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Ecodesign of new circular economy scheme for Brewer's side streams

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New Strategies for Improving the Sustainability of Breweries: Full Waste Recovery for Aquaculture Feed

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Start date: 01/09/2017

Finish date: 31/12/2020 -> 30/06/2021

Budget: 1,551,455 € (EU contribution: 874,952 €)

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Objective:

To **demonstrate the feasibility of** an innovative and sustainable **Valorisation Scheme to** increase significantly **the brewer by-products recovery** by **their up-grading as aqua-feed ingredients:**

- Through a full scale trial, in real operational conditions.
- In a real case study (north-east of Spain), in a representative EU brewing producing region.

Consortium:

All agents in the valorisation value chain are involved

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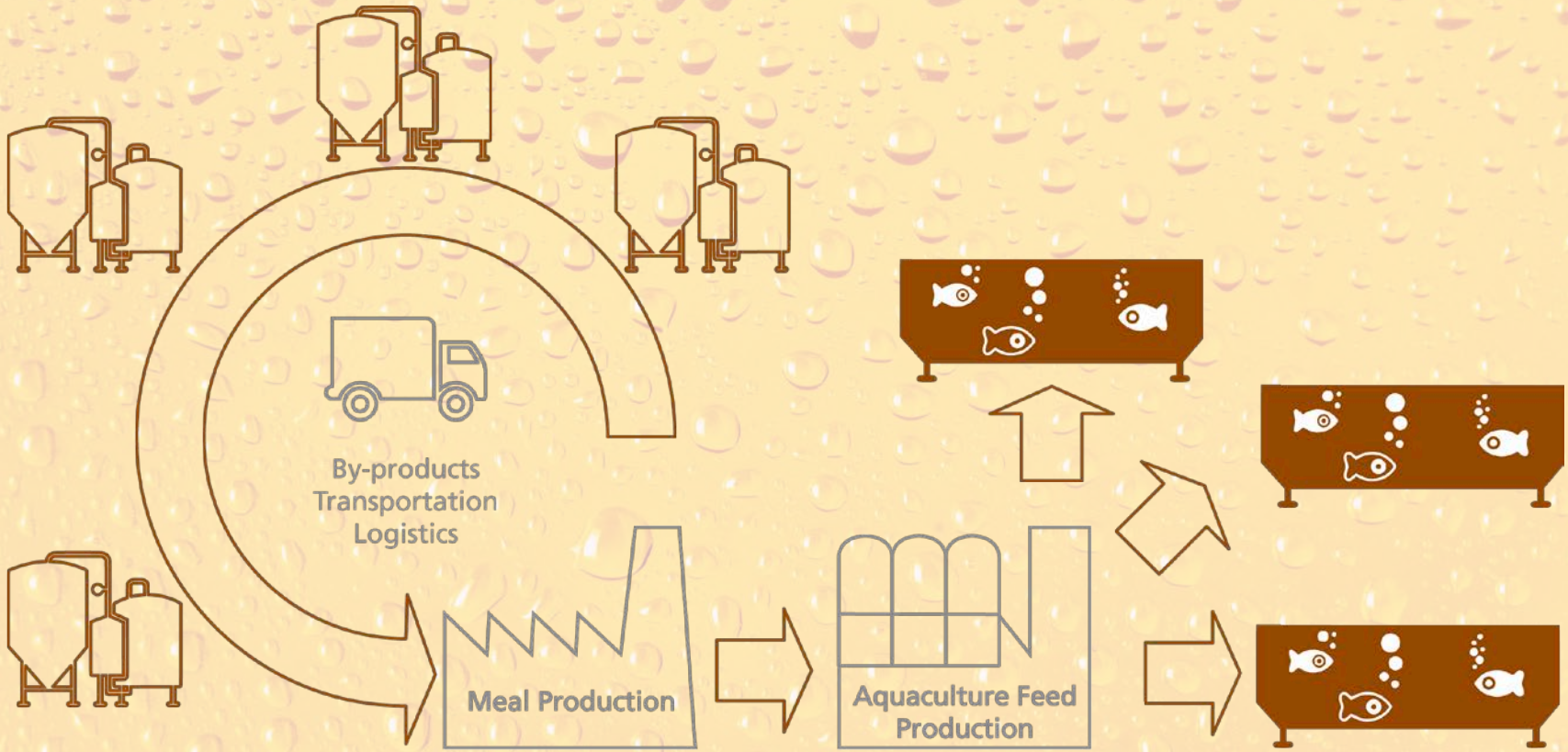

