## Executive Summary:

ROD-PICKER aimed to develop, construct and test an automatic harvesting and sorting system for Short-Rotation Plantations (SRP) cuttings. The prototype developed during the two-year project consists of two modules: a harvesting module that works attached to a tractor and a sorting, cutting and bundling unit that prepares the harvested rods for their shipment to the end customer.

The prototypes developed in the project fulfill the requirements initially set for them. The harvesting module can be attached to a tractor and used in single or double row plantations. The increased speed of operation and the higher quality of the cuts results in a higher yield and a reduction in the time required to harvest, as well as in the costs.

The operations of sorting the rods harvested, cutting the parts that will not be sold (end of the branches, which are too thin to sprout, and side branches) and binding them in bundles and boxing is carried out by the second module of the prototype. This uses different sensors to analyze each rod introduced, measure it and process it, creating bundles of 50 rods.

As a result of the use of the prototype the harvesting yield increases in a 300%, with a decrease in costs of 46%. The initial target of performance production of two boxes per day by a two-lined sorting and bundling unit instead of one box produced by 6-8 workers (status before the development of the ROD-PICKER system) has been achieved.

One of the main principles while developing the ROD-PICKER technology was to minimize harmful environmental impacts and to comply with national and international regulations. The prototype's components have been optimized in terms of energy efficiency.

The project has had an important task in terms of awareness rising and training to relevant stakeholders. Around seventy people (SRP farmers and representatives for the industry) have attended one of the three training events held at the facilities of LEMPE (partner in the project) and seen the prototype demonstrated, or in Sweden.

## Project Context and Objectives:

Biomass is increasingly being seen as an important energy resource for Europe. In 2010 the European Commission (EC) set the

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### Project Information

**ROD-PICKER**

- **Grant agreement ID:** 315416
- **Status:** Closed project
- **Start date:** 1 October 2012
- **End date:** 30 September 2014
- **Funded under:** FP7-SME
- **Overall budget:** € 1 693 364
- **EU contribution:** € 1 284 000
- **Coordinated by:** EGEDAL MASKINFABRIK A/S, Denmark
indicative target of doubling the share of all renewables of the EU's gross inland energy consumption to 30% by 2020. One possible strategy suggested by the Commission is to triple the use of biomass energy compared with 1997. The current EU Directive on the promotion of the use of energy from renewable sources obliges all member states to increase the common share of renewable energy sources in final energy consumption from 8.5% in 2005 to 20% in 2020. However, capacity growth of certain renewable energy sources (RES) is restricted facing technical, sustainable and especially economic limitations. The lion's share of the projected growth is allotted to the utilization of biomass sources, which make up for roughly one third of current final renewable energy consumption. About 85% of this share can be allotted to woody biomass.

The majority of the wood being used in the energy sector is applied in private households and small scale heating stations primarily for heat production. Recently, woody biomass is also co-fired in coal fired power plants to improve the plant's CO2 balance. The additional wood demand which supplements the consumption of the traditional wood industries will exceed the potential of domestic forest resources. Overseas imports of biomass which come along with additional higher costs for transport and handling will mostly be economically relevant for large scale consumers with access to deep water ports.

Due to sustainability requirements the biomass which can be harvested from European forests has only a limited growth potential. Therefore, the political focus has changed to the production of fast growing wooden biomass (Short-Rotation-Coppice (SRC) or Short-Rotation-Plantations (SRPs) on agricultural lands in Europe.

In parallel, the economic situation for European farmers deteriorated constantly during the last decade because of increasing cost pressures on agricultural products. Priorities in EU’s Common Agricultural Policy change and foresee to strengthen farmers’ role in rural development and fulfilment of quality standards for environment, animal protection and food security. To be competitive, farmers are obliged to adapt their business activities in terms of alternative products and quality requirements. Short-Rotation-Plantations are a very promising alternative source of income by cultivating fast growing tree-species as a source for bioenergy or other purposes with multifunctional characteristics. SRCS are highly efficient biomass production systems with additional environmental contributions such as biodiversity, soil protection and local climate. Thus, SRCs perfectly meet general requirements not only for farmers in the EU28. In general, SRCs can be defined as plantations with fast-growing tree species (e.g. poplars, willows and eucalyptus) grown in high-density plantations on fertile (or marginal) agricultural land to produce woody biomass with maximum rotation periods of less than 30 years.

