Potential of Forest Wood Biomass in Bulgaria and Market for Its Utilization

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Abstract:
The need of energy produced from renewable sources, wood biomass included, has mainly resulted from the struggle against energy dependence and the perpetual rise of the oil prices and the climate change prevention by reducing the hazardous emissions of the greenhouse gases into the atmosphere.
The total annual increment in our forests is about 14,5 Mio m³ of the growing stock, i.e. the annual harvesting amounts at – and below – 50% of the annual increment of the forests. An increase of the actually harvested quantities of wood is possible and it may rise up to 8-10 Mio m³ of fallen wood mass if the required forest infrastructure, technological equipment of wood processing companies and, of course, markets are available, but they have been missing by the moment. The use of such logging residues, as branches, brushwood and others are, has been considered extremely low by the moment, as it is considered that the assimilation of such residues would be economically unprofitable and would provoke damages in forest environment. There is a certain experience in collecting and pre-shredding of logging residues for a further use by some small-size local heating systems or small enterprises, or public buildings as schools, hospitals, sports and recreation facilities etc.
There is a definite need to build forest infrastructure, to provide for a appropriate management of the existing forests, to create new forests, where short rotation plantations to produce wood biomass should also be included; power capacities should be introduced for biomass production; conversion, consume and use of energy produced by utilizing the above mentioned wood potential.
The potential quantities of the forest wood biomass in our country, by regions, are indicated in the elaboration, as well as some possibilities reflecting the utilization of that biomass for energy production, and some trends for development of the forest sector activity in Bulgaria.

Keywords: renewable energy, wood biomass, logging residues, utilization

1 Introduction

A National Long-Term Program for Promotion of Biomass Usage within the period 2008 – 2020 has been elaborated and adopted in Bulgaria. Along with it, there is also a National Renewable Energy Action Plan approved on June 30th, 2010, on energy obtained from renewable sources, where the following below is cited: "The biomass is a renewable source capable for energy production, being of the greatest potential in Bulgaria, where the distribution of the main renewable energy sources is, as following: biomass 36%; hydro-energy 31%; wind energy 7, 5% and others".

It is expected, in EU, an increase in the wood harvesting, which will be more than 20% by 2020, forestry waste included, respectively, predominantly depending upon the economic growth and the political resolutions. The greatest changes are expected to occur in the Baltic Countries and in the South-Eastern Europe ones (Asikainen et al. 2008).

The largest quantities of the forest wood waste in Bulgaria have been accumulated in the logging areas, and, to a less extent, at temporary storages. There are mainly branches and brushwood which thickness is below 3 cm, as wood waste of a thickness over 3 cm cover the standard of firewood. Leaves (needles) can also be added to the former ones, taking into consideration that there are modern technologies available for their processing. Besides, it should be taken into account that in the cutting areas, for one or another reason, there are also standard types of wood consisting in branches, which are included to the forestry

waste, as well. According to literature sources, those branches amount to 1,1 – 3,75% of the marked forest mass (Dinev 2007).

There are about 65% waste of the total wood harvesting to be easily assimilable for bioenergy production (Perlack et al. 2005). Such waste products consist in tree tops, branches, twigs, leaves, sometimes stumps and small trees standing after the harvesting of high-value assortments.

It often occurs that the decisive factor, in economic terms, contributing to the wood usage for energy production, is a complex of objective factors of the stands, as it is, for example, the access to the forests. The results have indicated that the costs of production are highly variable, depending upon the used technologies for logging and the correlation between the conventional wood assortments and firewood (Puttock 1993).

The increased demand of forest biomass has its positive aspects, as following ones: the reduction of the costs for production and the application of new methods and technical solutions for the biomass assimilation. There is a market for the wood biomass: and it gives an opportunity that the potential could be enlarged for the suppliers of biomass to the largest plants for the production of thermal energy.

The assimilation of the forest biomass (incl. residues) potential in our country depends upon the availability of the main factors, as following below: the usage of efficient technologies for biomass gathering; primary processing of raw material and keeping; as well as the introduction of systems for direct combustion of biomass; appropriate technologies and plants for energy production and transfer; the availability of such an infrastructure which could give the possibility for the use of various types of biomass; the development of market for biomass in our Country, and others.

