

Short Rotation Woody Crops (SRC) plantations for local supply chains and heat use

Project No: IEE/13/574



Identification of suitable areas for SRC production in the region Achental, Germany

WP6 – Task 6.4 / D6.4

August 2015



Authors: Wolfram Kudlich, Wald21 GmbH

Editors: Dr. Stefan Hinterreiter, Wolfgang Wimmer, Christian Epp, Biomassehof Achental, Deutschland

Contact: Biomassehof Achental GmbH & Co.KG
Dr. Stefan Hinterreiter
Email: Stefan.Hinterreiter@biomassehof-achental.de
Tel: +49 (0) 8641 / 69 41 43 0
Eichelreuth 20
83224 Grassau, Deutschland
www.biomassehof-achental.de

The SRCPplus project (Short Rotation Woody Crops (SRC) plantations for local supply chains and heat use) is supported by the European Commission in the Intelligent Energy for Europe Programme. The sole responsibility for the content of this report lies with the authors. It does not necessarily reflect the opinion of the European Union. Neither the EASME nor the European Commission are responsible for any use that may be made of the information contained therein. The SRCPplus project duration is March 2014 to April 2017 (Contract number: IEE/13/574).

SRCPplus website: www.srcpplus.eu



Co-funded by the Intelligent Energy Europe
Programme of the European Union

Contents

Acknowledgements	4
Abbreviations	5
1 Introduction	6
2 SRC plantation “Kendlmühlfilzn”	6
3 SRC plantations “Vogtareuth”	8
3.1 Aerial view	8
3.2 Initial situation	8
3.3 Climate, location and selection of the right tree(s)	9
3.4 Limit distance, erosion, browsing and fence	10
3.5 Preparation, planting and maintenance	11
3.6 Ecological optimization / evaluation	11
3.7 Efficiency / earnings forecast	12
3.8 Attachments and further information	13
4 SRC plantation at St. Leonhard am Wonneberg (“Waginger See”)	16
4.1 Aerial view	16
4.2 Initial situation	16
4.3 Climate, location and selection of the right tree(s)	17
4.4 Limit distance, erosion, browsing and fence	17
4.5 Preparation, planting and maintenance	18
4.6 Ecological optimization / evaluation	19
4.7 Efficiency / earnings forecast	20
4.8 Attachments and further information	21
5 SRC plantations “Vogtareuth”	24
5.1 Aerial view	24
5.2 Initial situation	24
5.3 Climate, location and selection of the right tree(s)	26
5.4 Limit distance, erosion, browsing and fence	26
5.5 Preparation, planting and maintenance	27
5.6 Ecological optimization / evaluation	27
5.7 Efficiency / earnings forecast	28
5.8 Attachments and further information	30
6 Conclusions and recommendations	32

Acknowledgements

The author would like to thank the European Commission for supporting the SRCplus project as well as the members of Biomass Trading Centre (BAT), Grassau (Germany) for the trust that they have placed in me and for the commissioning to write this deliverable.

Abbreviations

a.s.o.	and so on
Abs.	“Absatz” = section
DWD	“Deutscher Wetterdienst” = German Weather Service
FFH	flora fauna habitat
FIS	“Flurstück” = plot or land parcel
Nr.	number
PflSchG	“Pflanzenschutzgesetz” = Plant Protection Act
SRC	Short Rotation Crops (Coppice)

1 Introduction

The aim of this report is to identify potential new SRC plantations in the region Achental, Germany, which is performed by Wolfram Kudlich, an expert for SRC in southern Germany.

The determination of suitable new SRC plantations is based on the areas described in D6.1 ("Potential für Kurzumtriebsplantagen in der Region Achental, Deutschland") and shown in Figure 1:

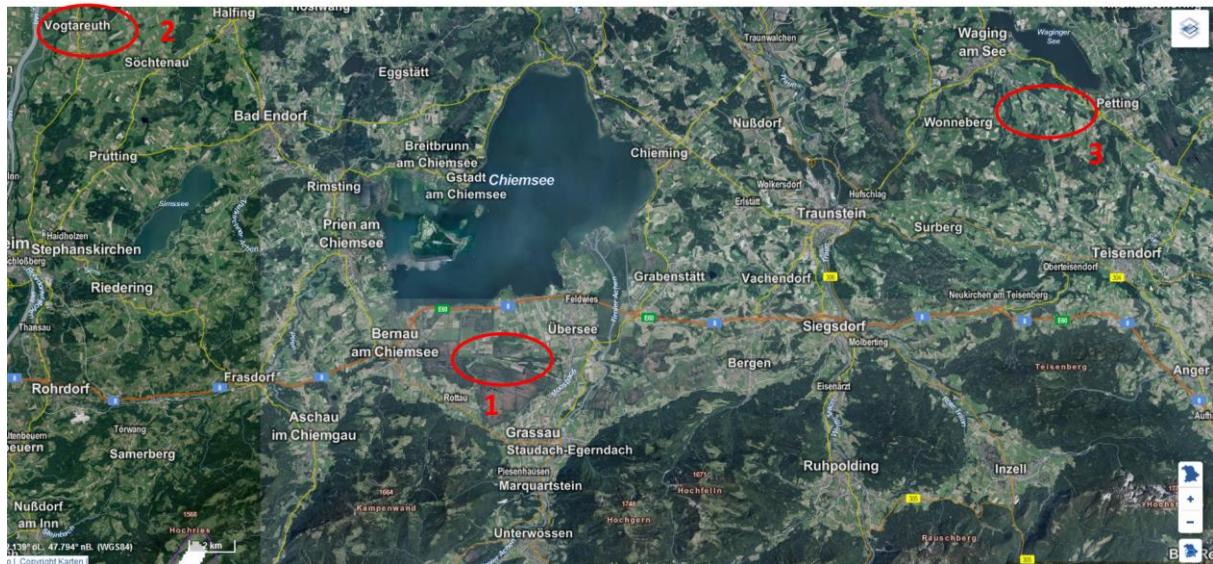


Figure 1: Location of possible new SRC plantations as mentioned in D6.1

As shown in Figure 1, the possible new plantations can be named as 1) "Kendlmühlfilzn", 2) "Vogtareuth" and 3) "Waginger See". In the following chapter 2 to 4, possible and potential new SRC plantations are presented and shortly discussed.

2 SRC plantation "Kendlmühlfilzn"

The location "Kendlmühlfilzn" (see Figure 2, taken from D6.1) has been excluded from further investigations because of being too worthy of preservation. Here the gain of having a local supply chain for woodchips in comparison to the existing ecological system is too less.

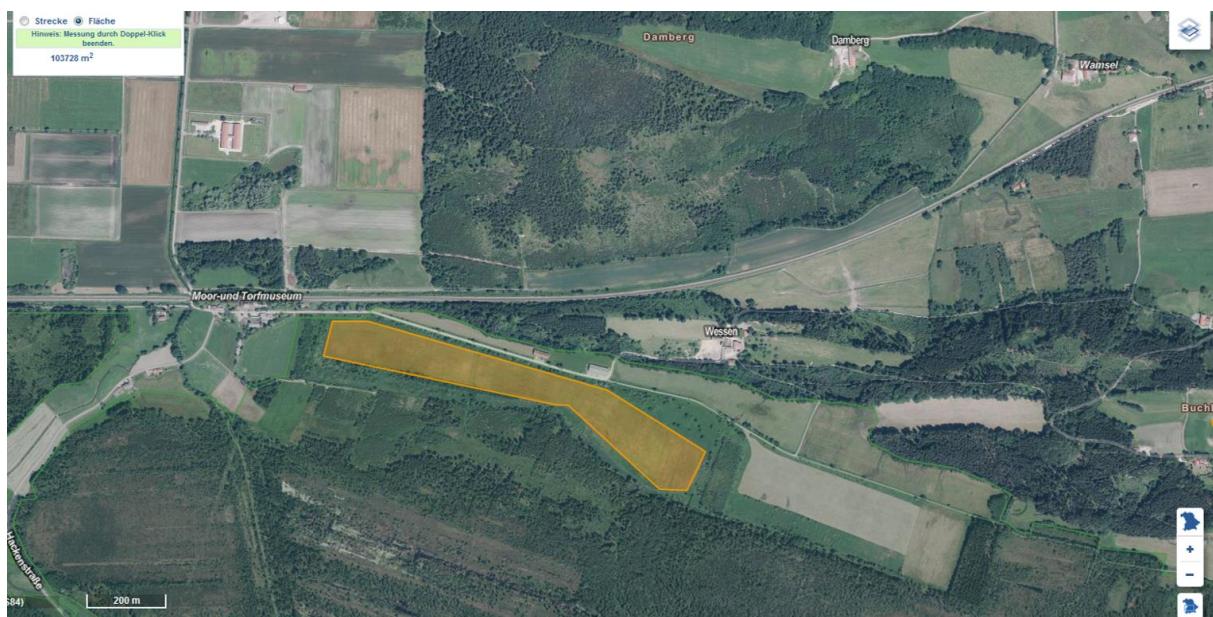


Figure 2: Potential location for a new SRC plantation nearby Übersee ("Kendlmühlfilzn")

Therefore, the considered area will not be further investigated. But instead of this area, a second area nearby Vogtareuth has been figured out to be another potential new SRC plantation in the region.

