

**ДЛЯ АМБИЦИЙ
ЭКОЛОГИЧНОГО
О
УСТОЙЧИВОГО
ПИВОВАРЕНИЯ**



Brewers Compass[®] Пивоварение с ячменем

КЛАССИЧЕСКОЕ ФЕРМЕНТНОЕ РЕШЕНИЕ

САМОЕ ЭФФЕКТИВНОЕ

ВСЕ-В-ОДНОМ

Константин Кляритский
Февраль 2020, Алматы

BRIGHT SCIENCE. BRIGHTER LIVING.™

Пивоварение с ячменем. Экономии и снижение влияния пива на CO₂-выбросы

В среднем:
55% ячменя
В рецептуре
=
10% CO₂
Снижения выбросов


В среднем:
100%
несоложенки
В рецептуре
=
16-20% CO₂
Снижения выбросов

Качество солода и ячменя под угрозой из-за изменения климата

Жара и засухи влияют на качество ячменя

- Дефицит и перебои поставок: - большая цена
- Большее содержание белка: - проблемы с мутностью
- Меньший выход экстракта: - больше затраты на сырье
- Меньшая диастатическая сила: - проблемы со степенью сбраживания

Увеличение длительности затирания для увеличения степени сбраживания имеет негативный эффект на производственные мощности, вкус и аромат.



Урожай ячменя могут упасть на **17%** Из-за жары и засухи

Переход с солодовых рецептур на несоложенные

Революция несоложенного пивоварения

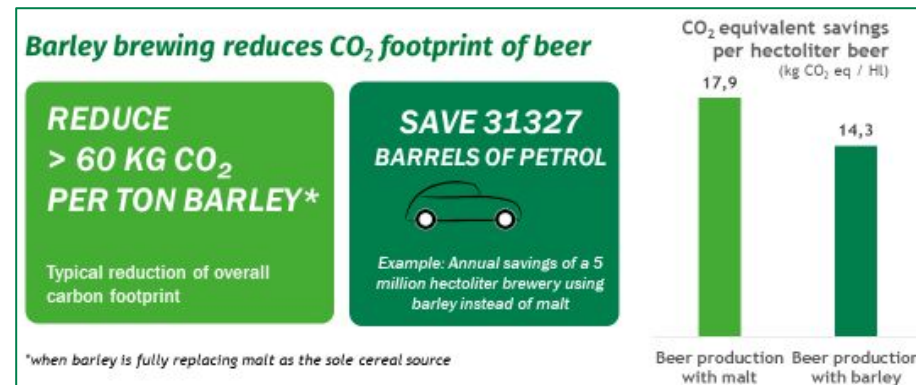
Соложение - традиционный, но затратный процесс

- Высококачественное сырье
- Требуется много воды
- Требуется много энергии
- Влияние на выбросы CO₂ - 7...10%

Включение (большого количества) ячменя

в рецептуру пива

- Несоложеное сырье используется уже десятилетия
- Наиболее популярные виды несоложенки - ячмень, рис, кукуруза, сорго
- Растет интерес к несоложенке из-за экологических преимуществ



DSM помогает преодолеть вызовы пивоварения с несоложенным сырьем

Вызовы пивоварения с несоложенным сырьем

- Недостаток диастатической силы, повышенная твердость, специфические свойства зерна
- Требуются инвестиции: Ферменты, Молотковая дробилка, Отварочный котел, Машфильтр
- Удержание хорошего вкуса и свойств пива



Ферменты DSM и команда пивоваров помогут преодолеть вызовы пивоварения с несоложенным сырьем

Brewers Compass[®]

Самое эффективное, классическое ферментное решение для ячменного пивоварения. Все-в одном.