The cultivation of fast growing trees is not a new trend. Already in 1970, first test trials have been established in Germany and Scandinavia. Willow and poplar are the predominant species grown in Central and Northern Europe. Rising prices for fossil fuels and the EU Directive on the promotion of the use of energy from renewable sources raise the public awareness and political support for sustainable energy wood production. These factors abet the recent expansion of SRC areas.

Despite the advantages listed above and the political support, the vast majority of farmers are still skeptical about SRCs on their own lands. Common constraints are the relative novelty of the crop, the non-availability of planting and harvesting technology, high costs of establishment and the limited lease periods for agricultural areas. Further, the still ambiguous regulatory framework concerning SRC and the absence of effective support programs hinders the expansion of SRC. However, there are concrete intentions of several EU member states which should be implemented within the next years.

Based on this background the SME proposers planned to develop, construct and test an automatic harvesting and sorting system for SRC cuttings. The system should be able to combine the harvesting (cutting), sorting and packaging of the SRC cuttings. ROD-PICKER aims thus to achieving the following objectives:

**Overall objectives:**
- Development of an innovative, competitive and automatic harvesting and sorting system for SRC cuttings for European energy farmers.
- Enable the broad implementation of SRC in Europe by reducing the costs of the SRC cuttings by 60%.
- To increase the general competitiveness and sustainability of the European agricultural sector

**Scientific and technological objectives:**
- To develop, build and test a ROD-PICKER prototype including a harvesting, sorting and packaging module
- To reach and assure the compatibility of the ROD-PICKER prototype with existing handling and transport equipment

**Environmental objectives:**
- By producing SRC cuttings in a more cost-efficient way, the production of wooden biomass for the European biomass sector could be increased by 30% each year

**Socio-economic objectives:**
- To develop and test a market oriented and cost-efficient harvesting and sorting system which can be introduced successfully in the European agricultural market and worldwide
• To reach a market share in Europe of new sold harvesting and sorting systems for SRCs of at least 50% in the year 2017
• To distribute and commercialise the developed harvesting and sorting system in markets which will be not addressed directly by the SME consortium (world licence)
• To reduce the costs of harvesting and sorting of SRC cuttings for the final user by at least 60%
• To increase the production efficiency of SRC cuttings in comparison to manual harvesting for the final user by at least 500% by the same number of workers
• To summarize the existing knowledge in harvesting and sorting systems and transfer this knowledge to potential end users (awareness rising)
• To increase competitiveness of European farmers and therefore safe and create employment in rural areas
• To create new jobs in the production, maintenance and operation of the proposed system

The works in the first period of the project were the determination of end-user requirements and the design of the prototypes. In the second period, the RTD partners finalised the design of the modules and built the prototypes, which were then thoroughly tested under lab and real conditions. Furthermore, the system's performance and economic analysis were performed. Using the prototypes ensures a reduction of costs of a 46% against the current methods used (mostly manual), and a crop performance of 0.8 h/ha harvested, which entails an improvement of a 300% against current values in the industry.

Project Results:
Exploitable foreground foreseen and its status at the end of the project:
Result 1: ROD-PICKER modules and units developed and tested
Module 1: Cutting and Transport
The cutting unit has been specifically designed for ROD-PICKER. The unit can be used for both single rows and double rows without retrofitting. The cutting unit is driven by powerful hydraulic motors to achieve a high cutting speed. Optional milling heads beneath the cutting unit enable a subsequent trimming cut. Hereby, bastard branches and ramifications could be removed without additional cost effective working steps. The severed rods are fixed by geometrically optimized gripper fingers and are transported to the sorting module. The system is particularly modified to safeguard the susceptible rods. In comparison to the state of harvesting technology the cutting and transport module distinguish itself by an increased performance and a protective conveyance of the material.

Figure 1: The harvesting module during field tests in early 2014

Module 2: Sorting
Within the second module the rods are preselected by sensor controlled scanning. Being fully automatised, this working step represents a downright new development and has not been examined regarding its technical implementation. So far, planting material has been preselected and preconditioned manually after the harvesting step. The module shall detect and sort out damaged rods autonomously. Within the subsequent working step rootstocks and shoot apexes, which are of no use for planting material production, are removed. This step as well is carried out automatically and sensor controlled (each rod is individually scanned and measured). Clippings and damaged rods are stored in a separate container and could be used for energy recovery later.

