Notat

# Biobaserede vækstsubstrater til planteproduktion (BioSubstrate)

**Afrapportering af følgende projektleverancer fra GUDP-projektet, 2019-2021:**

- **M6.4. Værdikæder opstillet ud fra de genererede datablade.**
- **M2.5: Datablade for valgte biomasser udarbejdet til WP6. (Bilag 1)**
- **M3.5: Datablade for processering udarbejdet til brug i AP6. (Bilag 1)**

**Forfatter: Jørgen Hinge, Teknologisk Institut. September 2021**

I arbejdspakke 2 og 3 er en række nye biobaserede substrater blevet fremstillet og efterfølgende screenet ad flere omgange, dels hos AU FOOD i Århus og dels hos virksomhedspartnerne Økologihaven, Hunsballe og Gartneriet Kjærgårdsminde. Substraterne er blevet screenet i forskellige blandingsforhold med standard vækstmedier. På baggrund heraf – og efter drøftelser med Pindstrup - er det besluttet at gennemføre scenarieberegninger for tre alternative biobaserede substrater:

- Komposteret pileflis
- Separerede og tørrede fibre fra afgasset gylle (AST-fibre)
- Ekstruderet træflis

For hver af disse tre substrater er opstillet håndteringskæder med henblik på at undersøge de økonomiske konsekvenser af delvis erstatning af traditionelle vækstsubstrater samt at gennemføre miljø- og klimamæssig livscyklusvurdering.

I dette notat beregnes prisen for slutprodukterne for de tre håndteringskæder, mens de miljø- og klimamæssige effekter behandles i M6.3.

Som bilag 1 til notatet findes de datablade, som er udarbejdet i Milepælene M2.5 og M3.5.

I tabel 1 er vist beregningerne for prisen for håndtering og behandling af de tre alternative substrater. For alle tre råvarer (AST-fibre, komposteret pileflis og ekstruderet træflis) gælder, at slutproduktet er formuleret som en blanding med 25% ”råvare”, 50% spagnum og 25% ”anden biomasse” efter Pindstrups anvisning.

Det er vigtigt at pointere, at der i denne sammenstilling alene er fokus på håndterings- og logistikomkostningerne for de tre scenarier; de resulterende ”priser for færdigprodukter” er derfor ikke et udtryk for forventede reelle salgspriser i detail-leddet.

Prisen for råvaren ses at udgøre i størrelsesordenen 25% af prisen for de respektive slutprodukter. Da blandingsforholdet med spagnum og ”anden råvare” antages at være ens for de tre substrater, er det således råvareprisen for substraterne, der bestemmer prisforholdet mellem de færdige produkter. Der foreligger ikke data for eventuelle forskelle i mængden af næringsstoffer og evt. øvrige tilsætningsstoffer, der skal tilføres de tre blandinger. Imidlertid ses det i tabel 1, at eventuelle forskelle vil være af minimal betydning for den totale pris for slutproduktet.

*Tabel 1. Oversigt over produktionsomkostninger for tre værdikæder for biobaserede vækstsubstrater.*