Brewers Compass®

Enable up to 100% barley brewing

Save costs

- Replace malted barley
- Flexibility to brew with lower quality (malted) barley
- Improve brewhouse efficiency of barley recipes, ~98% brew house yield

Easy to implement

- All-in-one liquid enzyme solution
- Keep a good tasting beer with DSM brew master support
- Proven solution in the brewing industry
- Suitable for organic, clean label solution

Sustainable brewing

- Save water, energy and reduce carbon footprint up to 22%
- Support local farmers



The best performing all-in-one classical enzyme solution

Brewers Compass®

Experiences with Brewers Compass®

- Mash profile was optimized for brewhouse time available
- Wort high in fermentable sugars, good FAN levels, low in β -glucan
- Excellent mash filtration rate (<2 hours empty-to-empty)
- Standard physiochemical properties
- Good head retention and flavor stability




IF ALL BEER PRODUCED IN THE USA WAS MADE WITH 100% BARLEY AND BREWERS COMPASS®



Расчитайте ваши ЭКОНОМИИ

DSM Adjunct Brewing Business Calculator



Start Costs & Settings Current Recipe + Results

Costs & Settings Tabs

Laboratory yield Raw Materials		Grist Costs	
Malt (%)	<input type="text" value="67"/>	Malt (€/ton)	<input type="text" value="550"/>
Barley (%)	<input type="text" value="78"/>	Barley (€/ton)	<input type="text" value="280"/>
Wheat (%)	<input type="text" value="69"/>	Wheat (€/ton)	<input type="text" value="250"/>
Sugar (%)	<input type="text" value="99"/>	Sugar (€/ton)	<input type="text" value="800"/>
Optional (%)	<input type="text" value="99"/>	Optional (€/ton)	<input type="text" value="800"/>

Enzyme costs (€/kg)

Mats L Classic (€/kg)

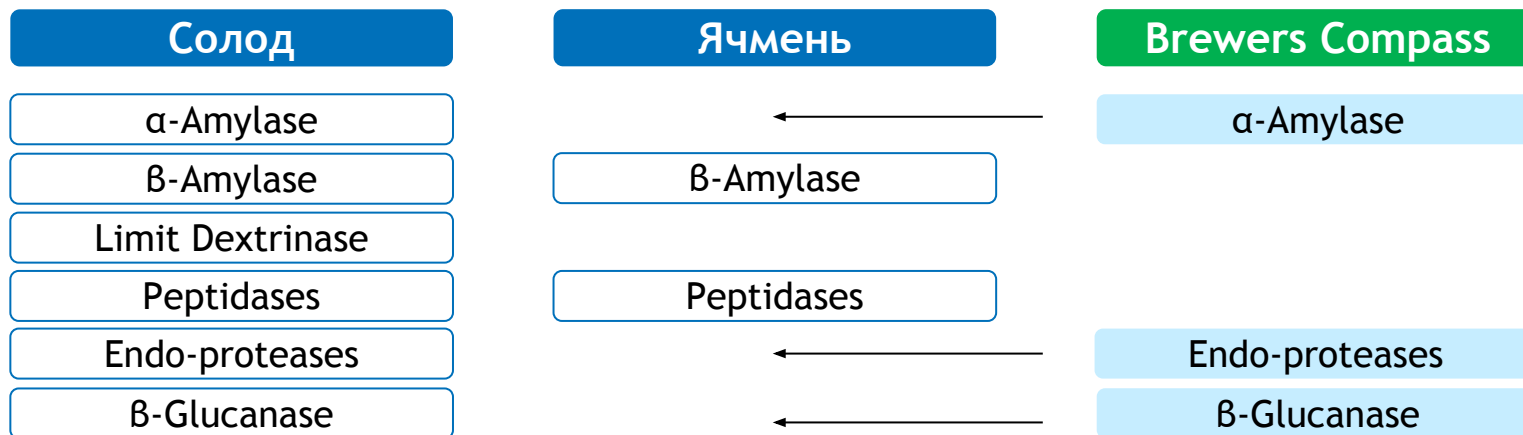
[Calculate my costs savings](#)