Further information are written in the following chapters.

3 SRC plantations “Vogtareuth”

The first site for a potential new SRC plantation is located nearby Vogtareuth (“Gemarkung: Vogtareuth FlSt Nr. 41) and is again one of the plots mentioned in D6.1.

3.1 Aerial view



Figure 3: Aerial view of the potential new SRC plantation at Vogtareuth

3.2 Initial situation

- Establishment of a SRC plantation planned for 2015. The size of the new plantation shall be about 5.3 ha, which is really big related to the mean size of a Bavarian SRC plantation of 1.1 ha.
- Previous use: Corn field
- Utilization of the produced SRC woodchips: personal use (own woodchip boiler)
 - 100% marketing
 - The manager of the plantation is a part-time farmer and he wants to do as much as he can on its own (planting, establishment, ..., marketing). He's planning to manage the plantation with a midi rotation and harvest it by means of his own half- and fully-mechanical harvesting machines, dry the woodchips and market them on its own.
 - However a farm succession is missing. But the plot is ideal for a mini rotation (short-term, agricultural optimized land management) because of the size and the trafficability during winter. Therefore a yield-optimized plant plan will be chosen, which allows different harvesting methods (→ selling the woodchips to the Biomass Trading Centre is possible).

d) Mini and midi rotation can be performed:

- Maximum variability aimed in terms of harvesting techniques and time of harvest.
- Harvest possible with mini (3-4 years) and midi rotation (6-10 years).
- Harvest in sections and/or appropriated and in line with the market possible
- Tree height at time of harvest
 - Mini rotation: about 7-10 m; trunk diameter about 8-12 cm
 - Midi rotation: about 13-18 m; trunk diameter about 12-20 cm

e) Harvesting method

- Harvest shall be performed during winter
- Fully mechanical harvest:
 - Harvest performed by contractor(s)
 - Only useful with a plot-size of more than 2.5 ha due to high transportation costs (harvester) and high amounts of unproductive areas (on turning area(s) no trees can be planted).
 - Direct marketing with low prices and technical drying with waste heat of a biogas plant possible (weighing costs)

Advantage: High area efficiency (0.5-0.8 ha per hour) by relatively low harvesting costs. Management possible, even if personal contribution isn't possible any more.

- Half-mechanical harvest (motor-manual or bundler)
 - Storage of the trunks at the field edge until end of summer; accordingly chipping
 - Produced product: storable woodchips

Advantage: Harvest can be performed by farmer on its own (if he owns the machinery). A former silo can be used as storage place. If drying is possible at the site, higher (drying) costs can be compensated by gaining a higher selling price.

f) Planting plan – Amount of seedlings

- The advised planting plan allows fully-mechanical and half-mechanical harvesting → adjusted yield optimized:
- Distance between the rows: 2 m
- Distance within the rows: 0.75 m
- 6,666 Seedlings per ha

3.3 Climate, location and selection of the right tree(s)

a) Climate

Annual precipitation about 1.000 mm and about 2/3 during growing period (see DWD-data 1961-1990 of Vogtareuth)

Average annual temperature lies between 7.5 and 8 °C (see DWD-data 1961-1990 of Traunstein – Axdorf).

Summary for Vogtareuth: very good conditions related to rainfall and satisfying conditions related to the average annual temperature for a new SRC plantation.

b) Location – soil properties

Relatively fresh loamy soil with stronger parts of sand in the centre. From west to east: LIII – LSII – LII. The average soil quality ("Ackerzahl") varies between 49-38-54.

Result of the soil analysis:

- Silty loam with a pH-value of 6.4.
- Nutrients:
 - Magnesium – value "D" (oversupply).
 - Phosphorus – value "C" (optimum)
 - Potassium – value "A" (heavy undersupply)

c) Protection area

The site is not located within a conservation area, protected area or so called FFH-area.

d) Selection of the trees and diversity of varieties

- In terms of yield issues a careful consideration between willow and poplar leads to the advice – appropriate to the location and the probably higher rotation period – to plant poplar.
- Only tested and according to the German Forest Reproductive Material Act certified seedlings shall be used.
- Due to soil condition and good water supply (rainfall) there are no restrictions in choosing the right poplar species. A guideline for choosing the right high performance species can be the list of recommendations of the Bavarian Office for Forest Seeding and Planting ("ASP Teisendorf").
- Related to a high ecological diversity and risk spreading at minimum three different poplar species shall be planted. The recommendation of Wald21 is: Max 1, 3, 4; H275; Matrix 11, 24, 49 as well as Fritzy Pauley.

3.4 Limit distance, erosion, browsing and fence

a) Limit distance and opportunity to turn

- Basically the legal limit distance of 2 m has to be fulfilled.
- As turning area in the north – besides the paved way – a limit distance of 5 m is recommended.
- In the east, a small way crosses the plantation. No further limit distances in addition to the width of the way (4-5 m) have to be fulfilled.
- In the south grassland is bordering the plantation, which belongs to the farmer. No limit distances are foreseen because in winter time the grassland can be used by machinery without any problems.
- Flowering fields: it is recommended to plant flowering fields as limit distances in the north and west as well as road in the east. This will increase the biodiversity and the chance for the opponents of the common insect pests – like ladybirds, ichneumon fly, a.s.o. – to establish on the poplar plantation.

b) Erosion

There's no risk of erosion given because of the almost plane plot.

c) Game animals / browsing / fences / water voles

At this location, there's a low danger of browsing and fraying by roe deer and red deer. Subsequently the game tenant shall be informed about a new SRC plantation and hunting is recommended if necessary. Based on environmental and costs issues fencing is basically not recommended because if maintenance will be performed and the growth is like expected, the trees will be too big for fraying within the first year of establishment.

There's no danger of water voles due to the former use of the site.

3.5 Preparation, planting and maintenance

a) Preparation

- In years of infavourable framework conditions additional support could be taken from herbicides. In this case special care should be taken on choosing a herbicide without negative impact on the surrounding environment.
- Ploughing the site (about 25 cm deep), soonest 10-14 days after spraying.
- Harrowing: in order to prepare the soil for planting and to avoid reconsolidation (raise packer roller), a rotary harrows shall be used. Harrowing shall applied only immediately before the planting
- Fertilization: because of the heavy lack of potassium, a starter plant / initial fertilizer of 150 kg /ha is recommended. The fertilizer shall be spread out before harrowing

b) Planting

- Planting will be performed mechanically. The planting machine will press the seedling on grade in the soil like it will be done by hand. A further opening of the soil by means of a (plough) share or broach can be waived. Through this an ideal soil contact can be achieved. Moreover the risk of desiccation can significantly be decreased and the connection to the soil capillary system can be speed up.
- Subject to the weather condition the planting / sowing date shall be performed in the second half of April.

c) Maintenance

- Weed control is recommended because of the size of the plot. Recommended agents and doses can be found in the cultural instructions.
- Pay attention: In advance an exemption shall be obtained according "§ 22 Abs. 2 PflSchG".
- The use of a post-emergence herbicide is only selectively possible (see cultural instructions). Therefore it is recommended to start at an early stage with hoeing; mulching is definitely a worse alternative.