| AST fibre - pris for slutprodukt | | | | | | | | | Komposteret pil - pris for slutprodukt | | | | | | | | Ekstruderet gran - pris for slutprodukt | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | | | | | |
| **Råvare** | | kr/m3 | | %TS | | | | | **Råvare** | | kr/m3 | | %TS | | | | **Råvare** | | kr/m3 | | %TS |
| Afgasset gylle | | 1 | | 8 | | | | | Pileafgr på rod | | 40 | | 50 | | | | | | 0 | | 50 |
| Separering | | 18 | | | | | | | Høst (JF) | | 30 | | | | | | Høst | | 0 | | |
| Separering diverse | | 0 | | | | | | | Diverse høst | | | | | | | | Diverse høst | | | | |
| Pris | | 19 | | 25 | | | | | Pris for pileflis | | 70 | | 50 | | | | Gran chips | | 125 | | 50 |
| | | | | | | | | | | | | | | | | | | | | | |
| **AST behandling** | | | | | | | | | **Kompostering** | | | | | | | | **Ekstrudering** | | | | |
| Separerede fibre | | 19 | | 25 | | | | | Pileflis | | 70 | | 50 | | | | Gran chips | | 125 | | 50 |
| AST anlægsafskr. | | 5 | | | Tal kommer fra Svend | | | | Komp. Anlægsafskr. | | 10 | | | | | | Komp. Anlægsafskr. | | 5 | | |
| AST manpower | | 10 | | | | | | | Komp. Manpower | | 20 | | | | | | Komp. Manpower | | 10 | | |
| AST Energiforbrug | | 2 | | | | | | | | | | | | | | | Strømforbrug | | 7 | | |
| AST Diverse | | 1 | | | | | | | Komp. Diverse | | | | | | | | Komp. Diverse | | | | |
| Pris fra AST | | 37 | | 70 | | | | | Pris fra NyVraa | | 100 | | 50 | | | | Pris fra ekstruder | | 58,8 | | 50 |
| | | | | | | | | | | | | | | | | | | | | | |
| **Transport til Pindstrup** | | | | | | | | | **Transport til Pindstrup** | | | | | | | | **Transport til Pindstrup** | | | | |
| Pris fra AST | | 37 | | 70 | | | | | Pris fra NyVraa | | 100 | | 50 | | | | Pris fra ekstruder | | 58,8 | | 50 |
| Transport | | 20 | | | | | | | Transport | | 20 | | | | | | Transport | | 0 | | |
| Pris leveret hos Pindstrup | | 57 | | 70 | | | | | Pris leveret hos Pindstrup | | 120 | | 50 | | | | Pris leveret hos Pindstrup | | 58,8 | | 50 |
| | | | | | | | | | | | | | | | | | | | | | |
| **Formulering af slutprodukt** | | | | | | | | | **Formulering af slutprodukt** | | | | | | | | **Formulering af slutprodukt** | | | | |
| Anlægsafskrivning | | 0,8 | | | | | | | Anlægsafskrivning | | 0,8 | | | | | | Anlægsafskrivning | | 0,8 | | |
| Truck | | | | | | | | | Truck | | | | | | | | Truck | | | | |
| Manpower | | 0,4 | | | | | | | Manpower | | 0,4 | | | | | | Manpower | | 0,4 | | |
| Diverse | | 0,6 | | | | | | | Diverse | | 0,6 | | | | | | Diverse | | 0,6 | | |
| Råvarer | % iblandet | | Pris/m3 | | | | | | Råvarer | % iblandet | | Pris/m3 | | | | | Råvarer | % iblandet | | Pris/m3 | |
| AST fibre | 25 | 14,25 | 57 | 70 | | | | | Komposteret pileflis | 25 | 30 | 120 | | | | | Ekstruderet granflis | 25 | 14,7 | 58,8 | |
| Spagnum | 75 | 63,75 | 85 | | | | | | Spagnum | 75 | 63,75 | 85 | | | | | Spagnum | 75 | 63,75 | 85 | |
| Kokos | | 0 | | | | | | | Kokos | | 0 | | | | | | Kokos | | 0 | | |
| Perlit | | 0 | | | | | | | Perlit | | 0 | | | | | | Perlit | | 0 | | |
| Forest Gold | | 0 | | | | | | | Forest Gold | | 0 | | | | | | Forest Gold | | 0 | | |
| Anden råvare | 0 | 0 | 50 | | | | | | Anden råvare | 0 | 0 | 50 | | | | | Anden råvare | 0 | 0 | 50 | |
| Øvrige ingredienser | kg iblandet | | Pris/kg | | | | | | Øvrige ingredienser | kg iblandet | | Pris/kg | | | | | Øvrige ingredienser | kg iblandet | | Pris/kg | |
| N | 0,2 | 1,48 | 7,4 | | | | | | N | 0,2 | 1,48 | 7,4 | | | | | N | | 0,2 | 1,48 | |
| P | 0,07 | 1,4 | 20 | | | | | | P | 0,07 | 1,4 | 20 | | | | | P | | 0,07 | 1,4 | |
| K | 0,15 | 2,25 | 15 | | | | | | K | 0,15 | 2,25 | 15 | | | | | K | | 0,15 | 2,25 | |
| Andet | | | | | | | | | Andet | | | | | | | | Andet | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | |
| **Pris for færdigprodukt pr m3** | | 84,93 | | | | | | | **Pris for færdigprodukt pr m3** | | 100,68 | | | | | | **Pris for færdigprodukt pr m3** | | 80,67 | | |

*Bilag 1. Datablade for fremstilling og processering af biomasser til biobaserede vækstsubstrater.*