The purpose of this study is to make an assessment of the available and potential resources of forest wood biomass which are being obtained nowadays and will be obtained in the future in Bulgaria. The main data have been drawn on the base of the actually cut quantities of wood, following the respective Forestry Management Projects (Forestry Plans): it is being made for the very first time in the history of Bulgaria, by Forestry Enterprises.

2 Material and methods

The forest territory in the Republic of Bulgaria covers 4, 1 Mio of hectares, approximately, which results to about 33% of the national territory. The deciduous forests consist in 68% of the forest area while the coniferous ones, about 32% of the area. As a result of the large-scale afforestation activities conducted during the second half of the Twentieth Century, the total wood resource in Bulgaria has been increasing in continuous trend.

Totally, the potential of the waste biomass has been calculated as amonting to 91, 5 PJ/year. The forest potential is equal to almost 19% of the entire biomass potential; and, as it is expected, it will be increasing on. The technical potential of the forest biomass for energetic use has been estimated to amount to about 44, 4 PJ/year (6, 7).

The main forestry waste consists in branches and brushwood obtained by felling and after the primary processing of wood materials. The technologies, available and applicable nowadays in our country, do not permit the above mentioned waste to be used for obtaining of a basic wood harvesting production; but in case, more appropriate technologies are introduced, that same type of waste could be harvested and utilized.

Every year there are about 3, 0 Mio m^3 of wood which are obtained by the wood category, being 2, 5 Mio m^3 of that same one used by the population as fire wood for primitive stoves of 20-40% efficiency. As it is evident, an enormous potential is available for a construction of highly efficient power plants for wood biomass, energetic chips, pellets, briquettes and others included.

The demands of fire wood require researches and a development of a new design for wood products, which will influence on the purchase, the cutting and the transportation of the traditional wood assortments.

There are boilers for direct combustion of wood waste within a large range (25 - 1100 kW), which are offered at the Bulgarian market. But it is required that such type of waste which includes waste from wood harvesting: branches, bark and brushwood should be pre-cut (pre-crushed); the same waste can be used by small-sized local power plants or small-sized enterprises, or public works or municipal buildings as schools, hospitals, sports and leisure centers and so on.

3 Results and discussion

The total resource of wood in the forests of the Republic of Bulgaria is about 643 Mio m^3, 6 up to 7, 5 Mio m^3 growing stock is (5 - 6 Mio m^3 of fallen wood) of which are annually harvested in the last years (See Figure 1).

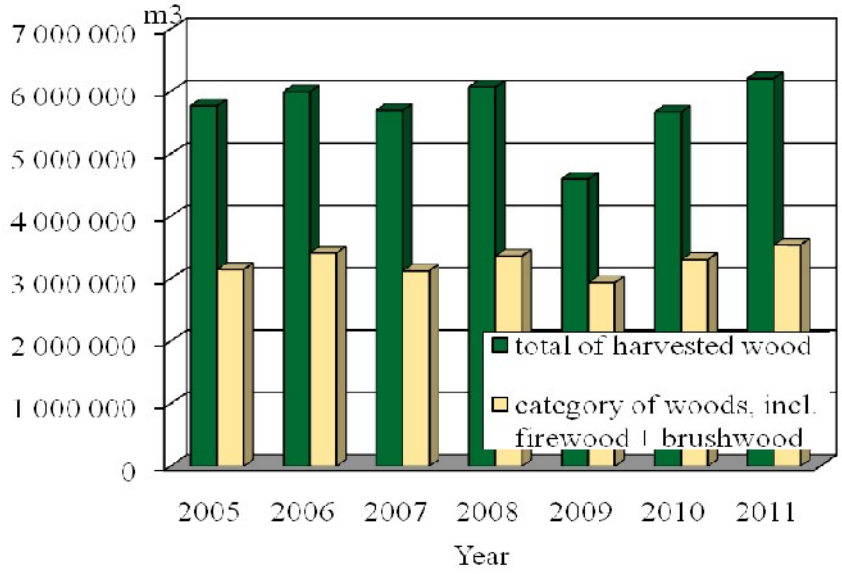

Figure 1: Share of wood for energy (energetic purposes) to the total volume of the wood obtained in the Republic of Bulgaria

Taking into consideration the assortment and the age structure, the tree species and other specific characteristics of the Bulgarian forests, there are 70%, approximately, of the obtained wood which is used for technological and energetic purposes, i.e., for particle boards, cellulose and fire wood, on the national scale.

