Optimized Fuels for Sustainable Transport

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Deliverable 1.7

Short Rotation Coppice Plantations

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Status and progress of established SRC plantations

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1. Summary

Between 2009 and 2011 roughly 230 ha of short rotation coppice (SRC) plantations have been established in 5 different regions in Germany and Poland, exceeding the project aim by 15%. The cooperation concept developed within OPTFUEL has been implemented successfully, aligning the needs of farmers and biomass off-takers. The plantations proved the practical feasibility of large-scale commercial energy wood productions and provided testing area for different tree varieties, planting techniques and management measures as well as for additional R&D activities of universities.

After CHOREN's insolvency, the SRC fields are now managed by the respective farmers, whereas almost all farmers in Brandenburg and Poland joined a long term off-take agreement with Energy Crops GmbH (a subsidiary of Vattenfall) to supply biomass to their heat & power plants in Berlin. Lignovis signed new contracts for all fields in Saxony. Other plantations are now operated by farmers on their own risk. Lignovis maintained a very good relationship to all farmers after CHOREN's insolvency.

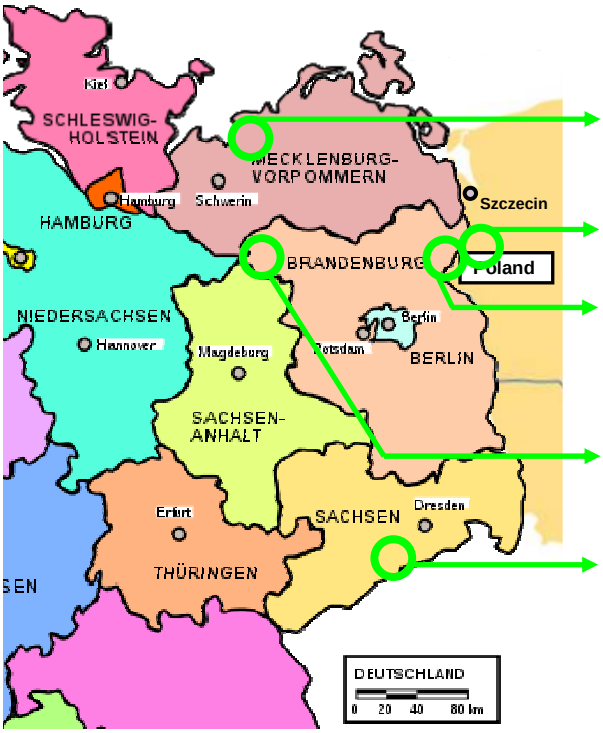
Each year ratings have been executed on OPTFUEL fields to assess the plantations development. Additionally commercial harvesting activities provided hands-on numbers on biomass yields. In the Freiberg region the harvested volumes equates a mean annual increment (MAI) of 8 bdt/ha/a in the first rotation after 4 years. The yields of the following rotations will be higher as the trees' rooting systems are developed and weed competition is lower. Over the whole 20 year life time biomass yields between 8 and 14 bdt/ha/a are assumed for most OPTFUEL plantations.

Ratings and visual assessments of OPTFUEL plantations showed a diverse development as the trees' growth depends on several parameters (e.g. tree variety, soil quality, weed competition, groundwater access and rainfalls). Poplar and willows, which are cultivated on more than 95% of the OPTFUEL area, showed the best results. On all fields, effective weed-management in the first year after establishment proved to be crucial for a good plantation development.

Due to the establishment and management of OPTFUEL plantations, Lignovis was able to identify the best performing tree varieties, cost efficient management activities and preferred growing conditions. Lignovis will continuously implement the know-how, gathered during the OPTFUEL project in commercial SRC activities and future R&D activities.

2. Status of SRC plantations under OPTFUEL

Within the OPTFUEL Project 230 ha of SRC plantations have been established in five different regions in North-East-Germany and Eastern Poland between 2009 and 2011. The last 20 ha have been planted 2011 in North-West Poland, exceeding the project's goal of 200 ha SRC plantations.