BIOSUBSTRATE

The project is supported by GUDP, Denmark

| | | | | | | |
|---|---|---|---|---|---|---|
| **Category:** | Crop | | | | | |
| **Crop:** | Willow, composted | *Salix Viminalis* | | x | | |
| **Nomenclature \| Sheet ID:** | WillowDK | | 102 | x | | |
| **Country:** | Denmark | DK | 2 | | | Insert customised figures in green cells |
| **Date:** | | | | | | |
| **Contact:** | Jørgen Hinge, Technological Institute, jhi@teknologisk.dk | | | | | |
| **Details** | | | | | Source | **Remarks** |
| Crop ID related to harvest method | Willow crop for mechanical harvest | | | x | | |
| Crop description | Management of the plantations and water availability highly affects the productivity. | | | | 2 | |
| Propagation materials | Willows are planted either as cuttings 18-20 cm long or rods. Species are selected for their tolerance to specific climate and soil conditions, susceptibility to pests and diseases, ease of propagation and speed of vegetative growth | | | | 2 | |
| Suitable harvest methods | Whole shoot harvesters or modified forage harvesters equipped with a header suitable for direct harvest of willow on fields. | | | | 2 | |
| Timing of combine harvest | Harvests take place on a two to five year cycle, and are carried out in winter after leaf fall and when the soil is frozen. | | | | 2 | |
| Storage | | | | | | |
| | | | | | | |
| | | | | | | |
| Website | | | | | | |
| Type of crop | SRC - can be used for numerous applications | | | | | |
| References | Søren Ugilt Larsen, 2010. Kalkuler for energipil. AgroTech | | | | 1 | |
| | Hinge J. et al. (2013). Assessment. | | | | 2 | |
| | | | | | | |
| | | | | | | |
| **Specifications and data** | **Units** | **Range** | **Figure used** | | *Ref* | |
| ***Biomass*** | | | | | | |
| Description | | | | | | |
| Dry matter | % dry matter | 48-55 | 50 | x | *1,2* | |
| Yield | ton DM per hectare | 7-15 | 11,4 | x | *1* | |
| Oil content | % of DM | | N/A | x | | |
| Bulk density of seeds | kg biomass/m³ | | | | | |
| Bulk density of chips | kg dry matter/m³ | | | | | |
| *Timing of crop harvest* | % | | 100 | | | |
| January | % | 0-100 | 20 | x | | |
| February | % | 0-100 | 20 | x | | |
| March | % | 0-100 | 20 | x | | |
| April | % | | | x | | |
| May | % | | | x | | |
| June | % | 0-100 | | x | | |
| July | % | | | x | | |
| August | % | | | x | | |
| September | % | | | x | | |
| October | % | | | x | | |
| November | % | 0-100 | 20 | x | | |
| December | % | 0-100 | 20 | x | | |
| Crop cost at field | Euro/ton DM | | 24 | x | *2* | Cost of crop 85 % of DK costs |
| Nutrients, pesticides and work/fuel consumption | MJ/ha | | | | | |
| Direct energy consumption | GJ/ton DM | | | | | |
| Indirect energy consumption | GJ/ton DM | | | | | |
| Total energy consumption | GJ/ton DM | | | x | | |
| Direct $CO_2$ emission | kg/ton DM | | | | | |
| Indirect $CO_2$ emission | kg/ton DM | | | | | |
| Total $CO_2$ emission | kg/ton DM | | | x | | |
| **Data validity** | | | | | | |
| Average field size | hectares/field | | 5 | | *2* | |
| Minimum cropping area | tons DM/season | | 57 | x | *2* | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **Category:** | Harvest | | | | | |
| **Crop:** | Willow | | x | | | |
| **Nomenclature \| Sheet ID:** | WillowChipsDK | | 202 | x | | |
| **Country:** | Denmark | DK | 2 | | | Insert customised figures in green cells |
| **Date:** | | | | | | |
| **Contact:** | Jørgen Hinge, Technological Institute, jhi@teknologisk.dk | | | | | |
| **Details** | | | | | **Source** | **Remarks** |
| Biomass harvested | Willow crop harvested from November until March | | | | | |
| Short description/ID of machinery | Tractor driven harvester blowing chips into attached trailer | | | x | | |
| Characteristics of equipment/machinery | Harvester and harvesting head is suitable for direct harvest of willow on fields | | | | | |
| Description of machinery | Can be used for direct harvest and chopping of grass, corn, grain, willow as well as pick up chopping of swathed grass and grain crops. Biomass is unloaded at end of field by the harvester. | | | | | |
| Contractor | Harvest is carried out by biomass growers or a contactor. | | | | | |
| Equipment can be applied for | Can be used for grass, oil crops, short rotation crops etc. | | | | | |
| Manufacturer | | | | | | |
| Website | | | | | | |
| References | Pedersen, J. (2012). Høst og økonomi i piledyrkning. Konferencebilag fra Plantekongres 2012 | | | | **1** | |
| | Nielsen, K. V., Hinge J., Kofman, P. D., Schmidt, E. R., Jensen, J.-M. (1997). Helårsforsyning af pil til kraftvarmeproduktion. | | | | **2** | |
| | Joergensen K., Andersen J. T., Hansen B. O., and Maegaard E. (2011) Farmtal online. Danish Knowledge Centre of Agriculture. | | | | **3** | |
| | Hinge J. et al. (2013). Assessment. | | | | **4** | |
| **Specifications and data** | **Units** | **Range** | **Figure used** | | ***Ref*** | |
| ***Biomass input*** | | | | | | |
| Description | | Willow standing on root at field | | | | |
| Dry matter content | % dry matter | 50-60 | 50 | | *2* | |
| ***Biomass output*** | | | | | | |
| Description | cm | Chipped willow, average lenght 3 cm | 3,0 | | *2* | |
| Dry matter | % dry matter | 50-60 | 50 | x | *2* | |
| Bulk density | kg biomass/$m^3$ | | 297 | | | |
| Bulk density | kg dry matter/$m^3$ | 147-155 | 148 | x | *2* | |
| **Output-input ratio** | **% DM output/input** | | **95** | x | *4* | |
| Cost of basic machine | Euro | 250.000-400.000 | 335.570 | | *3* | Selfpropelled 800 HP |
| Cost of dedicated equipment | Euro | 50.000-150.000 | 120.805 | | *1* | |
| Total cost | Euro | 250.000-550.000 | 456.376 | | | |
| Net harvest capacity | ton DM/hour | 12-25 | 36,0 | | *1* | |
| Efficiency | % | 50-80 | 75,0 | | *4* | Efficiency on field |
| Gross harvest capacity on field | ton DM/hour | | 27,0 | | | |
| Efficiency | % | 50-90 | 90,0 | | *4* | Logistic set up - distance between fields |
| Gross harvest capacity - actual scenario | ton DM/hour | | 24,3 | | | |
| Overall efficiency | % | | 67,5 | x | | |
| Harvesting costs | Euro/ton DM | | 23,18 | x | | Calculated considering also reference 1 |
| Fuel consumption | l diesel/hour | 100-175 | 114 | | *3* | |
| Cost of direct energy consumption | euro/l | | 0,75 | | | 1: Cost of energy - diesel |
| Energy cost, euro/ton DM | euro/ton DM | | 3,53 | | | Costs according to country code |
| Direct energy consumption | GJ/ton DM | | 0,17 | | | |
| Indirect energy consumption | GJ/ton DM | | 0,09 | | | Estimate |
| Total energy consumption | GJ/ton DM | | 0,26 | x | | |
| Direct $CO_2$ emission | kg $CO_2$/ton DM | | 14,78 | | | |
| Indirect $CO_2$ emission | kg $CO_2$/ton DM | | 7,68 | | | |
| Total $CO_2$ emission | kg $CO_2$/ton DM | | 22,46 | x | | |
| Security of supply | 80 % probability that actual harvest is not delayed more than [-] of weeks | | 6 | x | *4* | |
| **Data validity** | | | | | | |
| Minimum harvest volume | tons DM/season | 1.000-2.000 | 6.075 | x | *4* | |