Раскрывает диастатическую силу ячменя

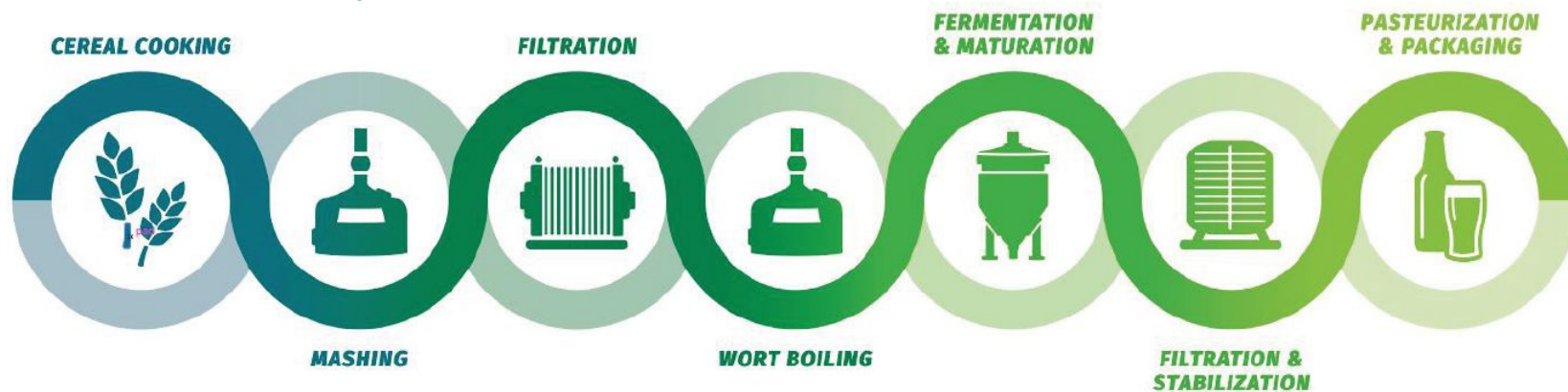
Brewers Compass® повторяет диастатическую силу солода

Ферментные активности



Добавляется в начале затирания

Brewers Compass[®]



Сохранить тот же вкус. Пивовары DSM поддержат

Проверить параметры сусла науровень

- FAN
- Профиль сахаров
- Вязкость
- Бета глюканы



Тест в промышленном масштабе. **Пивовары DSM поддержат**

- Тест с местным сырьем в лаборатории
- Tepral filtration



Внедрение на заводе. Пивовары DSM поддержат

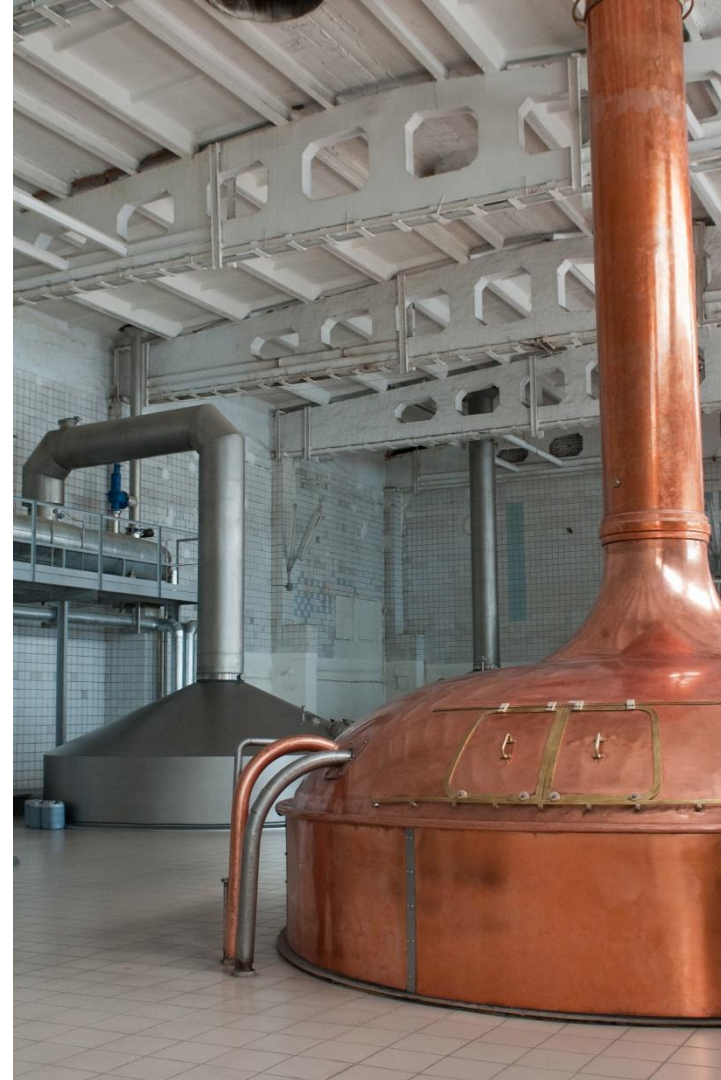
Демонстрация производительности варницы

Обучение клиентов

- Дозирование ферментов
- Лабораторный анализ
- Мониторинг эффективности

Тонкая настройка

- Спецификация дробления
- Диаграммы затирания



Пивоваренные лаборатории , Delft (NL) и Shanghai Служба технологической поддержки клиентов