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The case study

Raw materials:

- **Spent Yeast (BSY) :** 5.400 Tn/year
- **Spent Grain (BSG) :** 28.000 Tn/year

Production program:

- **Days of production** : 5 days /week. Total: 200 days / year
- **Hours per day** : 24 hours / day

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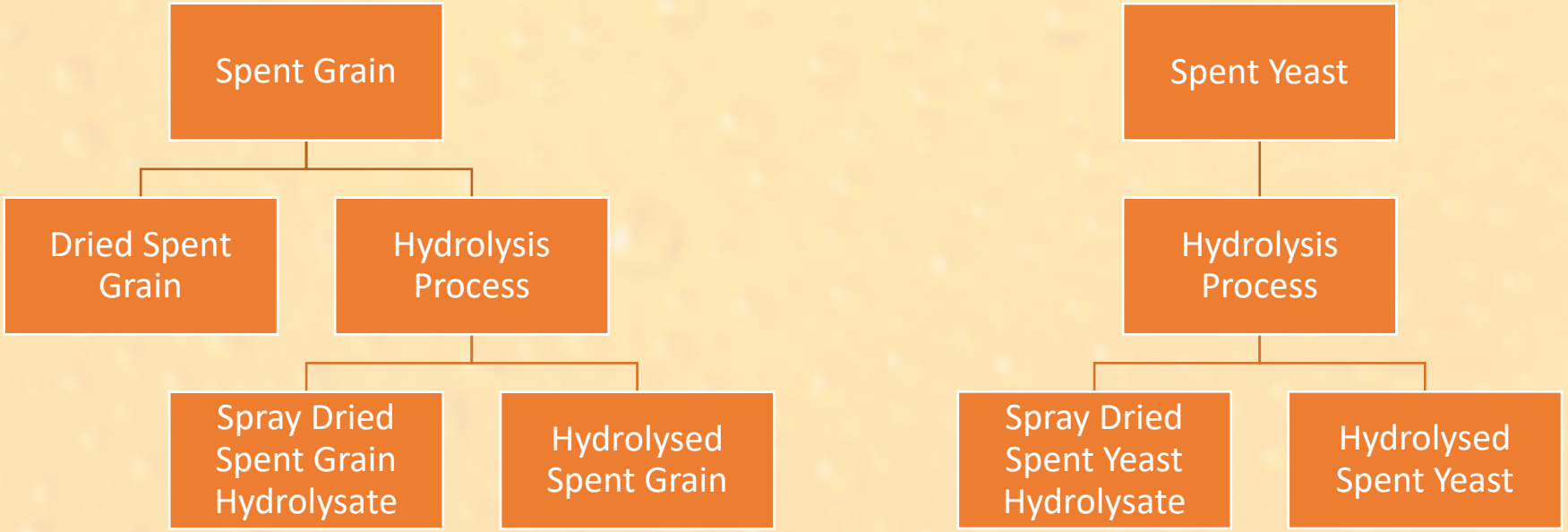
The process

- Biorefinery process
- Designed to reduce energy demand
- Optimized to meet aquaculture feed ingredients requirements



Ecodesign of new circular economy scheme

➢ **Eco-design of all the steps of the valorisation scheme**:

- The raw material collection
- The valorisation process (biorefinery scheme)
- The facilities
- The use of the products
- The location
- …

Ecodesign of new circular economy scheme

➢ **Based on the Life Cycle Assessment (LCA) analysis**:

- Regulated by ISO 14040.
- **All the inputs and outputs with higher environmental impact.**
- A comparison between current management and proposed valorisation.