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|---|---|---|---|---|---|---|
| **Category:** | Loading | | | | | |
| **Crop:** | Willow | | | x | | |
| **Nomenclature \| Sheet ID:** | WillowChipsLoadingDK | | 902 | x | | |
| **Country:** | Denmark | DK | 2 | | | Insert customised figures in green cells |
| **Date:** | | | | | | |
| **Contact:** | Jørgen Hinge, Technological Institute, jhi@teknologisk.dk | | | | | |
| **Details** | | | | | **Source** | Remarks |
| Biomass loaded | Composted willow chips | | | | | |
| Short description/ID of machinery/working procedure | Wheel loader | | | x | | |
| Characteristics of equipment/working procedure | Wheel loader and bucket is suitable for loading of bulky biomass etc. | | | | | |
| Description of equipment/working procedure | Chips loaded onto lorry and trailers parked next to the storage | | | | | |
| Contractor | Loading is carried out by the biomass growers or a contactor. | | | | | |
| Manufacturer | Numerous manufacturers | | | | | |
| Website | N/A | | | | | |
| | | | | | | |
| References | Danske maskinstationer | | | | **1** | |
| | Nielsen, K. V., Hinge J., Kofman, P. D., Schmidt, E. R., Jensen, J.-M. (1997). Helårsforsyning af pil til kraftvarmeproduktion. | | | | **2** | |
| | Hinge J. et al. (2013). Assessment. | | | | **3** | |
| | | | | | | |
| **Specifications and data** | **Units** | **Range** | **Figure used** | | *Ref.* | |
| ***Biomass input*** | | | | | | |
| Description | cm | Composted willow chips | 3 | | | |
| Dry matter content | % dry matter | 50-60 | 49 | | *3* | |
| Bulk density | kg biomass/$m^3$ | | 302 | | | |
| Bulk density | kg dry matter/$m^3$ | 145-155 | 148 | | *3* | |
| ***Biomass output*** | | | | | | |
| Description | | Composted willow chips | 3 | | | |
| Dry matter | % dry matter | 50-60 | 49 | x | *3* | |
| Bulk density | kg biomass/$m^3$ | | 302 | | | |
| Bulk density | kg dry matter/$m^3$ | 147-155 | 148 | x | *3* | |
| **Output/input ratio** | **% DM output/input** | | **99,5** | x | *3* | |
| Cost of basic machinery | Euro | 50.000-125.000 | 67.114 | | *3* | |
| Cost of dedicated equipment | Euro | | | | | |
| Total cost | Euro | 50.000-100.000 | 67.114 | | | |
| Net loading capacity | ton DM/hour | 42.278 | 30,0 | | *3* | |
| Efficiency | % | 50-80 | 75,0 | x | *3* | |
| Gross transport capacity on field | ton DM/hour | | 22,5 | | | |
| Loading costs | Euro/ton DM | | 2,9 | x | *3* | |
| Fuel consumption | l diesel/hour | | 20 | | *3* | |
| Cost of direct energy consumption | euro/l | | 0,75 | | | 1: Cost of energy - diesel |
| Energy cost, euro/ton DM | euro/ton DM | | 0,67 | | | Costs according to country code |
| Direct energy consumption | GJ/ton DM | | 0,03 | | | |
| Indirect energy consumption | GJ/ton DM | | 0,00 | | | |
| Total energy consumption | GJ/ton DM | | 0,04 | x | | |
| Direct $CO_2$ emission | kg $CO_2$/ton DM | | 2,80 | | | |
| Indirect $CO_2$ emission | kg $CO_2$/ton DM | | 0,33 | | | |
| Total $CO_2$ emission | kg $CO_2$/ton DM | | 3,13 | x | | |
| Security of supply | 80 % probability that actual loading is not delayed more than [-] of weeks | | 0 | x | *3* | Storages are placed on practical/feasible locations to secure loading and parking of lorries and trailers even during prolonged periods with rain/snow or similar |
| **Data validity** | | | | | | |
| Minimum loading volume | tons DM/season | | 50 | x | *3* | |