3.6 Ecological optimization / evaluation

a) Selection of the plot / landscape

- The planned SRC plantation has been used as acre / arable land and is sited in a plain besides the city of Vogtareuth.
- All areas surrounding the plantation belong to the farmer/manager or are sited close to a forest or are divided by a route plus turning area (10 m away from the

plantation). Therefore no shadowing or further negative effects on the plot shall occur.

b) Preparation of the plot / maintenance

- The use of herbicides for preparing the plot as well as using pre-herbicides according to the planting is recommended. Reason: a heavy pressure of weed is causing a careful mechanical weeding. To perform this can easily expand the planned time-frame (and costs). In combination with long droughts a high risk if default is given.
- For further maintenance (from end of May / beginning June) the use of a hoe is recommended.

c) Choice of species / diversity / variety trial

- A diversity of varieties stands for ecological diversity and risk distribution and subsequently also for a long-term yield optimization.

d) Rotation period

- The planting plan allows to use different ways of harvesting and managing the trees/plantation. Therefore it can be assumed that harvesting in sections will increase the diversity of varieties, because of creating/remaining natural habitats or refuges.

e) Harvest / drying / logistics

- According to the harvesting technique the trees can be stored, dried or sold (midi rotation) at the site or be sold as woodchips (mini rotation) to a regional/local customer with an appropriate combustion or a drying unit (e.g. Biomass Trading Centre).
- However, the almost quite energy-intensive harvest (half-mechanical; midi rotation) is in contrast to the low logistic costs because the woodchips can be produced at the site and stored and sold as "dry woodchips". In terms of using a short rotation with low harvesting costs (= low input of energy) the woodchips are transported directly to the customer – by rising distances the logistic costs are rising (= energy input).

f) Ecosystem services SRC / climate protection

- Almost 6% of the plot (turning area, route(s)) can be used for flowering fields, which has a positive effect in biodiversity.
- The positive ecosystem services of the SRC in comparison to arable farming is determined mainly due to the type of usage (= SRC plantation = "energy forest"). The main advantages are amongst others diversity of varieties, flora and fauna on the same plot, positive humus balance and fallow period ("Bodenruhe"), impacts at the field edge / buffer strips or zones, possibly positive biotope cross-linking effects. The diversity of the used tree species and the waiver of using herbicides play only a tangential role in this assessment.
- Climate protection and ecology were upgraded/improved by a SRC compared to the conventional agricultural usage.

3.7 Efficiency / earnings forecast

The following assumptions with a midi rotation have been used for the calculation shown in Figure 4 (only available in German):

- Investment costs: according to the offer and/or estimation.

- Increase in biomass: estimation of about 11.5 t (bone dry) /p.a. (due to the high amount of rainfall and the applied species an outstanding increase in biomass will be expected)
- Price for woodchips (see survey of C.A.R.M.E.N. e.V. at www.carmen-ev.de): average price for woodchips with a moisture content of 35%, plus 2% inflation rate (Average 2014 without 19% VAT): 125,90 EUR / t (bone dry).
- Harvesting costs / logistics / storage: figure based on experience, inflation rate 1%

KUP - Rechner				Vers. 1.0	Stand: 6.12.10	
Programm zur Berechnung der Wirtschaftlichkeit von Kurzumtriebsplantagen						
Info (1) Verfahren: 1 ha Kurzumtriebsplantage	Pappel		Pflanzjahr: 2015		Inflation %	
Info (2) Zeit zwischen 2 Ernten (Umtriebszeit)	7	Jahre	Info (13) Ø-Ertragszuwachs	11,50	t TMha u. Jahr	
Info (2) Umtriebe, Anzahl Ernten	x 3	Anzahl	Info (14) Erlös Hackschnitzel	81,83	€ / t FM	
Info (3) Standzeit, (Lebensdauer der Plantage) =	21	Jahre	entspricht bei WG 35,00%	125,89	€ / t TM	
Info (4) mechanische Bodenvorbereitung	150	€/ha	Info (15) GAP-Prämie bis 2013	0	€/ha	
Info (5) Pflanzenschutz zur Bodenvorbereitung	50	€/ha	Info (15) GAP-Prämie bis 2020	0	€/ha	
Info (6) Pflanzgutkosten	1.200	€/ha	Info (15) GAP-Prämie bis 2027	0	€/ha	
Info (7) Kosten der Pflanzung	400	€/ha	Info (15) GAP-Prämie bis 2033	0	€/ha	
Info (8) Sonstige (Pflanz-)kosten	150	€/ha	Info (16) Erntekosten prüfen	55,00	€/t TM	
Info (9) Pflegekosten nach der Pflanzung	300	€/ha	Info (17) Transportkosten	5,00	€/t TM	
SUMME Anlagekosten	2.250,00	€/ha	Info (18) Lagerkosten	2,00	€/t TM	
Info (10) Rekultivierungskosten	1.000	€/ha	Info (19) Sonstige Kosten	0,00	€/ Ernte u.ha	
Info (11) AFP-Zuschuss	0,00	€	Info (20) Pflegekosten nach Ernte	50,00	€/ Ernte u.ha	
Info (12) Zinssatz	3,00	%	Info (21) Pachtansatz	0	€/ha	
			Info (22) Gemeinkosten	50	€/ha	
			Info (23) Wagniskosten	0	€/ha	
ERGEBNIS						
Saldo Erlöse abzgl. Kosten						
gesamte Standzeit	Erlöse	Kosten	Saldo	Barwerte (Berücksichtigung von Zinsen)		
	40.709 €	21.850 €	18.859 €	Erlöse	Kosten	Saldo
pro Jahr	1.939 €	1.040 €	898 €	Info (25) 26.436 €	Info (25) 15.057 €	Info (25) 11.379 €
				Info (26)	Annuität	738 €
				Info (27)	Amortisationsdauer	7 Jahre
				Info (28)	kostendeckender Erlös Hackschnitzel	71,70 €
				Info (29)	Rendite nach der Methode "interner Zinsfuß"	18,68%
						Kapitalwert Unternehmergegewinn
						je t TM

Figure 4: Earnings forecast for the SRC plantation at Vogtareuth.

3.8 Attachments and further information

In Figure 5 there is shown the plant plan of the new SRC plantation at Vogtareuth.

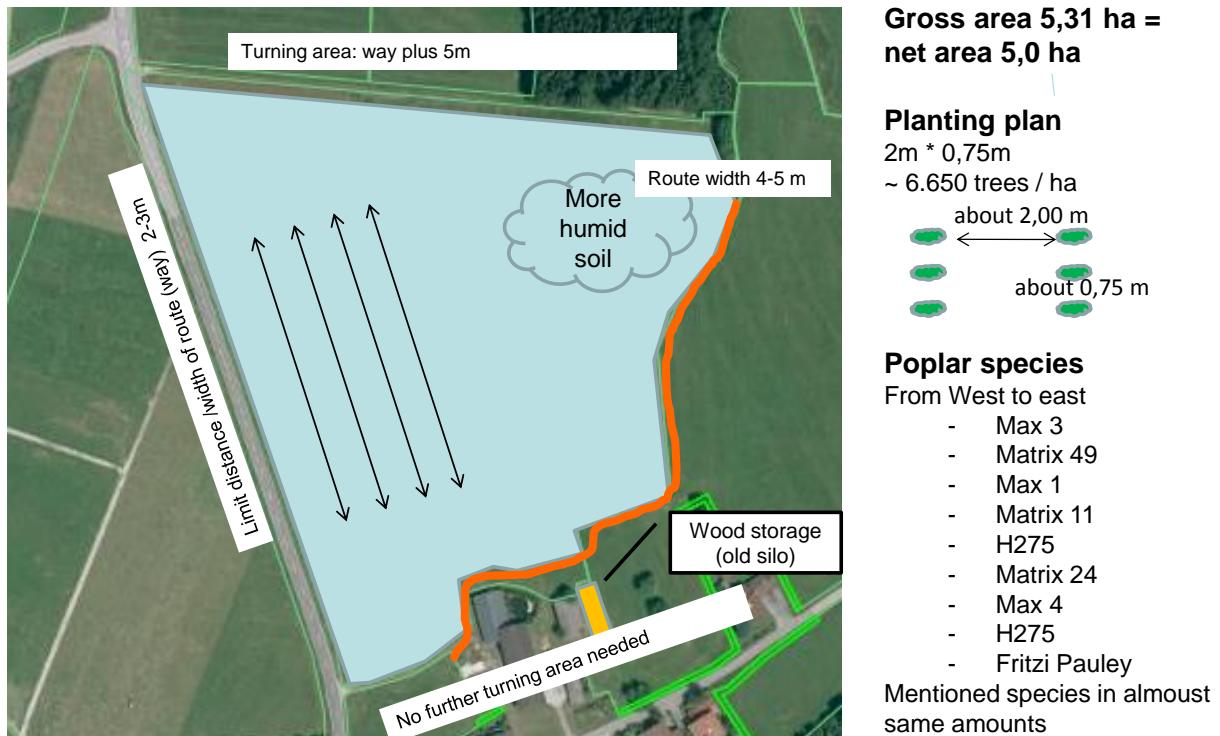


Figure 5: Planting plan at Vogtareuth

In Figure 6Figure 13 there are shown different machinery for the maintenance. It is important to know, that without a strict maintenance a successful establishment of a new SRC plantation is almost impossible.