Mecklenburg - Western Pomerania:
Kröpelin region
2009: ~ 43 ha on 5 fields with 2 partners
2010: ~ 35 ha on 3 fields with 1 partner

North – West Poland:
Szczecin region
2010: ~ 16 ha on 3 fields with 2 partners
2011: ~ 20 ha on 4 fields with 2 partners

North-West Brandenburg:
Schwedt region
2009: ~ 20 ha on 4 fields with 4 partners
2010: ~ 19 ha on 4 fields with 2 partners
2011: ~ 4 ha on 1 field with 1 partner

North-East Brandenburg:
Prignitz region
2009: ~ 25 ha on 2 fields with 1 partner

Saxony:
Freiberg region
2009: ~ 14 ha on 1 field with 1 partner
2010: ~ 33 ha on 6 fields with 2 partners

Figure 1: SRC plantations established under OPTFUEL

On almost all plantations different varieties of poplar and willow have been planted. New commercially available breeds have been tested to gain a broad experience regarding the performance for upcoming plantation projects. In total, more than 40 poplar and willow varieties are growing on OPTFUEL plantations. Small plots of black locust, eucalyptus trials and domestic trees have been tested on specific sites.

Plantations were established in double and single rows, with row distances between 1.80m and 2.40m. Poplar, which makes up for more than 2/3 of the plantation area, usually has been planted at a density of 10,000 cuttings per hectare. Willow, which covers almost 1/3 of the area, usually has been planted at a density of 13,500 cuttings per hectare.

The plantations were set up as demonstration fields to:

- Prove the feasibility of large scale biomass supply from SRC plantations
- Test different planting techniques and planting layouts

- Assess different weed control measures and harvesting chains
- Provide SRC plots for demonstration purposes and dissemination activities

The respective landowners joined a special cooperation agreement with CHOREN Industries, which operated the plantations until its insolvency in late 2011. As the successor of the CHOREN Biomass department LIGNOVIS GmbH continued the SRC activities and fulfils the outstanding OPTFUEL tasks. LIGNOVIS continued the cooperation with the partnering farmers in Saxony and agreed with the other partners to get access to all other OPTFUEL plantations for monitoring. The respective farmers now manage the remaining plantations. Lignovis continues to consult those (if requested) regarding plantation management and harvesting activities.

2.1. Ratings

Ratings of different poplar and willow varieties, black locust and other domestic tree species have been performed on OPTFUEL fields. The highest yielding varieties have been identified for specific site conditions. Lignovis is applying the gathered experience in new plantation projects.

The ratings have been executed in cooperation with experts of the Eberswalde University for Sustainable Development according to following methodology:

(1) Selection of representative samples plots of single varieties (considering diebacks and heterogeneity of growth)

(2) Measuring and marking of sample plot (average area of 40 m²)

(3) Mensuration of stem diameter at 1 meter height of trees within sample plot

(4) Definition of biomass function by harvesting, measuring, drying to 0% moisture and scaling of representative stems

(5) Calculation of stem mass based on diameter and biomass functions specific for each variety

(6) Calculation of average mass per hectare based on the average mass of the measured plot

(7) Calculation of the mean annual increment (MAI) by dividing the average mass by the age of the stands

Picture 1: Measuring of sample plot and mensuration of stem diameter (December 2012)

Picture 2: Representative stems for calculation of biomass function (December 2012)

The following table provides an overview over the MAI in bone dry tonnes (bdt) per hectare (ha) and year (a). Please note, that fields with different age of stands and different rotations have been measured.

	Field	Age of stands [years]	Rota-tion	Poplar Low [bdt/ha/a]	Poplar **Average** [bdt/ha/a]	Poplar High [bdt/ha/a]	Willow Low [bdt/ha/a]	Willow **Average** [bdt/ha/a]	Willow High [bdt/ha/a]
established in **2009**	**Freiberg II**	**3**	**1st**	based on harvest in February 2012:		**7,3 bdt/ha/a** (poplar & willow)			
	Freiberg II	**4**	**1st**	based on harvest in January 2013:		**8 bdt/ha/a** (poplar & willow)			
	Freiberg II	1	2nd	-	**-**	-	6,4	**7,9**	10,0
	Kröpelin I	4	1st	5,5	**7,4**	8,4	-	**9,9**	-
	Kröpelin II	4	1st	-	**4,6**	-	5,1	**7,1**	8,7
	Kröpelin III	4	1st	2,3	**5,8**	7,1	6,0	**6,7**	7,4
established in **2010**	Freiberg VI	3	1st	-	**-**	-	6,2	**7,7**	8,5
	Freiberg IIX	3	1st	2,5	**4,1**	5,8	5,0	**6,5**	7,6
	Kröpelin IV	3	1st	4,5	**4,9**	6,2	-	**-**	-
	Schwedt II	3	1st	-	**5,2**	-	4,1	**5,3**	5,9
	Schwedt II	2	2nd	-	**7,1**	-	-	**-**	-
	Schwedt III	3	1st	3,8	**5,3**	6,3	7,4	**8,2**	9,2
	Schwedt III (long rotati-on)	3	1st	1,7	**3,3**	4,4	-	**-**	-