In the last years, the share of the of the categories " fire wood " and " brushwood" amounts to 57%, averagely, of the total quantity of harvested timber in Bulgaria, varying from 55% to 64%. The wood biomass, where fire wood, wood waste and their derivates are also included, is of a great energetic potential but of a low degree of quantitative concentration; and that resource is often too distant from settlements. Besides, the terrain condition which are predominantly hard, the lack of a sufficiently developed infrastructure in the forests and of traditions and appropriate technologies for utilization of waste from wood harvesting suggest that there would be recommendable small-size heating systems, co-generating plants and others to be built.

The technologies and the technical equipment for wood harvesting and usage of wood waste need optimization and improvement. On the grounds of the new Forest Act and the secondary legislation, the optimized restructuring of the forest sector, it may be said that a real opportunity for a rise of the total

extent, to which wood can be utilized, exists; thus, it is also possible to get an increase of that type of wood biomass which is considered capable for energy production (See Table 1).

Table 1: Unused quantities of wood biomass in Bulgaria

Origin of wood biomass	Quantities, actually unused	Energetic equivalent, t.o.e./p.y. (tons of oil equivalent per year)
Total volume of forestry waste in m³/year	1 066 966	220 904
Economically accessible forestry waste in m³/year	373 438	77 316
Possible increase of waste in wood harvesting (a forecast for 2020), in m³/year	1 431 000	306 800
Industrial wood waste, tons of dry mass per year	50 000	23 000

The energetic equivalents of the additional quantities of wood fuel are, as following: in 2015 – 24500 tons of oil equivalent per year for coniferous wood and 111200 tons of oil equivalent per year for deciduous; in 2020 – 47200 tons of oil equivalent per year for coniferous wood and 259600 tons of oil equivalent per year for deciduous, respectively.

A major obstacle for an efficient utilization of the branches, brushwood and small-size wood for energy production is the high cost for harvesting; along with it, other difficulties should also be taken into account as the location of the forest massifs and the insufficient forest road network. For that reason, the forecast made for branches and brushwood usage corresponds to the available quantities.

It is difficult to make an assessment of the potential resulting from industrial wood waste. Some of the harvested quantities of wood waste are burnt in boilers where thermal energy is mainly produced, as well as some small quantities of electric energy are also obtained from. The rest of the wood waste is not used, because of its high moisture or missing introduction of technologies for wood briquettes and pellets production.

The development of trade centers for wood biomass has a potential for optimization of the acceptance, processing and sale of wood for energetic purposes. In that connection, a map has been elaborated of the economically accessible forest-wood waste from the wood harvesting in the Republic of Bulgaria (See Figure 2). Economically accessible waste is that one which can be collected and reduced into a state, easy for transportation, and, subsequently, should be supplied and processed, taking into account the costs, especially, such an amount of the cost price of the finished product which should not exceed the prime cost of that same product obtained from a normal raw material.

Most of the forestry waste can be utilized only under the form of briquettes, pellets or wood chips. The production of chips usually results cheaper as it does not need any pre-drying of the material or energy for its pressing. On the other part, there is no market, which should be sufficiently developed, in Bulgaria, for chips; and that is why their price varies within a wide range (See Table 2).

