which stands for Biomass – Simulation tools, Modelling, Observatory and System), taken up in the inter-ministerial report on biomass (2012): to unlock the mobilisation of biomass and to meet the public objectives and demands of industries, in particular that of energy, there is a need to undertake a research/action programme that makes it possible to share the works already carried out and to advance in a coordinated manner.

Bio-OSMOSE has been designed over a 10-year horizon, which is a reasonable length of time to largely unlock the situation. It is composed of 4 complementary modules that are interdependent: (i) information and data system, (ii) multicriteria evaluation approaches for value chains, (iii) modelling and optimisation, and (iv) assistance tools for decision making and simulation. Modules 2 and 4 are those that allow most directly answers to potential users and decision makers.

The project has been initiated and is currently being led by six organisations: INRA, CNRS, IFPEN, CEA, IRSTEA and FCBA (but this list remains open). The platform has been designed to combine the public/private actors, research and industry; it has a national focus, but must at least be opened up to Europe.

In the absence of a one-stop shop that meets all the needs identified in order to unlock mobilisation, promoters are counting on it that the Bio-OSMOSE topics are considered in calls for projects. Figure 5 illustrates the general design of the project and shows the interactions between the lead organisations and the ministerial and industrial partners.

FIGURE 5 GENERAL DESIGN OF THE BIO-OSMOSE PROJECT



Such an approach to the mobilisation of biomass; global, coherent, integrating the previous works and being deployed in the long term, remains to be built; it represents the only way that makes it possible to best articulate research and its application areas.

Alain THIVOLLE-CAZAT
 Pôle économie, énergie et prospective
 FCBA
 10 rue Galilée
 F-77420 CHAMPS-SUR-MARNE
 (Alain.THIVOLLECAZAT@fcba.fr)

Élisabeth LE NET
 Pôle économie, énergie et prospective
 FCBA
 10 rue Galilée
 F-77420 CHAMPS-SUR-MARNE
 Present address
 DEN/Institut de technico-économie
 des systèmes énergétiques
 CEA Saclay
 F-91191 GIF-SUR-YVETTE
 (elisabeth.le-net@cea.fr)