Table 1: Mean annual increment of selected fields in regard to tree species, age of stands and rotation

In the 1st rotation the best willow varieties usually show higher mean annual increments (MAI) compared to poplar. This is mainly caused by the higher planting density of willows. Starting with the 2nd rotation, it is expected that well managed poplar clones outperform willow varieties on most sites. However, for some site conditions willow shows generally higher growth rates than poplar. Based on the yields of harvesting operations on plantations in the Freiberg region an average MAI of 7- 8 bdt/ha/a was determined for the first rotation. This included stands of different poplar and willow stands alike. The actual yield was about 10% higher than previous ratings would suggest.

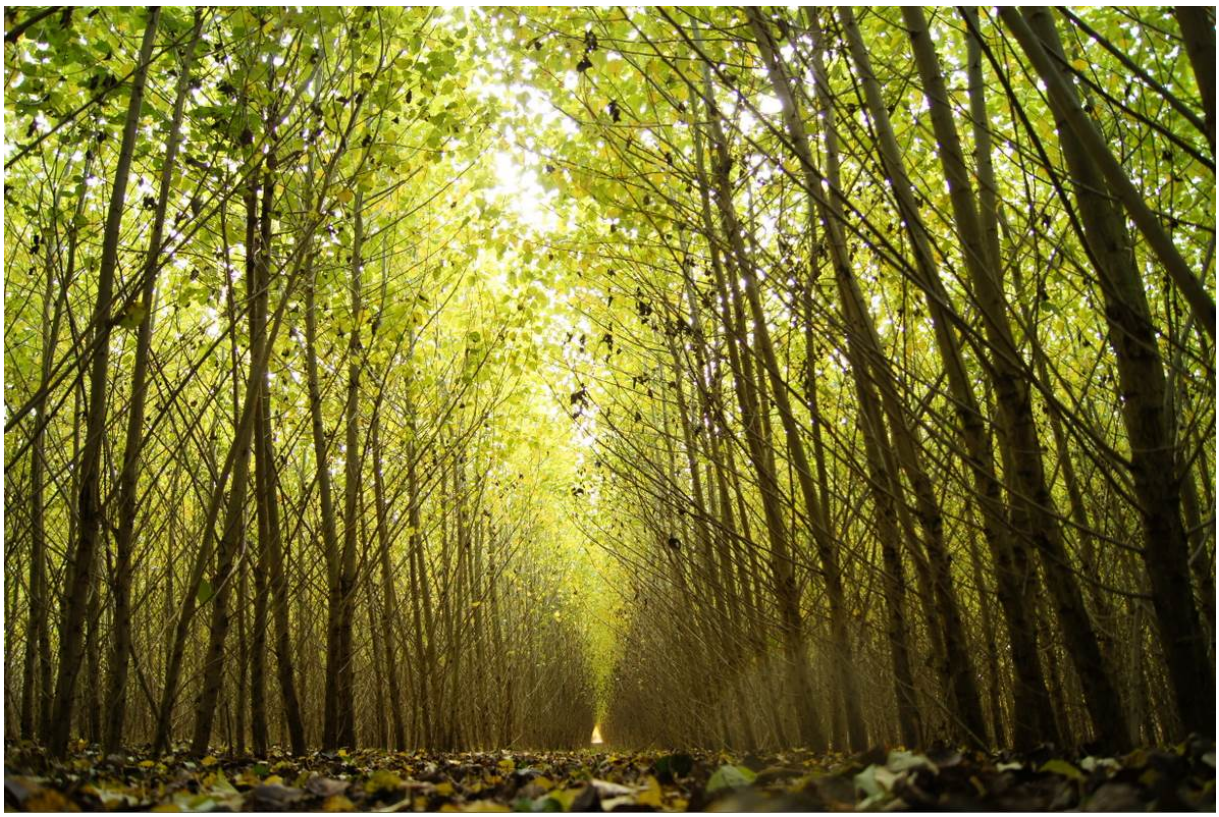
Under difficult site conditions black locust and alder showed comparable results to poplar and willow. But, as anticipated, unimproved domestic tree species (planted for diversification) showed about 60% lower growth rates compared to poplar and willow hybrids.