Integrated Basic Eco-Design of a model Recovery plant

- Plot convenience according to environmental criteria
- Architectural and shell design
- Structure design
- Construction materials selection
- Facilities design
- Operation & Maintenance Energy Efficient criteria
- Outside areas design
- Energy performance simulations
- Adapted to climate conditions

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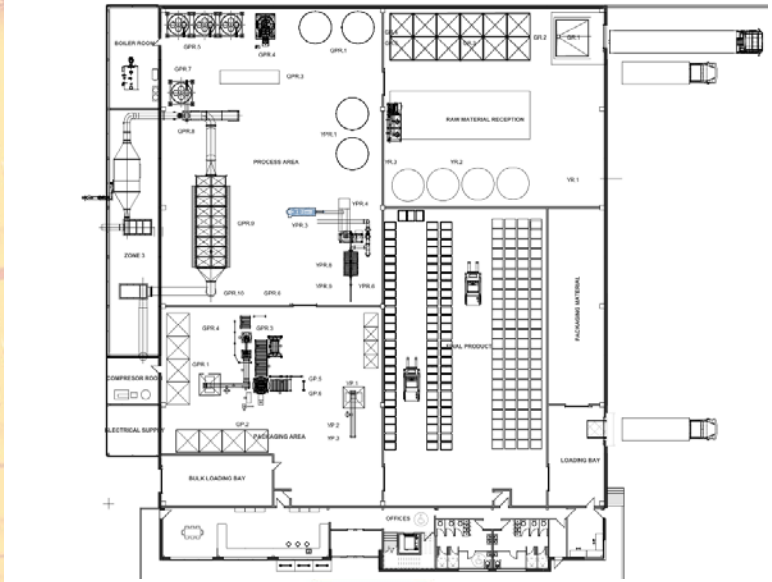
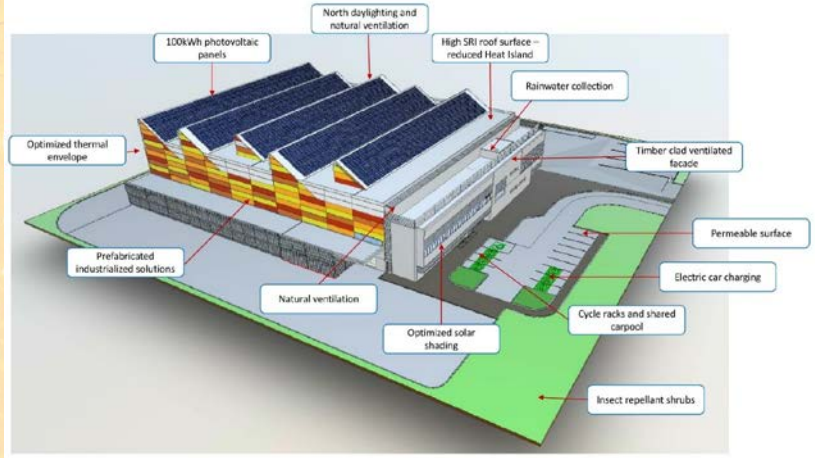
Model Recovery plant design:

- *Linear flows, no backward flows*
- *Compact U shaped manufacturing process*
- *Energy simulations*
- *Application of environmental certification criteria: BREEAM, LEED and WELL certification criteria.*
- *…*

Final LCA results show that the proposed building reached a reduction between 6% and 11% depending on the impact category analysed, compared with the preliminary design and an overall 24% reduction in embodied energy compared to a reference building.