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|---|---|---|---|---|---|---|
| **Category:** | Road transport | | | | | |
| **Crop:** | Willow | | | x | | |
| **Nomenclature \| Sheet ID:** | WillowChipsRoadTransport | | 1002 | x | | |
| **Country:** | Denmark | DK | 2 | | | Insert customised figures in green cells |
| **Date:** | | | | | | |
| **Contact:** | Jørgen Hinge, Technological Institute, jhi@teknologisk.dk | | | | | |
| **Details** | | | | | Source | Remarks |
| Biomass transported | Willow chips produced by a harvest machinery using a nominal cutting length of app. 3 cm | | | | | |
| Short description/ID of machinery/working procedure | Lorry and trailer | | | x | | |
| Characteristics of equipment/working procedure | Lorry and trailer are dedicated/suitable for transport of bulky biomass etc. | | | | | |
| Description of equipment/working procedure | Chips is loaded into lorry incl. trailers from local storages | | | | | |
| Contractor | Road transport is carried out by a contactor. | | | | | |
| Manufacturer | Numerous manufacturers | | | | | |
| Website | N/A | | | | | |
| | | | | | | |
| References | Danske maskinstationer | | | | 1 | |
| | Nielsen, K. V., Hinge J., Kofman, P. D., Schmidt, E. R., Jensen, J.-M. (1997). Helårsforsyning af pil til kraftvarmeproduktion. | | | | 2 | |
| | Hinge J. et al. (2013). Assessment. | | | | 3 | |
| | | | | | | |
| **Specifications and data** | **Units** | **Range** | **Figure used** | | | |
| ***Biomass input*** | | | | | | |
| Description | cm | Composted willow chips | 3 | | | |
| Dry matter content | % dry matter | 50-60 | 49 | | 3 | |
| Bulk density | kg biomass/$m^3$ | | 302 | | 2 | |
| Bulk density | kg dry matter/$m^3$ | 145-155 | 148 | | 3 | |
| ***Biomass output*** | | | | | | |
| Description | cm | Composted willow chips | 3 | | 2 | |
| Dry matter | % dry matter | 50-60 | 49 | x | 3 | |
| Bulk density | kg biomass/$m^3$ | | 302 | | | |
| Bulk density | kg dry matter/$m^3$ | 147-155 | 148 | x | 3 | |
| **Output/input ratio** | **% DM output/input** | | **99,5** | x | 2 | |
| Cost of basic machinery | Euro | 150.000-250.000 | 175.000 | x | 3 | |
| Cost of dedicated equipment | Euro | | | | | |
| Total cost | Euro | 150.000-250.000 | 175.000 | | | |
| Total volume of lorry and trailer | $m^3$ | | 80 | | 3 | |
| Gross transport capacity | ton DM/hour | | 2,1 | | 3 | |
| Efficiency | % | 50-95 | 95,0 | x | 3 | |
| Gross transport capacity - actual scenario | ton DM/hour | | 2,0 | | | |
| **Transport costs** | **Euro/ton DM** | | **36,9** | x | | |
| Fuel consumption | l diesel/hour | 25-50 | 29,4 | | 3 | |
| Cost of direct energy consumption | euro/l | | 0,75 | | | 1: Cost of energy - diesel |
| Energy cost, euro/ton DM | euro/ton DM | | 10,82 | | | Costs according to country code |
| Direct energy consumption | GJ/ton DM | | 0,52 | | | |
| Indirect energy consumption | GJ/ton DM | | 0,00 | | | |
| Total energy consumption | GJ/ton DM | | 0,52 | x | | |
| Direct $CO_2$ emission | kg $CO_2$/ton DM | | 45,36 | | | |
| Indirect $CO_2$ emission | kg $CO_2$/ton DM | | 0,09 | | | |
| Total $CO_2$ emission | kg $CO_2$/ton DM | | 45,44 | x | | |
| Security of supply | 80 % probability that actual transport is not delayed more than [-] of weeks | | 0 | x | 3 | |
| **Data validity** | | | | | | |
| Minimum transport volume | tons DM/season | | 50 | x | 3 | |