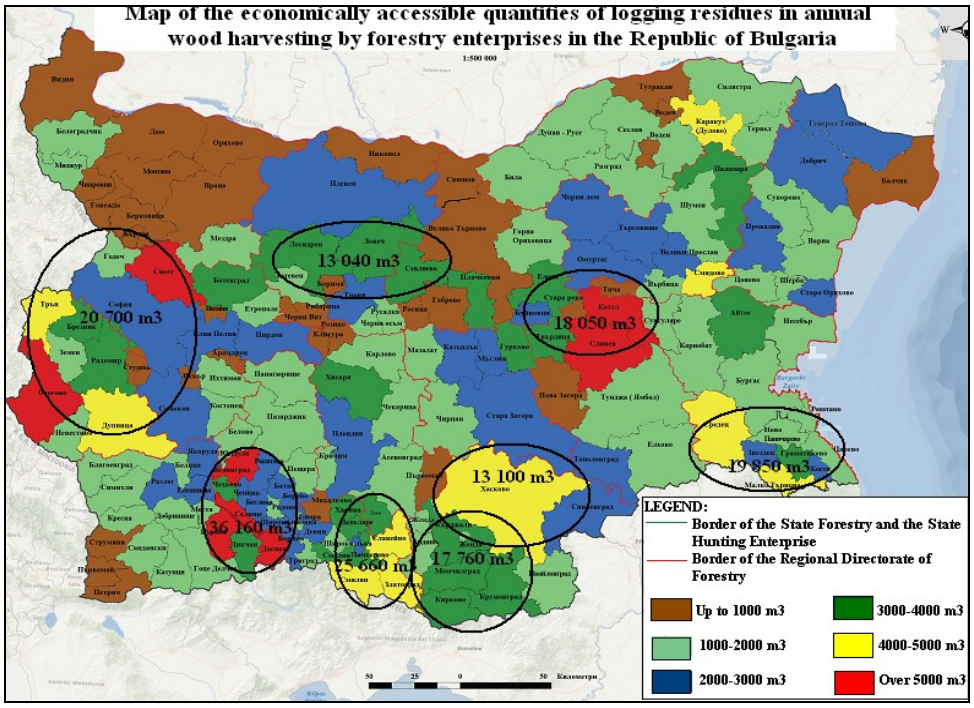

Figure 2: Economically accessible forestry waste in the Republic of Bulgaria per year

Table 2: Some indices of fuel in 2011 in the Republic of Bulgaria

Fuel	Calorific value	Price of fuel	Specific price of thermal energy	Costs for heating per month
Dry calibrated chips	4,88 kWh/kg	102,26 €/t	0,02 €/kWh	64,93 €
Wood chips at 60 km distance	3,14 kWh/kg	58,79 €/t	0,03 €/kWh	73,11 €
Fire wood	2,56 kWh/kg	61,36 €/t	0,03 €/kWh	74,13 €
Lignite coal (briquettes)	3,72 kWh/kg	89,48 €/t	0,03 €/kWh	93,57 €
Brown coal	4,07 kWh/kg	117,60 €/t	0,04 €/kWh	112,48 €
Wood pellets at 60 km distance	4,88 kWh/kg	184,07 €/t	0,04 €/kWh	116,57 €
Natural gas	9,01 kWh/m³	475,50 €/ 1000 Nm³	0,06 €/kWh	156,46 €
Electric energy	1, 00 kWh	0,090€/kWh	0,10 €/kWh	259,22 €
Diesel fuel	11,63kWh/kg	1066,55 €/t	0,10 €/kWh	284,28 €

The regions in Bulgaria, where the maximal economically accessible quantities of logging residues are available, have been indicated, by circles, on the map (S. Figure 2). Their range has been determined by preliminary studies of the impact of the transport distance on the economic efficiency of their consumption, which is maximum 40 – 50 km, taking into account the existing conditions in our Country. That is to say, it is economically inefficient if waste is transported to a distance of more than 40 – 50 km. It gives a clear picture of where the processing capacities for forest wood waste and the energy producing plants could be concentrated. That is why, there are the regions in the Central and Eastern parts of the Rhodope Mountains, where the total annual quantity of forest wood waste amounts to 92680 m³; the Central part of the Western Bulgaria around its capital Sofia, where the total annual quantity of the same waste amounts to 20700 m³; as well as the Mountain of Strandzha of 19850 m³ and others; which are considered as the most appropriate ones for that purpose.

The pellets are still a new kind of fuel at the Bulgarian market, which is mainly due to the high investment costs and a lower purchasing power of the potential consumers in Bulgaria, as compared to that one in the other Member States. Regardless of that, a number of attempts have been and are being made by local manufacturers in pellets production; and it is expected that production would gather pace along with a further economic development and a rise of the living standard, in the following years. Some 10 or 15 years ago, nobody even heard about heating by pellets use. It was in that same period, perhaps, when the first import of the pressed wood waste and wood chips started in Bulgaria. Nowadays, there are about 30 manufacturers of pellets in our Country and nine large factories. The total production capacity is 60000 tons/year, approximately, being 2/3 of the pellets exported predominantly to Italy. When many manufacturers are available, it obviously contributes to a creation of an accentuated competitive ambient, thus offering possibilities to obtain a relatively low price of the pellets as fuel.