Module 3: Bundling and Packaging
Within the last working module, the pretreated and preselected rods are concentrated and tied up into practical bundles of a preset total length. The user might adjust the diameter of the bundles automatically. The bundles are carried in special carrier boxes until the headland or the destined point of discharge is reached. These boxes represent an effective and protective solution regarding further transportation or storage. Present machines dump the rods at field side in a random pile. The consequential collection by grab is considered complicated and labor intensive.

Fig.2: General view of the sorting, cutting and bundling module
The development of this result is directly linked with the work packages 1, 2, 3, 4 and 5 of the Description of Work (DoW) of the project.

Result 2: Prototype of new ROD-PICKER system
The development of this result is directly linked with the work packages 1, 2, 3, 4 and 5 of the Description of Work (DoW) of the project.
Result 3: Prototype automatization and control unit, software
The control module of ROD-PICKER will be highly automated in order to minimize operation and maintenance work. Its design will include the interface between monitoring and control module, adequate hardware and software solutions and configuration (computer, control program).
The cost structure will be fixed, depending on the cost of the materials and manpower required to build the machines. These costs can be sold together or separately. The harvester can even be sold to SRP farmers to harvest them in rods, with just slight modifications. Revenues can be obtained from this service, but primarily they will stem from the sales of the machinery, and each of the systems can be installed, as well as the training required for the staff at the farm to operate the system adequately.

The exploitation model shall aim to achieve a close relationship to the customer. The system has some potential for adaptation to specific conditions at the farm where it will be installed and therefore, there is the chance for offering a premium service for the delivery and setup of the machines. The first and obvious service is the adaptation of the sorting unit to the facilities of the farm where it will be installed, as well as the training required for the staff at the farm to operate the system adequately.

Potential Impact:
Potential impact:
For the SME EGEDAL, which currently offers a semi-automatic planting machine for willow rods on the European market, offering also a parent tree quarters has been an objective for a long time. The opportunity to offer a new product for already established SRP farmers (existing customers) or supplying a unique, highly effective product for SRP parent rods harvest and selection that no other company can offer in their respective markets in Europe could significantly increase the company’s market position. EGEDAL anticipates the sale of ten machines within the first year of production. In the following years, sales should be increased by 20% annually.

The positive development of the market will also positively affect the SME partner SalixEnergi and Lempe. They are provided with an effective and economical working machine. The annual growth of SRC plantations in Europe is estimated to reach almost 30%. Without access to efficient harvesting technology both companies could not meet the steadily growing demand for planting material by their own capacities and would be dependent on imports from Eastern Europe (where low labor costs are low).

It would be possible to cope with the short harvesting intervals without additional labor cost efficiently and profitably. Both partners plan to increase their area of parent tree quarters. For example Lempe, as a specialist for cultivation and marketing of high performance poplar species in Europe, plans to increase the own parent tree quarters by 20 ha. Also additional harvesting service as a subcontractor would be enabled through the capacity increase and could generate a supplementary income. SalixEnergi, a pioneer regarding harvesting and management of SRC in Scandinavia, could make optimal use of its Europe-wide distribution network and act as the main distributor. Within the next 3 years SalixEnergi plans to increase the parent tree quarters for willow clones by 30 ha.

The realization and commercialization of the ROD-PICKER technology has a positive effect on the commercial activities of all 3 SME partners likewise. It facilitates the access to new market segments and the growth of the companies.

Two exploitation models for two groups of end-users: production and commercialization and exploitation by a cooperative. After discussing the possibilities of exploitation among the SMEs taking part in the project, it is clear that the two prototypes developed in the project are a viable product with prospects in the SRP market in Europe and beyond. The machines will be produced at EGEDAL, and commercialized using the network of SALIX and LEMPE. The main asset sold are the machines produced, and the main value propositions are the advantages the prototypes present for the harvesting of parent rods: faster harvesting, less waste material and a higher quality and a significant cost reduction. The fact that the project developed two prototypes will prove to be a highly valuable sales channel, as it will be used to demonstrate their features and benefits. Further revenues can be created from the maintenance and upgrade of the units sold once the line develops.