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| | | | | | | |
|---|---|---|---|---|---|---|
| **Category:** | Final formulation | | | | | |
| **Crop:** | Willow | | | x | | |
| **Nomenclature \| Sheet ID:** | Final formulation of product | | 1402 | x | | |
| **Country:** | Denmark | DK | 2 | | | |
| **Date:** | | | | | | |
| **Contact:** | Jørgen Hinge, Technological Institute, jhi@teknologisk.dk | | | | | |
| **Details** | | | | | **Source** | **Remarks** |
| Biomass | 25 % composted willow chips, 50 % spagnum, 25% "other subtratet" | | | | | |
| Short description/ID of machinery | Final formulation at Pindstrup | | | x | | |
| Characteristics of equipment/machinery | | | | | | |
| Description of machinery | | | | | | |
| Contractor | Stacking/insertion is carried out by staff of biorefinery or a | | | | | |
| Equipment can be applied for | Numerous manufacturers | | | | | |
| Manufacturers | N/A | | | | | |
| Websites | | | | | | |
| References | sel; Personal communication | | | | **1** | |
| | | | | | **2** | |
| | | | | | **3** | |
| | Hinge J. et al. (2021). Assessment. | | | | **4** | |
| **Specifications and data** | **Units** | **Range** | **Figure used** | | ***Ref*** | |
| ***Biomass input*** | | | | | | |
| Description | cm | | 3,0 | | *0* | |
| Dry matter | % dry matter | | 49 | x | *0* | |
| Bulk density | kg biomass/$m^3$ | | 302 | | | |
| Bulk density | kg dry matter/$m^3$ | | 148 | x | *0* | |
| ***Biomass output*** | | | | | | |
| Description | cm | | 3,0 | | *2* | |
| Dry matter | % dry matter | | 49 | x | *2* | |
| Bulk density | kg biomass/$m^3$ | | 302 | | | |
| Bulk density | kg dry matter/$m^3$ | | 148 | x | *2* | |
| **Output-input ratio** | **% DM output/input** | | **100** | x | *4* | |
| Cost of basic machine | Euro | | 200.000 | | | |
| Cost of dedicated equipment | Euro | | | | *1* | |
| Total cost | Euro | | 200.000 | | | |
| Net capacity | ton DM/hour | | 1.000,0 | | *4* | |
| Efficiency | % | 50-90 | 80,0 | | *4* | Efficiency at stacking spot |
| Gross capacity | ton DM/hour | | 800,0 | | | |
| Efficiency | % | 50-90 | 100,0 | | *4* | Logistic set up - distance between locations |
| Gross capacity - actual scenario | ton DM/hour | | 800,0 | | | |
| Overall efficiency | % | | 80,0 | x | | |
| stacking costs | Euro/ton DM | | 0,08 | x | | Calculated considering also reference 1 |
| Energy consumption | kWh hour | | 40 | | *3* | |
| Cost of direct energy consumption | euro per kWh | | 0,15 | | | |
| Energy cost, euro/ton DM | euro/ton DM | | 0,01 | | | Costs according to country code |
| Direct energy consumption | GJ/ton DM | | 0,00 | | | |
| Indirect energy consumption | GJ/ton DM | | 0,00 | | | Estimate |
| Total energy consumption | GJ/ton DM | | 0,00 | x | | |
| Direct $CO_2$ emission | kg $CO_2$/ton DM | | 0,16 | | | |
| Indirect $CO_2$ emission | kg $CO_2$/ton DM | | 0,01 | | | |
| Total $CO_2$ emission | kg $CO_2$/ton DM | | 0,17 | x | | |
| Security of supply | 80 % probability that actual harvest is not delayed more than [-] of weeks | | 0 | x | *4* | |
| **Data validity** | | | | | | |
| Minimum harvest volume | tons DM/season | 1.000-2.000 | 7.000 | x | *4* | |