Figure 6: Different machinery for the maintenance of the new SRC plantation

In the following pictures, the two predicted/recommended ways of harvesting are shown. Figure 7 shows the way for a midi rotation and Figure 8 shows the way for a mini rotation.



Figure 7: Possible way(s) for harvesting the SRC plantation with a midi rotation cycle



Figure 8: Possible way for harvesting the SRC plantation with a mini rotation cycle

4 SRC plantation at St. Leonhard am Wonneberg (“Waginger See”)

The second site for a potential new SRC plantation is located nearby St. Leonhard am Wonneberg (“Gemarkung: Wonneberg FlSt Nr. 116, 117”; nearby Waging am See, district Traunstein).

4.1 Aerial view



Figure 9: Aerial view of the potential new SRC plantation at St. Leonhard am Wonneberg

4.2 Initial situation

- a) Establishment of a SRC plantation planned for 2015. The size of the new plantation shall be about 1.1 ha
- b) Previous use: grassland (sown field)
- c) Utilization of the produced SRC woodchips: personal use (own woodchip boiler)
- d) Midi rotation should be achieved → harvest every 6 – 10 years:
 - High variability in terms of harvesting times: harvest in sections and/or appropriated possible
 - Tree height at harvesting time: about 13-18 m
 - Trunk diameter at harvesting time: about 12-20 cm
- e) Recommended minimum tree height at harvesting time: min. 13 m
- f) Harvesting method(s) (see also Chapter 4.8):
 - Moto-manual or half-/fully mechanical (harvester)

- Harvest will be performed during winter
- Storage of cut down trees beside the site possible until end of summer → after that chipping
- Produced product: storable woodchips

g) Planting layout and amount of seedlings:

- Planting distance and layout yield-optimized matched to the harvesting method.
- Distance between the rows 2 m and in between the lines/rows 1 m
- Amount of seedlings: 5000 per ha

4.3 Climate, location and selection of the right tree(s)

a) Climate

Annual precipitation about 1.200 mm and >740 mm during growing period (see DWD-data 1961-1990 of Waging am See)

Average annual temperature lies between 7.5 and 8 °C (see DWD-data 1961-1990 of Traunstein – Axdorf).

These data lead to the following result: at St. Leonhard am Wonneberg, there are very good conditions related to rainfall and satisfying conditions related to the average annual temperature for a new SRC plantation.

b) Location – soil properties

Relatively fresh loamy soil – southwards getting more clayey. At all with a good humus layer because of the former usage (L II b2 – LT). The average soil quality (“Ackerzahl”) has the figure 49.

c) Protection area

The site is not located within a conservation area, protected area or so called FFH-area.

d) Selection of the trees and diversity of varieties (plant plan can be found in Chapter 4.8)

- Because of the planned/achieved midi rotation period a careful consideration between willow and poplar leads to the advice – appropriate to the location – to plant poplar. This will probably lead also to a higher yield.
- Only tested and according to the German Forest Reproductive Material Act certified seedlings shall be used.
- Due to soil condition and good water supply (rainfall) there are no restrictions in choosing the right poplar species. A guideline for choosing the right high performance species can be the list of recommendations of the Bavarian Office for Forest Seeding and Planting (“ASP Teisendorf”).
- Related to a high ecological diversity and risk spreading at minimum three different poplar species shall be planted. The recommendation of Wald21 is: Max 3, H275, Matrix 11 and/or Matrix 49.

4.4 Limit distance, erosion, browsing and fence

a) Limit distance and opportunity to turn

- Basically the legal limit distance of 2 m to agricultural areas in the south, west and east and 4 m in the north have to be fulfilled.
 - At the site south- and eastwards no limit distances have to be taken care of, because of the fact that the plantation is surrounded with grassland. For this reason and in terms of harvesting the plantation, no further limit distances have to be taken care of.
 - To the north and west (towards the forest) there exists a small paved way. Due to an easier harvest an additional gap of 2 m to the paved way is recommended.
- b) Erosion
- A low risk of erosion is given according to heavy rainfall within the first months after planting.
- c) Game animals / browsing / fences / water voles
- At this location, there's the danger of browsing and fraying by roe deer and red deer. Subsequently the game tenant shall be informed about a new SRC plantation and hunting is recommended if necessary. Based on environmental and costs issues fencing is basically not recommended because if maintenance will be performed and the growth is like expected, the trees will be too big for fraying within the first year of establishment.
 - Within the first years until canopy, there exists a not negligible danger of water voles because of the former use of the site. If water voles occur in a higher amount, traps shall be used in order to avoid higher stock losses.

4.5 Preparation, planting and maintenance

a) Preparation

- If deep ploughing is applied in terms of ecological issues the usage of Round-Up (herbicide) can be waived.
- Deep ploughing shall be applied with a depth of 30 cm because of having the swards "at the bottom".
- Harrowing: in order to prepare the soil for planting and to avoid reconsolidation (raise packer roller), a rotary harrows shall be used. Harrowing shall applied only immediately before the planting.
- Fertilization: generally no starter plant / initial fertilizer is recommended. If the results of the soil analysis show a significant lack of nutrients, an advice will be handed in later.

b) Planting

- Planting will be performed mechanically. The planting machine will press the seedling on grade in the soil like it will be done by hand. A further opening of the soil by means of a (plough) share or broach can be waived. Through this an ideal soil contact can be achieved. Moreover the risk of desiccation can significantly be decreased and the connection to the soil capillary system can be speed up.
- Subject to the weather condition the planting / sowing date shall be performed in the second half of April or first half of Mai.

c) Maintenance

- Within the first year of growth there is basically the risk of desiccation of the seedling/tree during droughts.

- Weed control can be performed with preventive solutions, selective herbicides and/or mechanically.
- Because of the given conditions at the location (high annual precipitation in summer combined low risks of droughts; manageable plot size of about 1 hectare → minimum work intensity) a pure mechanical weed control can be advised. The farmer has to have in mind the higher time requirement with a mechanical wood control.
- The following mechanical weed control methods can be used: hoe, milling machine or mulcher.
- It is recommended to start with thorough chopping / milling at an early stage (by the appearance of the first weed(s) in May). This can be performed mechanically or by hand. So the plot shall be kept clean at the beginning.
- Later on (end of June / July) the stripes / bands between the tree rows shall be mulched when the weed is growing. Maintenance can be stopped when the trees reach an average height of about 1.5 m. Note: ideally this will be already mid of August (of the first year of growth) and at latest in the middle of the second year of growth respectively.
- Emergency program: The use of a post-emergence herbicide is only selectively possible (see cultural instructions). Good and effective experiences are only available by controlling thistle. Therefore it is insistently recommended to start at an early stage with hoeing; mulching is definitely a worse alternative.