For all varieties the MAI is expected to be at least 50% higher in the 2nd rotation, as root system is developed and weed competition was reduced in previous years. Over the whole 20 year life time a MAI between 8 and 14 bdt/ha/a is assumed for most OPTFUEL plantation. A more in depth look at the development of the specific OPFTEUL fields is provided below.

2.2. Kröpelin region

The former agricultural company is now managing the plantations on its own account. It is planned to harvest a portion of the fields established in 2009/10 in spring 2013 and the rest one growing season later. In general the plantations developed well. Most willow and poplar stands are dense and shade off weeds effectively. But in some stands of Italian black poplar clones dothichia canker (cryptodiaporthe populea) have caused apparent diebacks. Other poplar clones showed a higher resilience and have not taken serious damage.

Picture 3: Dieback of Italian poplar clone (AF2) due to dothichia canker on site nearby Kröpelin/Germany (July 2012)



Picture 4: Well established poplar (Max clone) stand on same field nearby Kröpelin/ Germany (October 2012)

On some poplar plots (established in 2009), a growth of more than 9 bdt/ha/a was measured in December 2012. Also some willow varieties on the same field exceeded 9 bdt/ha/a. On a field with stagnant moisture (established in 2009), which was considered as not suitable for conventional agriculture without additional drainage, poplar and willow showed high MAIs of more than 7 bdt/ha/a in the first rotation.

Picture 5: 3.5 year old alder plantation on wet soil near Kröpelin/ Germany (July 2012)

The established eucalyptus trials have not survived the frosts of the following very cold winter seasons (~ minus 20°C). Only a few trees have shown signs of regrowth. As a consequence, the agricultural partner recultivated the eucalyptus trials in 2012. The breedings which are cultivated in Scottish regions with mild climatic conditions during wintertime, might still need further adaption to cope with continental climate.

Picture 6: Eucalyptus test trial near Kröpelin/ Germany (February 2012)

A sister company of the agricultural cooperation partner (AgroEnergy) near Kröpelin, has established additional 45 hectare in the Prignitz region in 2011 on own account. The average development of these plantations is very well.

2.3. Prignitz region

In the Prignitz region the agricultural OPTFUEL partner now manages the OPTFUEL plantations on own behalf and also extended its SRC activities over the past years. In January 2013 the former OPTFUEL fields and some SRC fields of agricultural partner have been harvested. The average yield of all fields was reported to be 5 bdt/ha/a. Supported by the OPTFUEL project, SRC cultivation could be established as an integral part of company's business. The former OPTFUEL partner is planning the establishment of further plantations on his fields.

Picture 7: 2.5 year old well established poplar planations (Max clone) near Putlitz/Germany (Summer 2011)

2.4. Schwedt region

Almost all farmers with OPTFUEL plantations near Schwedt signed new cooperation agreements with Energy Crops GmbH, a subsidiary of Vattenfall. The cooperation model is similar to those developed by CHOREN and aims at the biomass supply of Vattenfall's biomass heat & power plants in Berlin. Some of the plantations established in 2009 and 2010 have been harvested in spring 2013. The harvest was organised by Energy Crops and was executed with a stem harvester. Based on their experience from OPTFUEL two of the former partners are intending to extend their plantation area in the upcoming years.

Picture 8: 1.5 year old poplar stands (regrowth after 1st harvest) nearby Schwedt (August 2012)

On the first established OPTFUEL field in that region, especially the willows show an impressive regrowth after the harvest in January 2011. A MAI of more than 11 bdt/ha/a has been measured on some plots after two growing seasons. As a reference, one plot of the best performing willow variety was not treated with herbicides and other weed control activities after harvest. The measured MAI did not exceed 2.5 bdt/ha/a on that plot. That should point out the importance of weed control even in the second rotation. The poplar plots on that site showed a moderate regrowth of app. 6 bdt/ha/a (weed competition on poplar sites was stronger and no management activities have been performed after the first harvest). It is assumed that the third vegetation year of poplar will result in significant higher growth rates.