It is noticeable that this is a specific niche market, very reduced geographically. The direct client for the ROD-PICKER systems are the producers of seedlings for SRPs, which is a segment of the SRP industry that hasn’t yet reached its maximum growth potential. The strong value propositions of the ROD-PICKER systems in terms of the improvements they bring to the normal operations of these enterprises and the savings the entail (production is up to four times cheaper in the case of the harvester and slightly less than three times cheaper in the case of the whole system (harvesting+ sorting and bundling) will however prove a strong argument to the first clients. In this sense, we consider that the offering aspect of this business is very strong. Infrastructure and channels are also well established due to the fact that the partners initiating and commercializing this endeavor are the market leaders for SRP machinery. The facilities at EGEDAL, where the machines will be produced, and the network of contacts and experience of SALIX and LEMPE ensure that the channels and customer relations are well established even before starting operations. The exploitation model shall aim to achieve a close relationship to the customer. The system has some potential for adaptation to specific conditions at the farm where it will be installed and therefore, there is the chance for offering a premium service for the delivery and setup of the machines. The first and obvious service is the adaptation of the sorting unit to the facilities of the farm where it will be installed, as well as the training required for the staff at the farm to operate the system adequately.

Revenues can be obtained from this service, but primarily they will stem from the sales of the machinery, and each of the systems can be sold together or separately. The harvester can even be sold to SRP farmers to harvest them in rods, with just slight modifications. The cost structure will be fixed, depending on the cost of the materials and manpower required to build the machines. These costs can
be brought down once the process is established at EGEDAL.

As we are aware of the high investment costs required to install the ROD-PICKER, more than 172,000, we are considering that the exploitation will most likely follow a cooperative model. In this way, producers of rods can share the harvester, transporting it to different fields. The sorting and bundling unit can be installed at one of the farms and be used for processing the harvest from all members.

An additional source of revenue for the members of the cooperative can be using the harvester for SRPs and a fee for this service. The costs are fixed for the machinery and its operation.

In many aspects, this business model is similar to selling the machines, the value propositions are the same, as are most of the channels, though oriented from farmer to farmer, from members of the cooperative to other prospective members. In this respect, the cooperative will have to decide its maximum possible number of farmers based on the area they own and the capacity of the machines. Due to the seasonality of the business, this will be a limitation also for future expansion plans.

Infrastructure will be also one of the main initial decisions the farmers will need to make, as the sorting, cutting and bundling unit requires a considerable amount of space for operation. That, however, should not be a problem in the sector we are dealing with. The key activities will also shift from the production of the machines to their operation, which becomes then the key resource.

This business concept could be the best option for farmers producing seedling material that are in a relatively close geographical area.

Increased performance in SRPs through the use of the ROD-PICKER system

In summary, the performance of the developed system is satisfying and good. The comparison with other systems has shown advantages (lower fuel consumption) and disadvantages (higher electricity consumption due to a higher degree of automation) of the system. The harvesting yield of the developed harvesting module (0.8 ha/h) is higher than those from alternative harvesting machinery (around 0.2 ha/ha).

The economic benefits of the ROD-PICKER system against current practices on farm are clear: with a decrease in costs of 46%, the impact on the sector entails lower prices for parent rods and higher benefit margins:

Table 1; Cost comparison between manual harvest and ROD-PICKER harvester

Figure 3; Cost comparison between manual harvest and ROD-PICKER harvester

For a better illustration, the cost pools of the two process variants are depicted next to each other in figure 3. In addition to direct cost savings, also a higher area performance is achieved by the ROD-PICKER harvester. Thus, the available harvesting window could be used more efficiently. This offers also the entrepreneurial potential to harvest third party parent tree quarters as a service provider.

Main dissemination activities:

ROD-PICKER envisages a dissemination and exploitation strategy that foresees dissemination activities to be performed along the project implementation and further activities aimed at the dissemination and exploitation of the project results. The project's dissemination activities have the general objectives of spreading the notion of automated SRP harvesting and handling, and of fostering the implementation of the new ROD-PICKER system among European farmers both in existing SRPs and in new facilities.

Activities and target groups:

In order to assure appropriate dissemination during and after its duration, raise awareness and assure the continuity of the achievements beyond, the dissemination strategy considers the following target groups:

- Agriculture SMEs (energy farmers), which could improve the efficiency of their harvesting processes by the implementation of the new ROD-PICKER technology.