BIOSUBSTRATE

The project is supported by GUDP, Denmark


| | | | | | | |
|---|---|---|---|---|---|---|
| **Category:** | Storage | | | | | |
| **Crop:** | Willow | | | x | | |
| **Nomenclature \| Sheet ID:** | Storage of final product | | 1503 | x | | |
| **Country:** | Denmark | DK | 2 | | | |
| **Date:** | | | | | | |
| **Contact:** | Jørgen Hinge, Technological Institute, jhi@teknologisk.dk | | | | | |
| **Details** | | | | | **Source** | Remarks |
| Biomass stored | Final product of mixed, composted willow chips and spagnum stored at Pindstrup | | | | | |
| Storage description - short | Storage of final product | | | x | | |
| Type of storage/equipment | | | | | | |
| Description of storage establishment and main charasteristics | | | | | | |
| Contractor | | | | | | |
| Manufacturer | N/A | | | | | |
| References | xxx, personal communication | | | | **1** | |
| | Nielsen, K. V., Hinge J., Kofman, P. D., Schmidt, E. R., Jensen, J.-M. (1997). | | | | **2** | |
| | Hinge J. et al. (2013). Assessment. | | | | **3** | |
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| **Specifications and data** | **Units** | **Range** | **Figure used** | | *Ref.* | |
|---|---|---|---|---|---|---|
| ***Biomass input*** | | | | | | |
| Description | cm | | 3 | | | |
| Dry matter content | % dry matter | 50-60 | 49 | | 3 | |
| Bulk density | kg biomass/$m^3$ | | 302 | | | |
| Bulk density | kg dry matter/$m^3$ | 147-155 | 148 | | 2 | |
| ***Biomass output*** | | | | | | |
| Description | cm | | 28 | | 3 | |
| Month of biomass insertion | months | Jan, Feb, Mar,.....Dec | Jan | | 3 | |
| Storage duration | number of months | 1-12 | 6 | | 3 | |
| Dry matter content | % dry matter | 50-60 | 48,1 | Δx | | A specific dry matter content according to months of storage |
| Bulk density | kg biomass/$m^3$ | | 306 | | | |
| Bulk density | kg dry matter/$m^3$ | 147-155 | 147 | x | 2 | |
| Output/input ratio | % DM output/input | | 82,9 | x | 2 | A specific output/input ratio is used for calculations according to month of biomass insertion and the duration of |
| Cost of basic storage facilities | Euro | 0 | 1.600.000 | | | |
| Cost of dedicated facilities | Euro | 0 | 0 | | | |
| Total cost | Euro | 0 | 1.600.000 | | | |
| Storage capacity | $m^3$ | 500-99.999 | 41.000 | | 3 | **Maximum at each location** |
| Storage costs | Euro/ton DM | | 20,31 | x | | |
| Energy consumption | kWh/ton DM | 35-50 | | | | |
| Cost of direct energy consumption | euro/l | | 0,11 | | | 1: Cost of energy - diesel |
| Energy cost, euro/ton DM | euro/ton DM | | 0,00 | | | Costs according to country code |
| Direct energy consumption | GJ/ton DM | | 0,00 | | | |
| Indirect energy consumption | GJ/ton DM | | 0,10 | | | |
| Total energy consumption | GJ/ton DM | | 0,10 | x | | |
| Direct $CO_2$ emission | kg $CO_2$/ton DM | | 0,00 | | | |
| Indirect $CO_2$ emission | kg $CO_2$/ton DM | | 8,73 | | | |
| Total $CO_2$ emission | kg $CO_2$/ton DM | | 8,73 | x | | |
| Security of supply | 80 % probability that removal of storages is not delayed more than [-] of weeks | | 0 | | 3 | |
| **Data validity** | | | | | | |
| Minimum storage volume | tons DM/season | 1000-2000 | 100 | x | 3 | |