Picture 9: 1.5 year old willows (left) and regrowing poplar after harvest (center) near Schwedt (June 2011)

On another field, where poplars have been initially planted for longer rotations, the poplar stands showed an impressive growth. Three growing periods after establishment, the average stem diameter at ground reaches 15 cm on some trees. Most field chippers are not capable of cutting these diameter, so a whole stem harvester was used for harvest in early 2013.

Picture 10: 3.5 year old poplar plantation with good growing results near Schwedt (June 2012)

Picture 11: Harvest of poplar stands (4 years old) near Schwedt (February 2013)

The ecologically enhanced SRC plantation, which has been set up in cooperation with the German Nature and Biodiversity Conservation Union (NABU) near Schwedt, showed a heterogenic growth 1.5 years after planting. The domestic trees grew in average only one third of the height compared the poplars and willows on that site. Regarding height, the poplars were slightly ahead of the willows. Partially, the domestic trees were affected by browsing of wild game. NABU is continuing the research project on that particular field but also includes other former OPTFUEL fields in their examinations. Lignovis supports the activities with ratings, economic calculations and regular plantation status updates.

2.5. Szczecin

Similar to the development in the Schwedt region, the former OPTFUEL partners joined the cooperation with Energy Crops. Only one field (app. 11 ha) has been reconverted to annual crops as the growth was below expectations and the further perspective for SRC wood seemed uncertain in that region after CHOREN's insolvency. The minor growth was caused by planting material of bad quality. Additionally a more effective weed control would have been necessary, but the farmer could not work on the site with heavy machines due to very wet soil conditions after planting. All other fields have developed well and show well established poplar and willow stands.

Picture 12: A young stand of poplar on very wet site nearby Szczecin/ Poland (August 2011)

Picture 13: Damage caused by game animals (red dear) in a 6 month old stand poplar near Sczcecin/ Poland (August 2010)

Picture 14: Well grown one year old Poplar plantation near Szczecin/Poland (July 2012)

2.6. Freiberg

All OPTFUEL fields nearby Freiberg are now managed by Lignovis in cooperation with the respective farmers. After the harvest in February 2012 on app. 5 ha, app. 11 ha (1st rotation) have been also harvested in January 2013. A NewHolland and a John Deere field chipper with a hydraulic driven cutting head of Salix Energi has been used. Based on the yield, the MAI of the harvested stands was around 8 bdt/ha/a within the first rotation. For the second rotation considerably higher yields are expected.

It is planned to harvest the remaining fields next winter (2013/14) as it proved out that a 4-years long first rotation reduces harvesting costs per ton significantly. Later on, it is expected that a 3-year harvesting cycle is ideal. With that, a continuous flow of wood chips could by generated each winter. The wood chips are marketed mostly to biomass heat and power plants. In 2012, SRC wood chips have been also delivered to the particle board industry.

In summer 2011 and 2012 yield depression has been caused by saw fly (Nematus papillosus) on some plots. Some varieties showed an increased resistance. Pesticides have not been applied yet, but the application will be considered if the infestation continues next growing season.

The regrowth after first harvest was excellent (except the Italian clones). The MAI of the one-year-old willows harvested in early 2012 almost matches the MAI of the 4 year old willows on the same site. In general, willow varieties showed a higher MAI within the first rotation than the poplar clones, although some poplar plots also exceeded willow. It is expected that the

poplars will catch up in the following rotations. The plantations around Freiberg will be monitored by Lignovis also beyond the OPTFUEL project to allow for long term yield assessments

Picture 15: Harvested plantation after a few months in front, 3.5 year old plantation in the back near Freiberg/ Germany (August 2012)

Picture 16: 3.5 year old poplar on OPTFUEL field near Freiberg/ Germany (October 2012)

Picture 17: Biodiversity on fields near Freiberg/Germany (September 2012/ summer 2011)

3. Plantation management

3.1. Weed control

Within the OPTFUEL project, the application of pre-emergent herbicides at the right time & conditions after planting was identified as beeing the most important weed control measurement. On plantations, where this could be implemented successfully, the germination of new weeds could be delayed until summer. This gave the trees the crucial advance and facilitates the following (mainly mechanical) weed control measures.

Picture 18: 6-month old test plot, where pre-emergent herbicides were not applied (front) and well developed willow stand (back) near Schwedt/ Germany (September 2009)

Several mechanical and chemical weed control techniques have been tested on OPTFUEL fields. Concerning mechanical measurements, especially rototillers have been used. Rototillers are offering good results and remove weeds effectively. However, application of rototillers on stone rich soils is limited, as downtime and cost increases significantly. A disc harrow modified for the plantation's row distance is considered as an alternative. More experience with different kinds of weed control machinery is needed for final assessment and will be gained in the next growing seasons.