These include those SRP farmers producing seedling material (“parent rods”) and SRP farmers.

- General public: Given the role played by public opinion concerning agriculture, it is important to consider the general public as a target group of the ROD-PICKER plan, raising awareness of advantages of the ROD-PICKER technology in relation to wooden biomass production and regional energy concepts.

The dissemination activities undertaken during the project aim at ensuring that the results are disseminated as swiftly as possible, with EGEDAL being responsible for assuring that they are compatible with the protection of intellectual property rights, confidentiality obligations and the legitimate interests of the SMEs.

The general dissemination instruments for the presentation of the project activities and expected results include:

- a web page, http://rod-picker.eu
The website, which was launched at the beginning of the project, has not only provided general information about the project, its objectives, partners and progress, but also has served as an online repository of the dissemination materials (the leaflets are available to download. The main training events and meetings have also been announced through the web, and extraordinary training material, such as the video prepared by TUD is available there.

An analysis-tool for the website shows a number of 20 – 30 clicks per day in average. The average number of visitors ranges on a consistent level during the analysed period (December 2013 – September 2014). Extrapolation of an average of 25 visitors per day lead to a total number of 10,000 – 15,000 clicks. The top referrers have been edeal.dk salixenergi.se and of course google.de.

- Two project leaflets

A digital version of the second leaflet in English and German language was uploaded in the website and made available for download since February 2014. It was also produced in a poster version, which enabled the presentation of the project at fairs and events.

- A project PowerPoint presentation

- Press releases published in generalist media

Different generalist media have used press releases of the consortium for a publication in their media. In the most cases these have been online releases. Examples are the publications on the websites Scinexx, 2013 – an online magazine on the topics of geography, geology, nature, environment, biology, ecology, health etc. – and on Proplanta, 2013 – an online-portal for agricultural topics. Further press releases in generalist media can be found in section 4.

- Appearances in radio or television outlets

In addition to reporting in magazines etc. ROD-PICKER used the tools at the reach of the partners to prepare audiovisual content for dissemination and training purposes. These included TV and internet video.

During the testing season the team of TUD recorded videos of the harvesting unit several times for internal use. One video of the harvesting module was published in www.youtube.com to the general public in June 2014. Its duration is 1:44 minutes and it shows the harvesting of willows in a nursery in Eastern Germany. It has had 260 visits since it is available.

- A second video with a duration of ca. 8:00 minutes was produced by the UPT to explain the function of the sorting and bundling unit. It was produced during the testing season in January/February 2014 in Germany. Figure illustrates a screenshot of the video which isn't available to the general public. But the SMEs have it for further dissemination purposes and it was used for explanation of the unit and general information about SRC during workshops, trainings, fairs and expert meetings.

- During a technical project meeting in Timisoara on 23rd October, 2013 the local TV station from Romania Digi24 took some footage about the development of the sorting and bundling unit developed by the UPT. Therefore interviews with all involved partners were conducted and the results of work at that time were shown to the TV-team. The results of their recordings were broadcasted through the channels of Digi24 on October 23rd, 2013. An online article as well as the broadcasted video can be found in (Digi24.ro 2013).

The specific dissemination activities consisted of the following activities:

- Including the project in the websites and/or newsletters of the partners (in the figure, the Newsletter published and sent by EGEDAL)
- Advertisement of the project at the SMEs and via institutions supporting the activities of this sector such as chambers of commerce, the relevant ministry of enterprise, as well as any industrial association they might belong to

Some of the conferences visited by the partners were organised by associations and organisms linked to the renewables or to the engineering sectors, such as VDI. Furthermore, a link to the project and to the video showing the operation of the harvester has been included in the web page of the market and information platform for SRP in Germany, KUP-Netzwerk (http://www.kup-netzwerk.info/).
Promotion on specialised trade fairs

The SMEs have participated in specialised fairs like the Agritechnica 2013 (12.-16.11.2013) in Hannover (Egedal, Salixenergi) at which the leaflet was mainly used by the SMEs to present the project.

The project has been also presented at the Hannover Messe 2014 – a general industrial fair with a wide variety audience but an integrated experts meeting called Industrial GreenTec – and the IFAT 2014 – a trade fair with a focus on environmental topics in Munich, Germany. At both fairs ttz had a stand where ROD-PICKER and other projects were presented.