4.6 Ecological optimization / evaluation

a) Selection of the plot / landscape

- The planned SRC plantation gently descends to the northwest and will there be enclosed / surrounded by a thin strip of forest. Therefore the plantation would almost not be noticed and perceived as disturbing because of the hilly and varied landscape.
- All areas surrounding the plantation belong to the farmer/manager. Therefore no shadowing or further negative effects on the plot shall occur.

b) Preparation of the plot / maintenance

- The use of herbicides can be waived.

c) Choice of species / diversity / variety trial

- A diversity of varieties stands for ecological diversity and risk distribution and subsequently also for a long-term yield optimization.
- The plot shall be used as a demonstration and best practice plantation for the region. Therefore a variety trial shall be performed in cooperation with the Bavarian Office for Forest Seeding and Planting ("ASP Teisendorf"). The aim is to identify as much plants as possible that are adapted to the particular location and thus can be used in other potential new plantations. This will lead to a higher diversity at the SRC plantations.

d) Rotation period / drying / less logistics

- The planned midi rotation (6 to 10 years) in combination with the half- or fully-mechanical harvest will allow a production of storable woodchips (until end of summer, the trunks or the wood will dry as expected to a moisture content of about 30-35% before chipping it). Thus the woodchips can be stored and be used at/on the farm.

- The advantage of this issue is less logistics and probably no technical drying is needed. → Effect: lower energy input.
- e) Harvest / rotation period
 - Harvesting in sections will increase the diversity of varieties, because of creating/remaining natural habitats or refuges.
- f) Ecosystem services SRC / climate protection
 - The positive ecosystem services of the SRC in comparison to arable farming is determined mainly due to the type of usage (= SRC plantation = "energy forest"). The main advantages are amongst others diversity of varieties, flora and fauna on the same plot, positive humus balance and fallow period ("Bodenruhe"), impacts at the field edge / buffer strips or zones, possibly positive biotope cross-linking effects. The diversity of the used tree species and the waiver of using herbicides play only a tangential role in this assessment.
 - Climate protection and ecology were upgraded/improved by a SRC compared to the conventional agricultural usage.

4.7 Efficiency / earnings forecast

The following assumptions have been used for the calculation shown in Figure 10 (only available in German):

- Investment costs: according to the offer and/or estimation.
- Increase in biomass: estimation of about 12 t (bone dry) /p.a. (due to the high amount of rainfall and the applied species an outstanding increase in biomass will be expected)
- Price for woodchips (see survey of C.A.R.M.E.N. e.V. at www.carmen-ev.de): average price for woodchips with a moisture content of 35%, plus 2% inflation rate (Average 2014 without 19% VAT): 125,90 EUR / t (bone dry).
- Harvesting costs / logistics / storage: figure based on experience, inflation rate 1%

KUP - Rechner			Vers. 1.0	Stand: 6.12.10
Hinweis: gelbe Felder sind Eingabefelder				
Programm zur Berechnung der Wirtschaftlichkeit von Kurzumtriebsplantagen				
Inb (1) Verfahren: 1 ha Kurzumtriebsplantage	Pappel		Pflanzjahr: 2015	Inflation %
Inb (2) Zeit zwischen 2 Ernten (Umtriebszeit)	7	Jahre	Inb (13) Ø-Ertragszuwachs	12,00 tTM/ha u. Jahr
Inb (2) Umtriebe, Anzahl Ernten	x 3	Anzahl	Inb (14) Erlös Hackschnitzel entspricht bei WG 35,00%	€ / t FM € / t TM 2,0%
Inb (3) Standzeit, (Lebensdauer der Plantage) =	21	Jahre	Inb (15) GAP-Prämie bis 2013	0 €/ha
Inb (4) mechanische Bodenvorbereitung	150	€/ha	Inb (15) GAP-Prämie bis 2020	0 €/ha
Inb (5) Pflanzenschutz zur Bodenvorbereitung	0	€/ha	Inb (15) GAP-Prämie bis 2027	0 €/ha
Inb (6) Pflanzgutkosten	900	€/ha	Inb (15) GAP-Prämie bis 2033	0 €/ha
Inb (7) Kosten der Pflanzung	400	€/ha	Inb (16) Erntekosten prüfen	55,00 €/t TM
Inb (8) Sonstige (Pflanz-)kosten	150	€/ha	Inb (17) Transportkosten	5,00 €/t TM
Inb (9) Pflegekosten nach der Pflanzung	600	€/ha	Inb (18) Lagerkosten	2,00 €/t TM
SUMME Anlagekosten	2.200,00	€/ha	Inb (19) Sonstige Kosten	0,00 €/Ernte u.ha
Inb (10) Rekultivierungskosten	1.000	€/ha	Inb (20) Pflegekosten nach Ernte	50,00 €/Ernte u.ha
Inb (11) AFP-Zuschuss	0,00	€	Inb (21) Pachtansatz	0 €/ha
Inb (12) Zinssatz	3,00	%	Inb (22) Gemeinkosten	50 €/ha
			Inb (23) Wagniskosten	0 €/ha
ERGEBNIS				
Saldo Erlöse abzgl. Kosten				
Erlöse Kosten Saldo				
42.479 € 22.552 € 19.926 €				
gesamte Standzeit pro Jahr				
2.023 € 1.074 € 949 €				
Barwerte (Berücksichtigung von Zinsen)				
Erlöse Kosten Saldo				
Inb (25) 27.585 € 15.500 € 12.086 €				
Inb (26) Annuität 784 €				
Inb (27) Amortisationsdauer 7 Jahre				
kostendeckender Erlös Hackschnitzel 70,74 € je t TM				
Info (28) Info (29) Rendite nach der Methode "interner Zinsfuß" 19,44%				

Figure 10: Earnings forecast for the SRC plantation at St. Leonhard am Wonneberg

4.8 Attachments and further information

General plant plan (see Figure 11) and plant plan of the variety of the Bavarian Office for Forest Seeding and Planting (ASP; see Figure 12):