Along with the development of the home market for pellets, a fast rise of their production is expected, as there are significant unused quantities of dry wood shavings and other waste available for that purpose. A ton of pellets can be purchased at a price varying from 65 up to 200 €, depending upon pre-packing and packing quality, volume and type.

The reason for that demand of pellets is the price leap of the fuel (see Table 2). The economic crises did also affect the manufacturers of the pellets, as the greatest part of them use as a raw material technological waste generated by wood processing enterprises. When the processed quantities of wood in such wood processing factories are reduced, there is also a decrease of the waste, used as a raw material for pellets production.

In the recent ten years, the wood briquettes production in Bulgaria has been highly developed. According to some unofficial estimates, the average annual quantity of the produced wood briquettes amounts at 9000 tons/year, approximately (i.e. about 3600 tons of oil equivalent per year).

Taking into account the data on the share of that wood, which, being harvested in Bulgaria, is considered capable for energy production (See Figure 1), as well as the fact that a part of fire wood shall not be used in the conventional way but shall be processed, instead, that is to say, transformed into chips, pellets and briquettes, a map has been made (and given on Figure 3) for the purposes and needs of this elaboration.

It will guarantee a much greater efficiency in combustion, as the really usable heat will arrive at almost 90%. The circles, given on Figure 3, indicate the maximal quantities of woods (firewood, woodpulp, wood-based panel mill etc.), where a part of wood can be efficiently used for processing: to be transformed into chips, pellets or briquettes. The analysis of the data evidences that a great part of the potential, mainly fire wood usable for energetic purposes, is concentrated in the mountainous part of the Region of Veliko Tarnovo (275720 m³), the district comprising the towns of Lovech – Teteven – Pleven (174220 m³), the district comprising the towns of Gurkovo – Stara Zagora (144100 m³), the district comprising the towns of Aytos – Nesebar (120370 m³) and others.

The most promising technologies for Bulgaria, also applicable in some other countries, for waste processing and transformation into chips, are the following ones: a) production of chips from wood waste by mobile chipper and supply of chips by specialized trailers and automobiles to the consumers; and b) supply of packaged forest wood waste in packets (bales), from the forest to the consumers, followed by a further production of chips.

We do consider, on the grounds of our few experiences, the chips production in the cutting area is of a low productivity. That is due to the fact that small quantities of waste are spread within the entire territory of the cutting area, and chipping machine needs significant time to move on, into that same area. An exception could be considered the logging residue chipper, but in such a case, its productivity will be significantly lower, compared to that one if the afore said machine operates at the same place. As about the second technology and the buncher, we recognize our lack of experience. The biggest defect of the afore mentioned machines is their high price. What is positive, regards to the choice of that technology, is the fact, there is no need of any other kinds of specialized machinery.