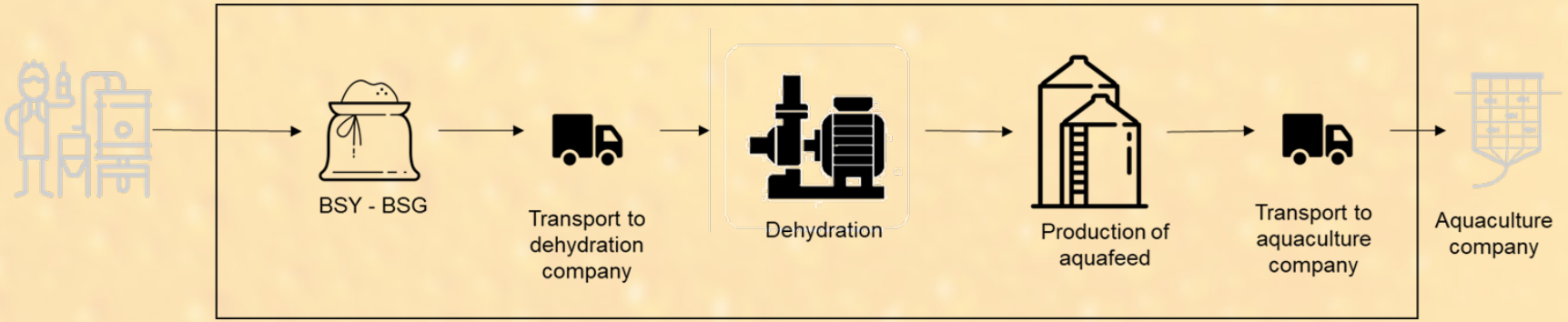


Environmental Assessment

System under study => Management of 1 ton of brewer´s co-products: spent grains and yeast.

Compared scenarios:

- Landfill
- Incineration
- Use as wet feed ingredient for livestock
- Valorisation: dried aquafeed ingredient



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Environmental Assessment

Environmental impact characterization of the valorisation of 1 ton of BSG as aquaculture feed ingredient

Impact Category	Unit	Processing BSG	Substituted ingredients	Valorisation of BSG
Climate change	kg CO_2 eq	2,00E+02	-4,74E+02	**-2,74E+02**
Ozone depletion	kg CFC11 eq	2,32E-05	-2,57E-05	**-2,43E-06**
Ionising radiation	kBq U^{235} eq	1,96E+01	-8,25E+00	**1,14E+01**
Photochemical ozone formation	kg NMVOC eq	3,19E-01	-1,35E+00	**-1,03E+00**
Particulate matter	disease inc.	2,95E-06	-2,03E-05	**-1,73E-05**
Human toxicity, non-cancer	CTUh	1,11E-06	-7,65E-06	**-6,54E-06**
Human toxicity, cancer	CTUh	4,65E-08	-2,15E-07	**-1,68E-07**
Acidification	mol H^+ eq	4,37E-01	-2,43E+00	**-1,99E+00**
Eutrophication, freshwater	kg P eq	3,55E-02	-6,50E-02	**-2,95E-02**
Eutrophication, marine	kg N eq	9,29E-02	-1,82E+00	**-1,73E+00**
Eutrophication, terrestrial	mol N eq	9,27E-01	-9,37E+00	**-8,45E+00**
Ecotoxicity, freshwater	CTUe	1,59E+03	-1,05E+04	**-8,92E+03**
Land use	Pt	1,12E+03	-4,42E+04	**-4,30E+04**
Water use	m^3 depriv.	-5,20E+00	-8,79E+01	**-9,31E+01**
Resource use, fossils	MJ	3,03E+03	-2,79E+03	**2,34E+02**
Resource use, minerals and metals	kg Sb eq	1,47E-03	-1,57E-03	**-9,65E-05**

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Environmental Assessment

Avoided impact when comparing the valorisation of 1 ton of BSG as aquafeed ingredient with current management alternatives

Impact Category	Unit	vs. incineration	vs. landfill	vs wet use
Climate change	kg CO_2 eq	3,13E+02	1,03E+03	1,48E+02
Ozone depletion	kg CFC11 eq	5,37E-06	2,43E-06	-9,51E-06
Ionising radiation	kBq U^{235} eq	-1,04E+01	-1,14E+01	-1,79E+01
Photochemical ozone f	kg NMVOC eq	1,30E+00	1,26E+00	5,04E-01
Particulate matter	disease inc.	1,99E-05	1,74E-05	-3,62E-06
Human toxicity, non-cancer	CTUh	1,06E-05	7,89E-06	-6,20E-06
Human toxicity, cancer	CTUh	2,57E-07	1,72E-07	-3,60E-08
Acidification	mol H^+ eq	2,24E+00	2,06E+00	-1,09E+00
Eutrophication, freshwater	kg P eq	7,81E-02	1,22E-01	-8,83E-03
Eutrophication, marine	kg N eq	1,87E+00	3,00E+00	-1,12E+00
Eutrophication, terrestrial	mol N eq	9,54E+00	8,45E+00	-4,65E+00
Ecotoxicity, freshwater	CTUe	1,06E+04	3,87E+04	5,97E+03
Land use	Pt	4,33E+04	4,34E+04	-3,49E+05
Water use	m^3 depriv.	1,08E+02	9,31E+01	-3,59E+00
Resource use, fossils	MJ	7,43E+00	-2,34E+02	-9,67E+02
Resource use, m.m	kg Sb eq	9,91E-04	9,65E-05	-3,53E-03