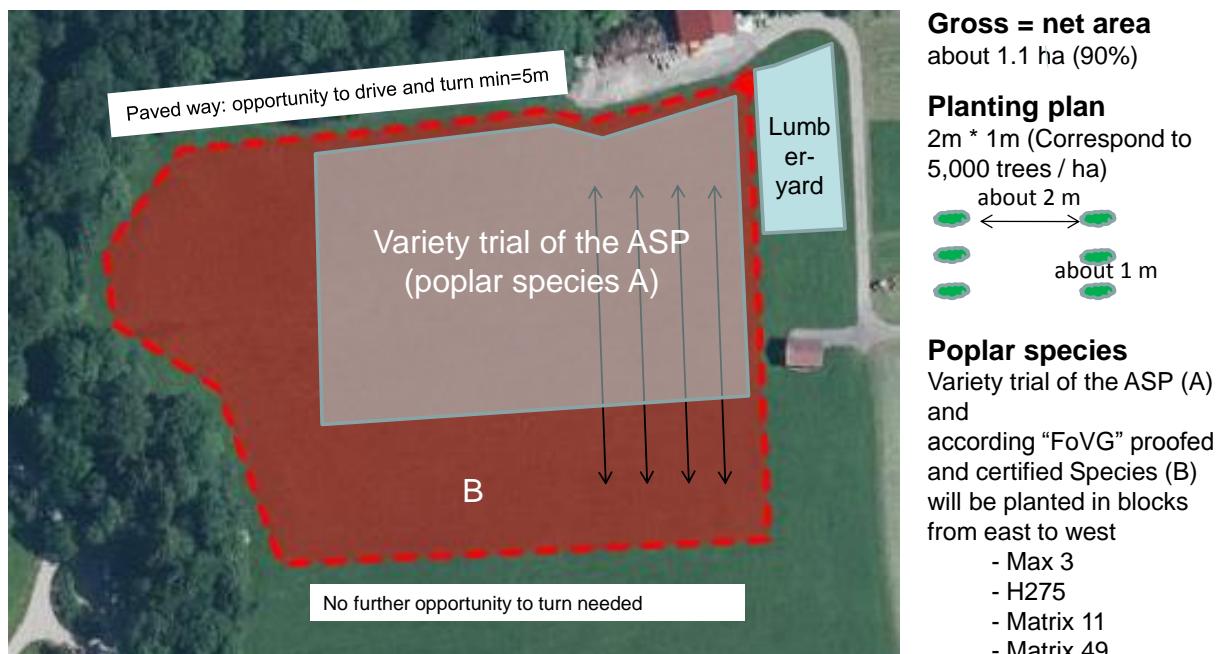


Figure 11: General plant plan of the SRC plantation at St. Leonhard am Wonneberg

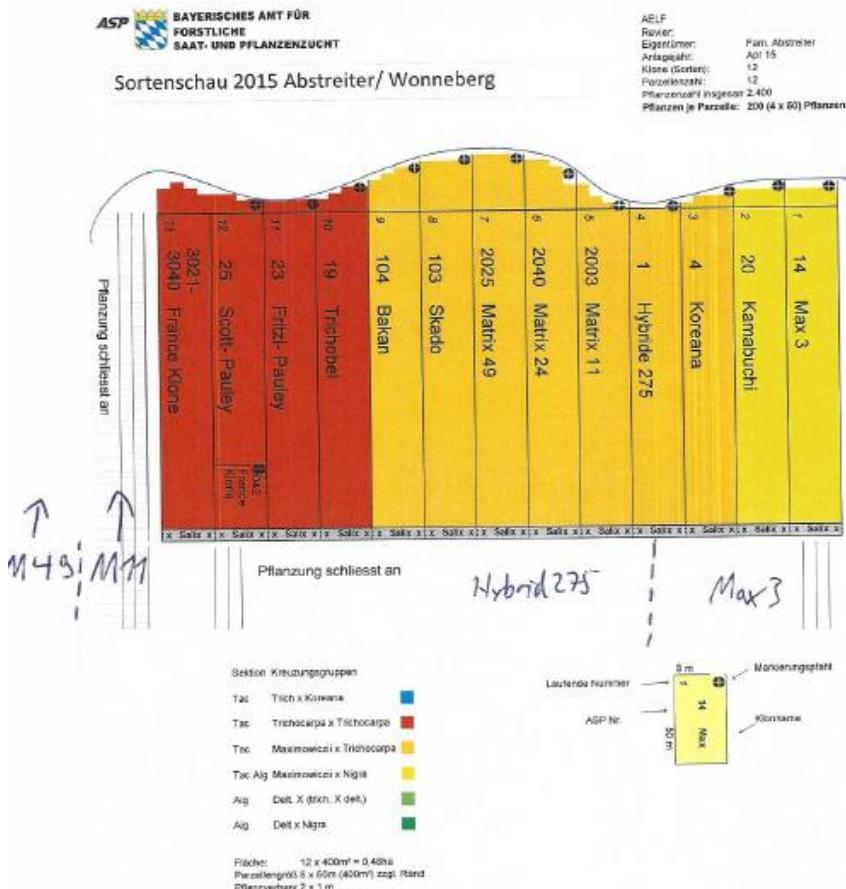


Figure 12: Plant plan of the variety trials of the ASP

In Figure 13 there are shown different machinery for the maintenance. It is important to know, that without a strict maintenance a successful establishment of a new SRC plantation is almost impossible!



Figure 13: Different machinery for the maintenance of the new SRC plantation

In Figure 14 the predicted/recommended way of harvesting is shown.



Figure 14: Predicted and/or recommended way of harvesting the SRC plantation St. Leonhard

5 SRC plantations “Vogtareuth”

As mentioned above, instead of the potential new SRC plantation at Übersee (“Westerbuchberg”) another site for a new SRC plantation with more chances of success has been chosen. This site is also located nearby Vogtareuth (Gemarkung: Vogtareuth FIST Nr. 592, 625) and has a size in total of 1.3 ha (0.61 ha + 0.69 ha), like the first listed in Chapter 3

5.1 Aerial view



Figure 15: Aerial view of the second potential new SRC plantation at Vogtareuth

5.2 Initial situation

- a) Establishment of a SRC plantation planned for 2016. The size of the new plantation shall be about 1.3 ha (0.61 ha + 0.69 ha), which has almost the mean size of a Bavarian SRC plantation of 1.1 ha.
- b) Previous use: Grain field
- c) Special feature:
 - Both subplots – divided by a (paved way) – are sited close to a slope, falling away to the north. Furthermore the new plantation is bordering to a housing development, thus higher limit distances are recommended. These limit distance areas can probably lead to an higher acceptance because of using them as flowering fields (front) or by planting fruit trees softening the landscape (longitudinal site).
 - Moreover the trees close to the housing development shall be harvested in an early stage of growth (< 12 m) or mini rotation cycles to avoid further shading of the houses.

- d) Utilization of the produced SRC woodchips: personal use (own woodchip boiler)
 - 100% marketing
 - The manager of the plantation is a part-time farmer and he wants to do as much as he can on its own (planting, establishment, ..., marketing). He's planning to manage the plantation with a midi rotation and harvest it by means of his own half- and fully-mechanical harvesting machines, dry the woodchips and market them on its own.
- e) Mini and midi rotation can be performed:
 - Maximum variability aimed in terms of harvesting techniques and time of harvest.
 - Harvest possible with mini (3-4 years) and midi rotation (6-10 years).
 - Harvest in sections and/or appropriated and in line with the market possible
 - Tree height at time of harvest
 - Mini rotation: about 7-10 m; trunk diameter about 8-12 cm
 - Midi rotation: about 13-18 m; trunk diameter about 12-20 cm
- f) Harvesting method
 - Harvest shall be performed during winter
 - Fully mechanical harvest:
 - Harvest performed by contractor(s)
 - Only useful with a plot-size of more than 2.5 ha due to high transportation costs (harvester) and high amounts of unproductive areas (on turning area(s) no trees can be planted).
 - Direct marketing with low prices and technical drying with waste heat of a biogas plant possible (weighing costs)
 - Advantage: High area efficiency (0.5-0.8 ha per hour) by relatively low harvesting costs. Management possible, even if personal contribution isn't possible any more.
 - Half-mechanical harvest (motor-manual or bundler)
 - Storage of the trunks at the field edge until end of summer; accordingly chipping
 - Produced product: storable woodchips
 - Advantage: Harvest can be performed by farmer on its own (if he owns the machinery). A former silo can be used as storage place. If drying is possible at the site, higher (drying) costs can be compensated by gaining a higher selling price.
- g) Planting plan – Amount of seedlings
 - The advised planting plan allows fully-mechanical and half-mechanical harvesting → adjusted yield optimized:
 - Distance between the rows: 2 m
 - Distance within the rows: 0.75 m
 - 6,666 Seedlings per ha

5.3 Climate, location and selection of the right tree(s)

a) Climate

Annual precipitation about 1.000 mm and about 2/3 during growing period (see DWD-data 1961-1990 of Vogtareuth)

Average annual temperature lies between 7.5 and 8 °C (see DWD-data 1961-1990 of Traunstein – Axdorf).

Summary for Vogtareuth: very good conditions related to rainfall and satisfying conditions related to the average annual temperature for a new SRC plantation.

b) Location – soil properties

Relativ frische lehmige und gute Ackerböden; Teilfläche West mit 61 bp – sL2D; Teilfläche Ost mit 55bp – L2b2

Relatively fresh loamy and good arable lands. Subplot in the west: 61 bp – sL2D. Subplot east: 55bp – L2b2.

c) Protection area

A part of Subplot east is within a water conservation area, the remaining sites are not located within a conservation area.

d) Selection of the trees and diversity of varieties

- In terms of yield issues a careful consideration between willow and poplar leads to the advice – appropriate to the location and the probably higher rotation period – to plant poplar.
- Only tested and according to the German Forest Reproductive Material Act certified seedlings shall be used.
- Due to soil condition and good water supply (rainfall) there are no restrictions in choosing the right poplar species. A guideline for choosing the right high performance species can be the list of recommendations of the Bavarian Office for Forest Seeding and Planting (“ASP Teisendorf”).
- Related to a high ecological diversity and risk spreading at minimum three different poplar species shall be planted. The recommendation of Wald21 is: Max 3, 4; Matrix 11, Matrix 49.