REFERENCES

- ADEME. — Contribution de l'ADEME à l'élaboration de visions énergétiques 2030 — 2050. Synthèse, 2012.
- AFO. — Forest Owners. — Agence européenne de l'énergie, 2011.
- ANABIO. — Analyse environnementale et socio-technico-économique des filières de production d'énergie ex-biomasse — ANR PNRB ; IFP (Coordination), INRA, FCBA, CEA, Air liquide, Total, Renault, 2008.
- BEE. — Biomass energy for Europe, European Project FP7, N° 213417. — 2010.
- BIOMAP. — Analyse environnementale, socio-technico-économique et évaluation des risques des filières bioénergies : applications pratiques à différentes problématiques. — ANR IFP (coordination). Suite ANABIO, 2010.
- BIOMASSE-ÉNERGIE — RÉSEAU RURAL FRANÇAIS. — Liste des 90 études de gisement de biomasse énergie identifiées dans le cadre de l'action n° 1 au 15 juillet 2010, classées par régions, territoires et commanditaires. — 2010. [En ligne] : disponible sur www.reseaurural.fr/biomasse_energie.
- CARTOFA. — Cartographie dynamique par département des gisements français de biomasse agricole et forestière. — GIE ARVALIS-ONIDOL, FCBA. Convention Tuck/GIE ARVALIS-ONIDOL programme ENERBIO, 2012.
- COLIN (A.), THIVOLLE-CAZAT (A.), COULON (F.). — Biomasse forestière, populiicole et bocagère disponible pour l'énergie à l'horizon 2020. Rapport d'étude. — Étude réalisée pour le compte de l'ADEME par IFN, FCBA, SOLAGRO, 2009-2010.
- COLIN (A.), HERVÉ (J.-C.), LUCAS (S.). — Prélèvement de bois en forêt et production biologique : des estimations directes et compatibles. — *L'IF*, n° 28, 3^e et 4^e trimestres 2011.
- DELEUZE (C.), MORNEAU (F.), CONSTANT (T.), SAINT ANDRÉ (L.), BOUVET (A.), COLIN (A.), VALLET (P.), GAUTHIER (A.), JAEGER (M.). — Le Projet EMERGE pour des tarifs cohérents de volume et biomasses des essences forestières françaises métropolitaines. — *Rendez-Vous Techniques*, n° 39-40, 2013, pp. 32-36.
- ECOBIO. — Une approche socio-économique et environnementale de l'offre de biomasse ligno-cellulosique, ANR PNRB 05, 2005-2009. — FCBA (coordination), GATE, CNRS, GIE ARVALIS-ONIDOL, INRA, ONF, UCFE, 2009.
- EMERGE. — Élaboration de modèles pour une élaboration juste et générique du bois énergie, ANR 2009-2013. — ONF (coordinateur), INRA, IGN, FCBA, Irstea, IDF, CIRAD, 2013.
- EUWood. — Real potential for changes in growth and use of EU forests. — EU project TREN/D2/491-2008, 2010.
- FranceAgriMer. — L'Observatoire national des ressources en biomasse — Évaluation des ressources disponibles en France. — édition 2012. — Les études de FranceAgriMer, 2012.
- FORESEE. — Forest Resource Estimation for Energy. — ANR FCBA (coordination), Irstea, ONF, IGN, 2011-2014. — 2014.
- GRDF. — Biométhane de gazéification. Évaluation du potentiel de production en France aux horizons 2020 et 2050. — Rapport final, 2013.
- GINISTY (C.), CHEVALIER (H.), VALLET (P.), COLIN (A.). — Évaluation des volumes de bois mobilisables à partir des données de l'IFN « nouvelle méthode ». — Rapport d'étude Convention Cemagref/IFN/DGFAR E 10/08 du 19 juin 2008. — 2009.
- LEVESQUE (D.), VALLET (P.), GINISTY (C.). — Biomasse forestière disponible pour de nouveaux débouchés énergétiques et industriels. Partie 1 : Analyse et synthèse des études existantes recensées au niveau national. — Convention DGFAR/Cemagref N°E19/06. Rapport final, 2007.
- LONGUETAUD (F.), SANTENOISE (P.), MOTHE (F.), SENG KESSIE (T.), RIVOIRE (M.), SAINT-ANDRÉ (L.), OGNOUABI (N.), DELEUZE (C.). — Modelling volume expansion factors for temperate tree species in France. — *Forest Ecology and Management*, vol. 292, 2013, pp. 111-121.
- REGIX. — Référentiel unifié, méthodes et expérimentations en vue d'une meilleure évaluation du gisement potentiel en ressources ligno-cellulosiques agricole et forestière pour la bioénergie en France. Projet ANR PNRB 05, 2005-2010. — GIE ARVALIS-ONIDOL (coordination), APESA, Chambre régionale d'agriculture du Centre, EDF, FCBA, FRCA Picardie, INRA, ONF, UCFE. — 2008.
- THIVOLLE-CAZAT (A.), COLIN (A.). — Analyse de la ressource forestière et évaluation de la disponibilité en bois en Lorraine à l'horizon 2025. — Convention DRAF Lorraine/FCBA N°ETU-2011-10/GN N°ETU-2011-11, 2012.
- VALERBIO. — Valorisation énergétique de la biomasse. — IFP (coordination), École des Mines de Paris, FCBA, convention Tuck, programme ENERBIO, 2010.
- VALLET (P.), DHÔTE (J.-F.), LE MOGUEDEC (G.), RAVART (M.), PIGNARD (G.). — Development of total above ground volume equations for seven important forest tree species in France. — *Forest Ecology and Management*, vol. 229, n° 1-3, 2006, pp. 98-110.

MOBILIZATION OF FOREST RESOURCES TODAY AND TOMORROW (Abstract)

The increasing wood energy demand could cause an important mobilization of forest resources and be the reason of the forest management sustainability. To assess this risk, it is necessary to determine precisely the availability of wood in the forest. The methods used to evaluate the resource and forest availability have improved, but, paradoxically, misunderstandings have arisen because the published results vary according to the methods, which require great attention to the explanations in support of figures published in different studies. Currently, harvest is still far from the total availability in forest wood, even if we consider only the technically and economically part harvestable. However, the objectives set in the forest, if realized, would lead to an exploitation of forests much more intensive, which raises the question of maintaining the fertility of forest soils. Research must thus work on solutions that allow the exploitation of forest products while maintaining a high level of productivity.