Picture 19: Mechanical weed control with a special rototiller for double row layouts on a young poplar stand nearby Szczecin/ Poland (July 2011)

Picture 20: Mechanical weed control with a special rototiller for single row stands on a young poplar stand nearby Kröpelin/ Germany (August 2010)

Picture 21: Mechanical weed control with a mulcher on poplar plantation near Schwedt/ Germany (June 2011)

Concerning chemical weed control, shielded spraying systems developed by the company Mantis ULV have been successfully used on OPTFUEL fields. These systems allow the efficient application of herbicides between the rows but also underneath the trees. Thereby, weeds can also be eliminated within the rows were the water competition with the trees is most critical. Due to the shields, the contact of herbicides with sprouts and leaves of the trees is avoided. As the applied spraying systems have been designed for pomiculture, additional modifications were necessary to increase the machines' robustness.

Picture 22: Chemical weed control with shielded spraying system

The costs for weed control via rototiller and application of selective herbicides by a shielded spraying system are comparable. In general, a combination of pre-emergent herbicides, mechanical weed control and selective herbicides has been applied on most OPTFUEL fields after establishment. On plots, where those measurements have been executed too late, additional measurements have become necessary in the following years. If weed control is performed professionally in the first year. Further weed control measures in the years commencing are not required or can be reduced to a one-pass mechanical action (e.g. disc harrow).

3.2. Pest control

Insects

Several insects feed on poplar and willow plant parts, but only the massive occurrence of those could pose a significant danger to plantations and yield expectations. Since 2009, four insect species have caused noticeable damage on OPTFUEL plantations. Once discovered, the pest populations have been monitored and documented frequently.

Picture 23: Feeding damage of saw fly (Nematus papillosus) larvae near Freiberg/ Germany (May 2012)

Pesticides have not been applied on OPTFUEL fields yet, but on two other sites in Brandenburg managed by CHOREN. After the first harvest, an infestation of blue willow beetle (Phratora vulgatissima) has been successfully contained with the application of Karate with an agricultural sprayer in early 2011. There was no further occurrence of willow beetle on these fields since then.

Picture 24: Willow beetle on harvested willow plantation near Schwedt/ Germany (April 2011)

All occurrences of pests, the impact on the plantations and the further development are described in the following table:

Name	Location and first observation	Impact	Measures	Development
Blue willow beetle (Phratora vulgatissima)	2 fields in Schwedt region 2011 (and 2012)	minor feeding damages	None, due to minor impact and active antagonists	Regrowth, small population also in 2012, active antagonists
	1 field in Schwedt region in summer 2012	Apparent feeding damages	None	
Sawfly (Nematus papillosus)	1 field in Freiberg region in summer 2011	Feeding damage on small parcel	None	Regrowth, continuing infestation in 2012
	5 fields in Freiberg region in summer 2012	Feeding damages on certain parcels	None, Scientific monitoring activities of TU Dresden	Reduction of population of 3rd generation in late summer (potentially increase of parasites and antagonists)
Poplar Leaf Beetle (Chrysomela populi)	1 field in Freiberg in summer 2011 (and 2012)	Feeding damages at shoot apex	None, to acceptable impact	Feeding damages in spring on young shoots of harvested fields, general damages in late summer

Lined Click Beetle (Agriotes lineatus)	1 field in Schwedt region in 2009	Bending and die back of young sprouts (feeding damage on bark at sprout base)	None, due to acceptable damage	Few damages limited to following spring

Table 2: Damages from insect pests on OPTFUEL plantations

The feeding damages from insects did not pose a significant risk for the plantations' development so far. Some populations even collapsed within one growing season. Natural antagonists and parasites are usually balancing problematic developments within an acceptable period of time. However, continuous monitoring remains important to identify crucial threads early enough and to initiate counter measures immediately. In the upcoming growing season, Lignovis will especially observe the sawfly population on the plantations in Freiberg region. Though the population has been decreased due to natural factors in last summer, the appliance of pesticides might become necessary if the sawfly larvae are also spreading to so far unaffected areas of the plantations. The pest developments in Freiberg region are continuously observed by the TU Dresden and the Eberswalde University for Sustainable Development.