5.4 Limit distance, erosion, browsing and fence

a) Limit distance and opportunity to turn

- Basically the legal limit distance of 2 m has to be fulfilled.
- A municipal road (width: 5 m) is bordering north of the plot, therefore a limit distance of 2 m is basically sufficient; at the housing development it shall be 4 m and in the far west – because of the protection area – it shall be 6 m.
- In the east 4-5 m are sufficient plus the way for a suitable drive on.
- In the south 3 m limit distance are recommended in order to have a suitable bypass of the plantation.
- In the west the limit distance plus the protection area plus turning area shall have a width of 10 m.

b) Erosion

There's only a low risk of erosion given because of the slim size and the low slope gradient of the plot.

c) Game animals / browsing / fences / water voles

- At this location, there's a low danger of browsing and fraying by roe deer and red deer. Subsequently the game tenant shall be informed about a new SRC plantation and hunting is recommended if necessary. Based on environmental and costs issues fencing is basically not recommended because if maintenance will be performed and the growth is like expected, the trees will be too big for fraying within the first year of establishment.
- There's no danger of water voles due to the former use of the site.

5.5 Preparation, planting and maintenance

a) Preparation

- In years of infavourable framework conditions additional support could be taken from herbicides. In this case special care should be taken on choosing a herbicide without negative impact on the surrounding environment.
- Ploughing the site (about 25 cm deep), soonest 10-14 days after spraying.
- Harrowing: in order to prepare the soil for planting and to avoid reconsolidation (raise packer roller), a rotary harrows shall be used. Harrowing shall applied only immediately before the planting
- Fertilization: generally no starter plant / initial fertilizer is recommended. If the results of the soil analysis show a significant lack of nutrients, an advice will be handed in later.

b) Planting

- Planting will be performed mechanically. The planting machine will press the seedling on grade in the soil like it will be done by hand. A further opening of the soil by means of a (plough) share or broach can be waived. Through this an ideal soil contact can be achieved. Moreover the risk of desiccation can significantly be decreased and the connection to the soil capillary system can be speeded up.
- Subject to the weather condition the planting / sowing date shall be performed in the second half of April.

c) Maintenance

- Basically a pre-emergence herbicide according to the establishment/planting is recommended.
- In terms of waiver herbicides, it is recommended to start at an early stage with a mechanical weed control.

5.6 Ecological optimization / evaluation

a) Selection of the plot / landscape

- The planned SRC plantation has been used as acre / arable land and therefore the use as SRC can be seen as an upgrading.
- All areas surrounding the plantation belong to the farmer/manager or are divided by hedges or are located in the south so that no shadowing or further negative effects on the plot shall occur.

b) Preparation of the plot / maintenance

- The use of herbicides for preparing the plot as well as using pre-herbicides before to the planting is recommended so that a evenly distributed grow can be achieved.
 - For further maintenance (from end of May / beginning June) the use of a hoe is recommended.
- c) Choice of species / diversity / variety trial
- A diversity of varieties stands for ecological diversity and risk distribution and subsequently also for a long-term yield optimization.
- d) Rotation period
- The planting plan allows to use different ways of harvesting and managing the trees/plantation. Therefore it can be assumed that harvesting in sections will increase the diversity of varieties, because of creating/remaining natural habitats or refuges.
- e) Harvest / drying / logistics
- According to the harvesting technique the trees can be stored, dried or sold (midi rotation) at the site or be sold as woodchips (mini rotation) to a regional/local customer with an appropriate combustion or a drying unit (e.g. Biomass Trading Centre).
 - However, the almost quite energy-intensive harvest (half-mechanical; midi rotation) is in contrast to the low logistic costs because the woodchips can be produced at the site and stored and sold as "dry woodchips". In terms of using a short rotation with low harvesting costs (= low input of energy) the woodchips are transported directly to the customer – by rising distances the logistic costs are rising (= energy input).
 - Usually all produced woodchips can be sold locally or in the region. Therefore no big distances are between production and use site.
- f) Ecosystem services SRC / climate protection
- About 20% (!) of the plot (turning area, route(s)) can be used for flowering fields, which has a high positive effect in biodiversity.
 - The positive ecosystem services of the SRC in comparison to arable farming is determined mainly due to the type of usage (= SRC plantation = "energy forest"). The main advantages are amongst others diversity of varieties, flora and fauna on the same plot, positive humus balance and fallow period ("Bodenruhe"), impacts at the field edge / buffer strips or zones, possibly positive biotope cross-linking effects. The diversity of the used tree species and the waiver of using herbicides play only a tangential role in this assessment.
 - Climate protection and ecology were upgraded/improved by a SRC compared to the conventional agricultural usage.

5.7 Efficiency / earnings forecast

The following assumptions with a midi rotation have been used for the calculation shown in Figure 16 (only available in German):

- Investment costs: according to the offer and/or estimation.
- Increase in biomass: estimation of about 10 t (bone dry) /p.a. (due to the high amount of rainfall and the applied species an increase in biomass will be expected). Although

it has to be harvested before the ideal date of harvest because of limiting the (vertical) growth of the trees.

- Price for woodchips (see survey of C.A.R.M.E.N. e.V. at www.carmen-ev.de): average price for woodchips with a moisture content of 35%, plus 2% inflation rate (Average 2014 without 19% VAT): 125,90 EUR / t (bone dry).
- Harvesting costs / logistics / storage: figure based on experience, inflation rate 1%

KUP - Rechner			Vers. 1.0	Stand: 6.12.10
Hinweis: gelbe Felder sind Eingabefelder				
Programm zur Berechnung der Wirtschaftlichkeit von Kurzumtriebsplantagen				
Info (1) Verfahren: 1 ha Kurzumtriebsplantage	Pappel		Pflanzjahr: 2016	Inflation %
Info (2) Zeit zwischen 2 Ernten (Umrübszeit)	7	Jahre	Info (13) Ø-Ertragszuwachs	10,00 t TMha u. Jahr
Info (2) Umrübszeit, Anzahl Ernten	x 3	Anzahl	Info (14) Erlös Hackschnitzel	81,83 € / t FM
Info (3) Standzeit, (Lebensdauer der Plantage) =	21	Jahre	entspricht bei WG 35,00%	125,89 € / t TM
Info (4) mechanische Bodenvorbereitung	150	€/ha	Info (15) GAP-Prämie bis 2013	0 €/ha
Info (5) Pflanzenschutz zur Bodenvorbereitung	50	€/ha	Info (15) GAP-Prämie bis 2020	0 €/ha
Info (6) Pflanzgutkosten	1.200	€/ha	Info (15) GAP-Prämie bis 2027	0 €/ha
Info (7) Kosten der Pflanzung	400	€/ha	Info (15) GAP-Prämie bis 2033	0 €/ha
Info (8) Sonstige (Pflanz-)kosten	150	€/ha	Info (16) Entekosten prüfen	55,00 €/t TM
Info (9) Pflegekosten nach der Pflanzung	300	€/ha	Info (17) Transportkosten	5,00 €/t TM
SUMME Anlagekosten	2.250,00	€/ha	Info (18) Lagerkosten	2,00 €/t TM
Info (10) Rekultivierungskosten	1.000	€/ha	Info (19) Sonstige Kosten	0,00 €/Ernte u.ha
Info (11) AFP-Zuschuss	0,00	€	Info (20) Pflegekosten nach Ernte	50,00 €/Ernte u.ha
Info (12) Zinssatz	3,00	%	Info (21) Pachtansatz	0 €/ha
			Info (22) Gemeinkosten	50 €/ha
			Info (23) Wagniskosten	0 €/ha
ERGEBNIS				
Saldo Erlöse abzgl. Kosten			Barwerte (Berücksichtigung von Zinsen)	
Erlöse	Kosten	Saldo	Erlöse	Kosten
35.399 €	19.591 €	15.808 €	Info (25) 22.988 €	Info (25) 13.578 €
gesamte Standzeit			Info (25) 9.410 €	
pro Jahr			Info (26)	Info (26) Annuität
				Info (26) 610 €
			Info (27) Amortisationsdauer	Info (27) 7 Jahre
				Info (28) kostendeckender Erlös Hackschnitzel 74,36 € je t TM
				Info (29) Rendite nach der Methode "interner Zinsfuß" 17,02%

Figure 16: Earnings forecast for the SRC plantation at Vogtareuth.

5.8 Attachments and further information

In Figure 17 there is shown the plant plan of the new SRC plantation at Vogtareuth (2).