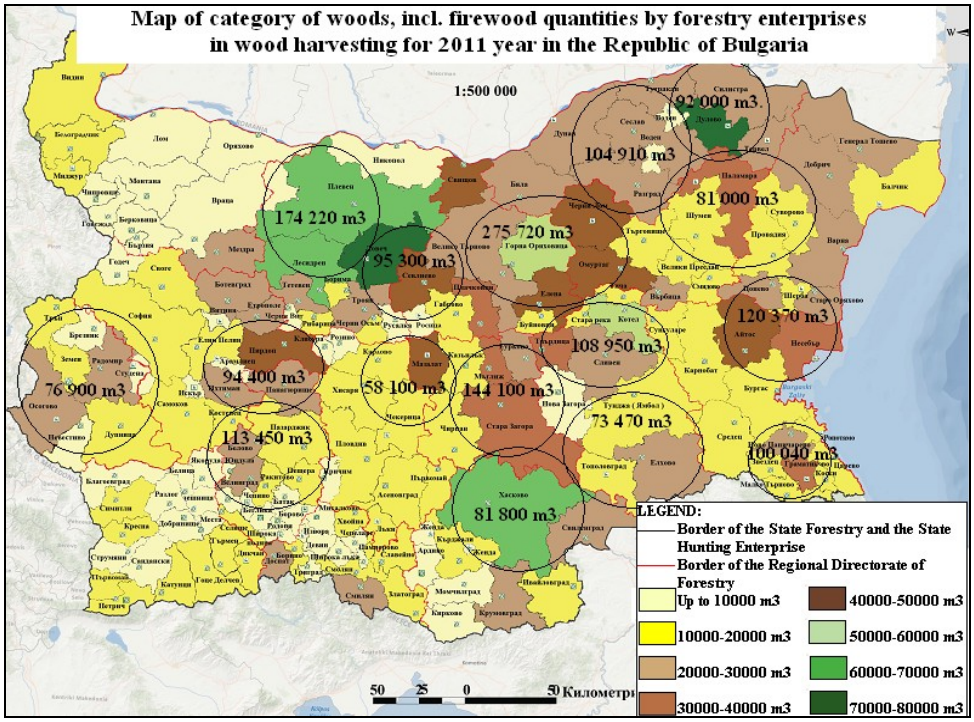

Figure 3: Quantities of the category harvested woods (firewood, woodpulp, wood-based panel mill etc), by Forestry Enterprises for 2011 in the Republic of Bulgaria

The purpose is the forestry waste of a low value to be transformed into a commercial product. In that case, the problems are related to the low value of the final product. For that reason, enormous efforts shall be made aiming at improvement of the work efficiency in the cutting areas, at reducing the costs, and, finally, at a necessary optimization of the entire production chain.

There are some reserves as regards to the extent of wood usage which has to be achieved, taking into consideration the forecasts and estimations provided by the Forestry plans (Forestry Management Projects), and, especially, regards to thinning operations where small- and medium-sized wood is harvested from. The stimulation of the market demand of such a type of wood for energetic purposes would assist the undertaking of that forestry measure which is of a significant importance for the state and sustainability of the young forests.

The share of the really conducted thinning has reached 40%, approximately, of the planned ones, regardless of the fact that an increase has been foreseen on the Forestry Management Projects in the recent years. It is also necessary to provide for an increase of the extent to which the usage of wood from temporarily inaccessible forest exploitation basins or the so called " closed basins " should arrive to.

As a whole, it may be said, taking into consideration the conditions in Bulgaria, and the forest wood biomass, that the usage of wood is strongly underestimated. The analysis of the data on the forest resources on a national scale has evidenced that since 1990, i.e. for the recent 22 years, the extent, which the annual use of wood has achieved to, varies from 33, 7% up to 50% of the total average annual growth of the forest in the Republic of Bulgaria. There are numbers to reflect precisely that strong underestimation of the extent which the use of wood has achieved to: both during the stage of projecting and subsequently, during the realization; i.e. that same potential has not be used by the present moment.

The harvesting of forest wood waste from thinning with the purpose of waste usage for biomass can be obtained along with the harvesting of the respective wood assortment or subsequently, in a further stage. That means the technology, applicable to the biomass harvesting, processing and transport, shall be introduced either into the existing one or into a newly applicable one for wood harvesting. Different

systems and technologies are used for the harvesting of wood assortments and different methods and technologies shall be applied to the harvesting of the waste of thinning.

4 Conclusions

The new Forest Act provides, with the purpose of a long-term planning of the activities performed by the State Forest Enterprises and the Logging and Wood Processing Companies and Firms for Wood Biomass Harvesting, that the State Forest Enterprises could contract with traders long-term agreements within a term up to 15 years: both for wood harvesting and wood sale. That is the way, opportunities to be created for reliability regards to wood resource, granted investments in new machinery, equipment, infrastructure, workers qualification and staffing; as well as, - last but not least, - for a sustainable production, management and implementation of the planned usage in the forests.

It can be definitely said: by simple normative measures only, the necessary resource of wood biomass for energy will not be provided; appropriate financial instruments and stimuli are also required with the purpose of improvement of the existing wood resource and creation of a new one, as well as to guarantee the assimilation and the processing of the forest resources for energy production from wood biomass.

What is necessary to be done in Bulgaria, it is the application of more efficient methods for assimilation, processing and transportation of the waste from thinning, before introducing that waste into the trade net.

A complex of measures, mechanisms, instruments is required to be applied to all and any sectors, - normative, fiscal, financial and organizational ones included, - to provide that a part of the forest wood biomass could be imposed as an alternative source of energy, competitive to the conventional fuels.

The State shall stimulate the usage of the forest wood biomass, - residues for heating and energy production included, as well, - by means of tax relief, grant schemes and more clarified procedures for the investors in technologies.

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