Picture 25: Poplar Leaf Beetle (Chrysomela populi)

Wild game

Browsing by game animals has occurred to a minor extend on almost all OPTFUEL plantations. In most cases this is limited to small plots (< 50 m²) on the fields' edge. Young stands in the growing season after establishment bear a higher risk to take significant damage, than older trees. However, up to now, no losses of tree plots have been observed on OPTFUEL

fields. Damaged trees regrew, leading to negligible yield losses on most plantations. Especially willow tends to regrow bushy, developing more sprouts than unaffected trees.

Picture 26: A polish willow variety („Start“) with high damages caused by game animals on a plantation near Schwedt/ Germany (2009)

The growth of larger trees, whose main sprout is out of reach for game, is not affected by browsing. However, by bending the trees, roe deer might even reach the top of two year old stands.

The following table lists only considerable browsing damage.

Name	Location and first observation	Impact	Measures	Development
Ruminant hoofed game	1 field in Kröpelin region in summer 2009	Browsing on wide areas of young willow plantation	None	Regrowth of damage with minor yield losses
	1 field in Kröpelin region in summer 2010	Browsing on wide areas of young willow plantations	Responsible hunter increased hunting pressure	Continuing browsing with notable yield losses
	2 fields in Prignitz region in summer 2009	Browsing on wide areas of young willow and poplar plantations	Responsible hunter increased hunting pressure	Regrowth of damage with minor yield losses, continuing browsing on small poplar plots

Table 3: Damages from wild game on OPTFUEL plantations

On OPTFUEL fields, only the hunting pressure was intensified to decrease the damage by game wild. The construction of fences, which is often proposed in literature, was dismissed as being too expensive.

Fungi

The dothichia canker (lat. Cryptodiaporthe populea) poses a risk to poplar plantations. Willows are not affected. Especially P. deltoides x P. nigra poplar hybrids are susceptible, whereas pure balsam poplars and P. maximowiczii x P. nigra showed resilience with only very few small areas infected. On OPTFUEL fields, the first significant damages have been observed in 2011. Plots of Italian P. deltoides x P. nigra poplar clones (AF2, AF8, Monviso) have been affected considerably, leading even to severe dieback of trees. The clone AF2 was affected most heavily – although in the first years AF2 has showed excellent growing results.

As the P. deltoides x P. nigra clones from Italy have been bred for South European climate and growing conditions, the cultivation in Central Europe (Germany and Poland) might have exposed the trees to too much stress, increasing their susceptibility to the fungi pathogens. The dead plots are planned to be replanted in the upcoming years (after harvest of plantation).

Picture 27: Plot of AF2 clones affected by dothichia canker near Kröpelin/ Germany(June 2012)

Cryptodiaporthe populea has also been observed on a few plots of balsam poplar breedings and hybrids (Max, NE 42, Grimminge, Vesten). However in most cases, those trees have recovered in the following growing season. The affected trees have been exposed to in-

creased stress (extreme low temperatures, high weed competition or draught) in the particular year of infestation. So far, fungicides have not been applied on OPTFUEL plantations.

The occurrence of dothichia canker has been listed in the following table:

Name	Location and first observation	Impact	Measures	Development
Dothichia canker (Cryptodiaporthe populea)	1 field in Kröpelin region in summer 2011	Signs of decline on some trees (Grimminge, Vesten clones)	None	Extension to Italian clones in 2012, no more signs of infestation at Belgian clones
	3 fields in Kröpelin region in summer 2012	Dieback of full plots of Italian clones, very minor infestation of some trees of Belgian and Max clones	None	
	3 fields in Szczecin region in summer 2012	Signs of decline and bark necrosis on some trees (Italian clones)	Replanting of affected plots with other variety after harvest in 2013	
	1 field in Schwedt region in summer 2011	Decline of trees of Italian clones	None	Extension of signs of dieback to all Italian clones
	3 fields in Schwedt region in summer 2012	Decline of single trees of Italian clones (also few German clones)	Replanting on heavily affected plots with other varieties in 2013	Some trees regrew from stem
	2 fields in Prignitz region in summer 2012	Decline of single clones and small plots from mostly Italian clones	Replanting on heavily affected plots with other varieties in 2013	

Table 4: Damages from fungi on OPTFUEL plantations

To mitigate the risk of a plantation's total dieback, the OPTFUEL fields have been established with a diverse species and variety structure. This measure pays off, as only a minor part (mostly AF2 clones) of the plantations is heavily affected by dothichia canker. To contain the spreading of the fungi and to avoid further yield deficits, Lignovis will replant affected plots with more resistant breedings proven well suitable for Central European conditions.