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Environmental Assessment

Environmental impact characterization of the valorisation of 1 ton of BSY as aquaculture feed ingredient

Impact Category	Unit	Processing BSY	Substituted ingredients	Valorisation of BSY
Climate change	kg CO_2 eq	7,07E+01	-2,46E+02	**-1,76E+02**
Ozone depletion	kg CFC11 eq	8,93E-06	-1,18E-05	**-2,92E-06**
Ionising radiation	kBq U^{235} eq	1,58E+01	-4,39E+00	**1,14E+01**
Photochemical ozone formation	kg NMVOC eq	1,58E-01	-7,06E-01	**-5,48E-01**
Particulate matter	disease inc.	1,66E-06	-1,10E-05	**-9,30E-06**
Human toxicity, non-cancer	CTUh	6,27E-07	-4,07E-06	**-3,45E-06**
Human toxicity, cancer	CTUh	2,11E-08	-1,14E-07	**-9,33E-08**
Acidification	mol H^+ eq	2,52E-01	-1,31E+00	**-1,06E+00**
Eutrophication, freshwater	kg P eq	2,84E-02	-3,21E-02	**-3,74E-03**
Eutrophication, marine	kg N eq	5,56E-02	-9,99E-01	**-9,44E-01**
Eutrophication, terrestrial	mol N eq	5,22E-01	-5,12E+00	**-4,60E+00**
Ecotoxicity, freshwater	CTUe	8,04E+02	-5,81E+03	**-5,01E+03**
Land use	Pt	7,65E+02	-2,40E+04	**-2,32E+04**
Water use	m^3 depriv.	-1,80E+01	-4,82E+01	**-6,62E+01**
Resource use, fossils	MJ	1,18E+03	-1,50E+03	**-3,18E+02**
Resource use, minerals and metals	kg Sb eq	8,29E-04	-8,41E-04	**-1,14E-05**

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Environmental Assessment

Avoided impact when comparing the valorisation of 1 ton of BSY as aquafeed ingredient with current management alternatives

Impact Category	Unit	vs wastewater
Climate change	kg CO_2 eq	1,77E+02
Ozone depletion	kg CFC11 eq	2,96E-06
Ionising radiation	kBq U^{235} eq	-1,14E+01
Photochemical ozone f	kg NMVOC eq	5,51E-01
Particulate matter	disease inc.	9,36E-06
Human toxicity, non-cancer	CTUh	3,46E-06
Human toxicity, cancer	CTUh	9,44E-08
Acidification	mol H^+ eq	1,07E+00
Eutrophication, freshwater	kg P eq	4,08E-03
Eutrophication, marine	kg N eq	9,49E-01
Eutrophication, terrestrial	mol N eq	4,61E+00
Ecotoxicity, freshwater	CTUe	5,03E+03
Land use	Pt	2,32E+04
Water use	m^3 depriv.	2,77E+01
Resource use, fossils	MJ	3,28E+02
Resource use, m.m	kg Sb eq	2,68E-05

Ecodesign of new circular economy scheme for Brewer's side streams

LIFE-BREWERY project have demonstrated that the valorization of brewers' co-products as aquafeed ingredients is **more sustainable** than current management practices.

Further environmental gains could be achieved if:

- Further reduce energy consumption (use of energy surplus).
- Further reduce transport distances between the brewery/ies, where the co-products are generated and ingredient production.

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Thank you!

Any question?

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