Publications in specialised magazines, according to the SME's business, market and target groups.

- In the context of the field tests a journalist of the German magazine “Energie aus pflanzen” (publisher: Forstfachverlag) – specialised in topics of renewable energies like energy production from biogas, use of wooden biomass etc. – was participating in the workshop and training activities. As a result of the participation a four-page article about these activities and the project in general was published in the issue 02/2014 of the mentioned magazine (see Figure 4).

- Issue 04/2013 of the above mentioned magazine contains a small article about the project in general and was published in mid-2013 with the headline “ROD-PICKER für die schnellere und schonendere Emte von Ruten” (english: ROD-PICKER for faster and gentler harvesting of rods). Other publications were given with releases in the “Forstmaschinenpro – a magazine about machinery in forestry (see Forstmaschinenprofi, 2014) and in the TASPO – a weekly published magazine about the green market in general (TASPO, 2014).

Scientific publications: The RTD performers have submitted six scientific publications prepared on the work performed in the project to the SMEs, and requested their consent to publication before its submission for review. In the case of UPT, The first publication was done in the “buletinal Agir”-journal, published by ”The General Association of Engineers of Romania” in July 2013 (Ionel, et al., 2013). It deals with the general background and idea of the project as well as the tasks fulfilled by UPT. A second publication was published in a conference transcript which was concerned with the determination of characteristics of energy willow rods (Tucu, et al., 2013).

The publications by TUD comprise the appearance in two conferences (these presentations are mentioned below in the corresponding section) and a publication in LANDTechnik, in March 2014, published by VDI, the German Engineering Association.

Expected exploitation:

The partners started discussing the need for patenting the results obtained from the end of the test season until the end of the project. In the discussion about IPR issues in the final meeting, all SMEs agreed on the following points, as collected in the final meeting’s minutes:

- Applying for a patent on any of the systems does not make much sense, as EGEDAL, SALIX and LEMPE belong to the top companies in Europe developing these technologies. The partners do not see a risk in other companies using this knowledge without permission.

- The prototype will remain at LEMPE, where it can be further used. Furthermore, it will be a permanent demonstration site for clients.

- It would be worth to pursue new projects under the SME instrument in Horizon2020 with the team in ROD-PICKER to improve the prototype and carry out a thorough market study. New proposals will be prepared in the upcoming calls.

The partners in the consortium have identified dissemination activities as necessary for the successful completion of the project, and have sought not only participating in events such as conferences and fairs, but also to present the project to their business partners. These contacts are not reflected in the tables for dissemination events due to their informal nature.

Even though dissemination of the project objectives and results is an objective for the partners, each beneficiary is aware of the restrictions in terms of disclosing confidential foreground.

Dissemination activities including but not restricted to publications and presentations shall be governed by Article II.30 of the Grant Agreement. In the case of a party objecting a publication has to show that its legitimate interests will suffer disproportionately great harm and shall include a request for necessary modifications. In order to avoid conflict, a party may not publish foreground or
background of another party, even if such foreground or background is amalgamated with the party's foreground, without the other party's prior approval. Any data which is to remain secret should be cleared labelled as confidential. Parties agree to abide by the default notice period foreseen in the grant agreement to communicate their planned dissemination activities with a notice at least 45 days prior along with sufficient information about the intended dissemination.

In the final meeting the partners have agreed on continuing the dissemination activities once the project is over, both attending to events (fairs, conferences) where the results of the project can be showcased, and meetings at Lempe, where the prototype can be used in demonstration workshops and meetings.

A session of the final meeting was dedicated to future dissemination events, and the partners have prepared a list of events where the objectives and results of the project can be explained to potential clients. A preliminary list of events comprises the references below:

- Visit of Danish farmers organized by EGEDAL to visit the prototype. Höfgen, Germany. Spring 2015.
- Agricultural Fair, Borgeby. Borgeby, Sweden 24-25 Jun 2015
- Agricultural Fair, Agritechnica. Hannover, Germany 8-14 Nov 2015. The possibility of bringing the prototypes to the fair is being discussed by the SME partners.

The RTDs have also expressed their compromise to further dissemination using the basic materials prepared during the project (leaflets, PowerPoint presentation)

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Related documents

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