4. Harvest

Harvesting activities and demonstration events have been performed beginning 2009 within the OPTFUEL project. Harvesting always took place during wintertime, when the trees are defoliated and frozen ground allows the use of heavy machinery. After each harvest, the regrowth of the trees was monitored and appropriate weed control applied. Different technology and harvesting chains were applied and assessed under OPTFUEL:

Harvesting season	Region	Harvesting technology
2009/2010	Kröpelin region	Field chipper (Krone) with harvesting head (Hüttmann)
2010/ 2011	Schwedt region	Whole tem harvester (Nordic Biomass) with separate wood chipping (Jenz)
2011/2012	Freiberg region	Field chipper (New Holland) with harvesting head (New Holland KUP 130)
2012/2013	*Freiberg region*	Field chipper (John Deere) with harvesting head (Salix Energi HSAB)

Table 5: Harvesting technologies applied and assessed within OPTFUEL project

The majority of the harvested plantations were 3 years old. But also 2 year and 4 year old plots have been harvested. Willow and poplar trees with a diameter of max. 15 cm have been directly chipped. This is assumed by most technology providers as the maximum for currently available field chipper equipment.

In January 2011 some plantations near Schwedt have been harvested with the Stemster TR by Nordic biomass. The whole stems were deposited at field sites. Some volumes were transported to the field side with a forestry forwarder. The chipping via mobile chipper was planned for the next summer. This lowers the water content of the wood significantly and enables the long-term stable storage of SRC wood. Due to the insolvency of CHOREN, the chipping was executed not before early 2012. The water content of the rods, stored for more than a year outside, was below 20 %.

Picture 28: The Stemster TR harvesting a 2 year old willow plant near Schwedt (January 2011)

Picture 29: Whole stem harvest of willow and poplar in Schwedt region (January 2011)

Picture 30: Harvested rods ready for chipping near Schwedt (August 2011)

Picture 31: Forestry forwarder assembling harvested rods near Schwedt (June 2011)

The field chippers used in the OPTFUEL project were chipping the wood directly into a tractor pulled trailer. The full trailers have been unloaded on a nearby intermediate storage. Depending on the distance to the storage, two to four tractors with trailers were required for the wood-chips transport to avoid idle time of the chipper. At the intermediate storage, the chips were loaded to trucks with a telescope-loader for transportation to the off-taker. Mostly walking floor trucks were used for the logistics to the end customer, which have been heat & power plants, heating plants, pellet mills and particleboard facilities. In 2011, the yield contained an increased share of fines, as temperature of minus 20°C made the wood brittle. To avoid high fines, the material should be harvested at higher temperatures not below minus 10°C if possible. In average, almost 22 bdt per hectare (which equals an MAI of 7.3 bdt/ha/a) have been harvested in Freiberg in 2011.

Picture 32: Harvest with field chipper (New Holland) on 3 year old plantation near Freiberg (February 2012)

Picture 33: Tractor with two trailers (20 cubic meters volume each) during harvest near Freiberg (February 2012)

Picture 34: Unloading wood chips at intermediate storage near Freiberg (February 2012)

Picture 35: Diameter of 3-year old poplar stems (Max clone) near Freiberg (February 2012)

Picture 36: Regrowth of harvested willows in Freiberg region (May 2012)

Picture 37: Harvest with field chipper (John Deere with HSAB head) on 3 year old willow plantation in Freiberg region (January 2013)

In February 2013, app. 14 ha of 3 and 4 year old poplar and willow have been harvested in Freiberg region with a John Deere field chipper equipped with a head of Salix Energi. The material was stored at a nearby intermediate storage and directly marketed to regional industrial off-takers. Based on the harvested volumes, the MAI of the first rotation was 8 bdt/ha/a and is expected to reach about 12 bdt/ha/a in the next rotations.

Following the harvests in winter 2011/12 and 2012/13, the remaining fields in the Freiberg region will be harvested in the next winter. The plantations in Freiberg, managed by Lignovis, demonstrate the feasibility of an efficient biomass production and harvesting regime supplying industrial users.