BIOSUBSTRATE

"Færdigt produkt med AST-fibre"

| | | | | | | |
|---|---|---|---|---|---|---|
| **Category:** | Product formulation | | | | | |
| **Crop:** | Separated, extruded and dried fibres from anaerobically digested l x | | | | | |
| **Nomenclature \| Sheet ID:** | Formulation of final product | | 1452 | x | | |
| **Country:** | Denmark | DK | 2 | | | |
| **Date:** | | | | | | |
| **Contact:** | Jørgen Hinge, Technological Institute, jhi@teknologisk.dk | | | | | |
| **Details** | | | | | **Source** | **Remarks** |
| Biomass (input) | Digested, separated extruded and dried fibres | | | | | |
| Short description/ID of machinery | Formulation of final product | | | x | | |
| Characteristics of equipment/machinery | Mixing of digested, separated, extruded and dried fibres with Spagnum, lime and nurtients | | | | | |
| Description of machinery | Biomass is picked up from pile with front loader and dropped into mixing divice | | | | | |
| Contractor | Pindstrup | | | | | |
| Equipment can be applied for | All types of finely cut/grinded/extruded biomass | | | | | |
| Manufacturers | n/a | | | | | |
| Websites | | | | | | |
| References | Hoff 2021 | | | | **1** | |
| | | | | | **2** | |
| | | | | | **3** | |
| | Hinge J. et al. (2021). Assessment. | | | | **4** | |
| **Specifications and data** | **Units** | **Range** | **Figure used** | | ***Ref*** | |
| ***Biomass input*** | | | | | | |
| Description | cm | 1,5-3 | 2,5 | | *0* | Extruded, dried fibres 3cm |
| Dry matter | % dry matter | | 80 | x | *0* | |
| Bulk density | kg biomass/$m^3$ | | 300 | | | |
| Bulk density | kg dry matter/$m^3$ | | 240 | x | *0* | |
| ***Biomass output*** | | | | | | |
| Description | cm | | 0,0 | | | |
| Dry matter | % dry matter | | 50 | x | | |
| Bulk density | kg biomass/$m^3$ | | 160 | | | **Hoff 150-170** |
| Bulk density | kg dry matter/$m^3$ | | 80 | x | | |
| **Output-input ratio** | **% DM output/input** | | **?** | x | | |
| Cost of basic machinery | Euro | | 100.000 | | *1* | ?? |
| Cost of dedicated equipment | Euro | | 0 | | *1* | |
| Total cost | Euro | | 100.000 | | | |
| Net capacity | ton DM/hour | 50-100 | 2,4 | | *1* | 3 tons/time 80% TS |
| Efficiency | % | 50-90 | 100,0 | | *1* | |
| Gross capacity | ton DM/hour | | 2,4 | | | |
| Efficiency | % | 50-90 | 80,0 | | *1* | |
| Gross capacity - actual scenario | ton DM/hour | | 1,9 | | | |
| Overall efficiency | % | | 80,0 | x | | |
| Formulation costs | Euro/ton DM | | 24,48 | x | | |
| Energy consumption | kWh/hour | | 10 | | *1* | |
| Cost of direct energy consumption | euro/kWh | | 0,11 | | | 3: Cost of electricity |
| Energy cost, euro/ton DM | euro/ton DM | | 0,56 | | | Costs according to country code |
| Direct energy consumption | GJ/ton DM | | 0,02 | | | |
| Indirect energy consumption | GJ/ton DM | | 0,03 | | | Estimate |
| Total energy consumption | GJ/ton DM | | 0,05 | x | | |
| Direct $CO_2$ emission | kg $CO_2$/ton DM | | 0,02 | | | |
| Indirect $CO_2$ emission | kg $CO_2$/ton DM | | 2,45 | | | |
| Total $CO_2$ emission | kg $CO_2$/ton DM | | 2,47 | x | | |
| Security of supply | 80 % probability that actual harvest is not delayed more than [-] of weeks | | 0 | x | *4* | |
| **Data validity** | | | | | | |
| Minimum volume | tons DM/season | 0 | 0 | x | *4* | |