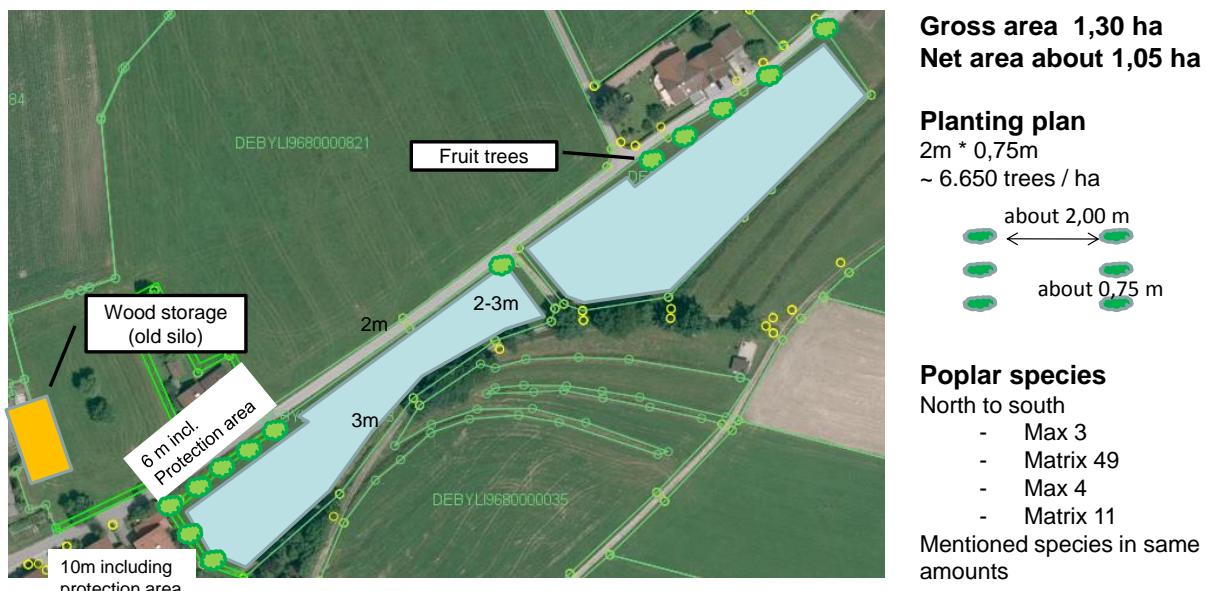


Figure 17: Planting plan at Vogtareuth (2)

In Figure 18Figure 13 there are shown different machinery for the maintenance. It is important to know, that without a strict maintenance a successful establishment of a new SRC plantation is almost impossible.



Figure 18: Different machinery for the maintenance of the new SRC plantation

In the following pictures, the two predicted/recommended ways of harvesting are shown. Figure 19 shows the way for a midi rotation and Figure 20 shows the way for a mini rotation.



Figure 19: Possible way(s) for harvesting the SRC plantation with a midi rotation cycle



Figure 20: Possible way for harvesting the SRC plantation with a mini rotation cycle

6 Conclusions and recommendations

1. Essentials

This report has identified three viable SRC plantations in the Achental region. Tab. 1 shows a comparison of the two plots at Vogtareuth and a parcel of land at St. Leonhard am Wonneberg.

Tab. 1 Comparison of three viable SRC locations

	Vogtareuth #1	Vogtareuth #2	St. Leonhard am Wonneberg
Size	5.4 ha	1.3 ha (0.61 + 0.69 ha)	1.1 ha
Previous use	Corn field	Grain field	Grass land
Utilization woodchips	of Personal use (own woodchip boiler) + marketing Selling the woodchips to the Biomass Trading Centre possible	Personal use (own woodchip boiler) + marketing Selling the woodchips to the Biomass Trading Centre or regional markets possible	Personal use (own woodchip boiler)
Potential rotation	Mini and midi	Mini and midi	Midi
Possible harvesting method	Fully- or half-mechanical	Fully- or half-mechanical	Moto-manual or half-/fully mechanical
Planting plan	36.000 seedlings	8.666 seedlings	5.500 seedlings per ha
Climate	Very good rain fall quantity Satisfying average annual temperature	Very good rain fall quantity Satisfying average annual temperature	Very good rain fall quantity Satisfying average annual temperature
Soil	Relatively fresh loamy soil with stronger parts of sand in the centre pH-value of 6.4	Relatively fresh loamy and good arable soil	Relatively fresh loamy soil - southwards more clayey Good humus layer because of the former usage
Soil quality	Varies between 49-38-54	West: 61; east: 55	49
Nutrients	Magnesium: oversupply Phosphorus: optimum Potassium: heavy undersupply	n.a.	n.a.
Location	Not within a conservation, protected or so called FFH-area	Subplot east is located within a water conservation area, the remaining sites are not located within a conservation area	Not within a conservation, water conservation area, the protected or so called FFH-area remaining sites are not located within a conservation area
Plot preparation	Herbicide and initial fertilizer use is recommended	Herbicide and initial fertilizer use is recommended	Herbicide use not necessary
Species recommendation	Minimum of three different poplar species	Minimum of three different poplar species	Minimum of three different poplar species
Erosion	No risk	Low risk because of the slim size and the low slope gradient of the plot	Low risk during heavy rainfall within the first months after planting
Damage by game animals	Low danger	Low danger	Danger of browsing and fraying by deer during the first year
Water voles	No danger	No danger	Danger because of the former land use
Fences	No fences necessary	No fences necessary	No fences suggested

Further risks	Weed control is recommended n.a. due to the size of the plot.	Risk of desiccation of the seedlings/trees during droughts
---------------	--	---

Vogtareuth #1 with its land size of 5.4 ha is rather large compared to the average size of Bavarian SRC plantations which is 1.1 ha,. The other selected plots with their respective sizes of 1.3 and 1.1 ha are very typical for Bavaria. At the plantations the trees can be harvested fully-automated or partially automated, depending on the strategy,. All three sites profit from highly sufficient precipitation. The average annual temperature is suitable for SRC. The fields consist of relatively fresh loamy soils with qualities ranging from 38 to 61. To prepare a plot, the application of herbicide and fertilizers may be advisable. In case of St. Leonhard, this is not necessary. The use of at least three different poplar species per location is advised with regard to ecological diversity and economic risk reduction. There is a slight risk of soil erosion during the first year at Vogtareuth #2 and St. Leonhard. There is no risk at Vogtareuth #1. Local wildlife may browse on the young seedlings and trees during the first year at St. Leonhard. Also water voles may cause problems for the tree's growth and survival. Because of their limited utility, fences are not advised here. For the big plantation of Vogtareuth #1, mechanic weed control is recommendable.

6.1 2. Economic case study St. Leonhard

Tab. 2 summarises the economic framework conditions, revenues and expenses. The calculation is done in an exemplary way for the selected site at St. Leonhard (Spot # 3). All these assumptions have been taken from current plantations in Bavaria and for this reason can be seen as highly representative for the selected sites.

Tab. 2 Basic data for the economic forecast of the SRC plantation

Estimated biomass production	12 t/ha p.a. (bone dry)
Net price for woodchips	125.90 € / t (bone dry)
Initial investment	2.200 €
Harvesting costs	55 €/t
Logistic costs	5 €/t
Storage costs	2 €/t
Care costs after harvest	50 €/harvest and ha
Overheads	50 €/ha
Recultivation costs	1.000 €/ha

Based on these assumptions a profit and loss forecast has been done in Tab. 3. This calculation was implemented on a net present value method. Also this analysis was done for the representative site in St. Leonhard. With revenues of 27.585 € during the 21 year project the profit is expected to be 784 € per year. The payback period is 7 years and the rate of return 19.44 %. Note that this calculation does not include costs for lease.

Tab. 3 Earnings forecast for the SRC plantation

Revenue	27.585 €
Total costs	15.500 €
Gross profit	12.086 €
Annuity	784 €
Payback period	7 years
Average rate of return	19.44 %

The exemplary economic calculation shows that the all selected sites can be implemented under economic viability. If the farmers decide for the investment to a high extend will depend on the information they will receive on SRC, their technical requirements, maintenance efforts and market opportunities. In this respect the information and dissemination activities of SRCplus particularly the Handbook translated into German language will give an important help.