Фокус на Затиране и
фильтрацию заторов,
Стабилизацию,
микроскопирование, анализ
мутности и глютена в пиве



Команда пивоваров по всему миру

DSM Food Specialties – DSM Brewing

Как мы это делаем...

МЕСТНЫЕ эксперты с многолетним опытом пивоварения, которые говорят в вашем языке осуществляют ТЕХНОЛОГИЧЕСКУЮ ПОДДЕРЖКУ ...

- Marlos Fernandes, North America
- Alberto Melgoza, Central America & Mexico
- Marcelo Gallardo, South America
- Torben Katzmann, Europe
- Pierre Lambert Smal, Middle East & Africa
- Denis Shirokovskiy, Middle East & Africa
- Konstantin Klyaritski, Russia
- Siaw Yon Miaw, Asia Pacific
- Hiro Furukawa, Japan
- Sam Li, China
- Jason Ma, China
- Theo Wijsman, Global coordinator



ПОРТФЕЛЬ ФЕРМЕНТОВ DSM ДЛЯ НЕСОЛОЖОНОГО ПИВОВАРЕНИЯ

ЯЧМЕНЬ	ДРУГОЕ СЫРЬЕ	УПРАВЛЕНИЕ СБРАЖИВАНИЕМ
Brewers Compass®	MATS® L Classic	Mycolase®
	Maxadjunct L	Maxadjunct L
	Maxazyme NNP DS	Amigase Mega®

DSM BREWING ENZYME PORTFOLIO

MASHING

DSM brewing enzymes

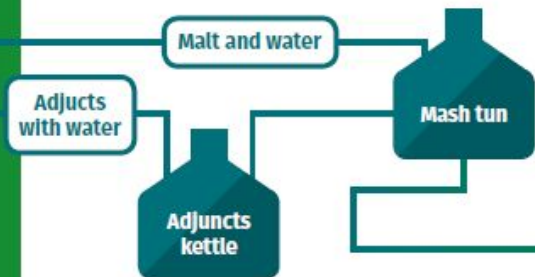
- MATS®
- Brewers Compass®
- Maxadjunct®
- Mycolase®
- Amlgase®
- Maxzyme®

Effects

- Efficient starch liquefaction when using adjuncts in brewing
- Enable adjunct/barley brewing
- Improve fermentability

Benefits

- Improve yield
- Flexible recipes
- Reduce costs
- Product low carb beers
- Source local raw materials
- Optimize brewhouse yield
- Produce high attenuated beers



WORT FILTRATION

DSM brewing enzymes

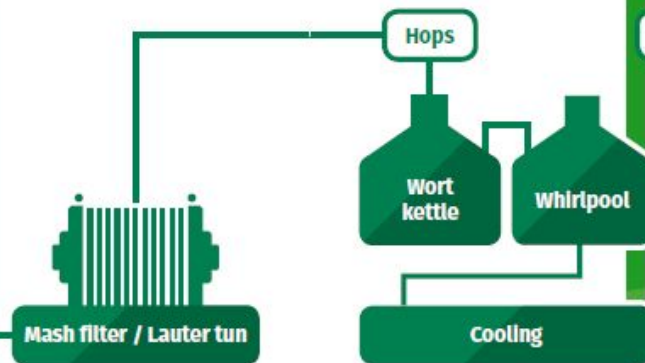
- Filtrase®

Effects

- Reduce wort viscosity

Benefits

- Improve mash filterability
- Guarantee good beer filtration



BOILING

FERMENTATION

DSM brewing enzymes

- Brewers Clarex®

Effects

- Simplify stabilization process

Benefits

- Increase capacity
- Produce gluten-free beer
- Reduce costs
- Meet sustainability targets

MATURATION

DSM brewing enzymes

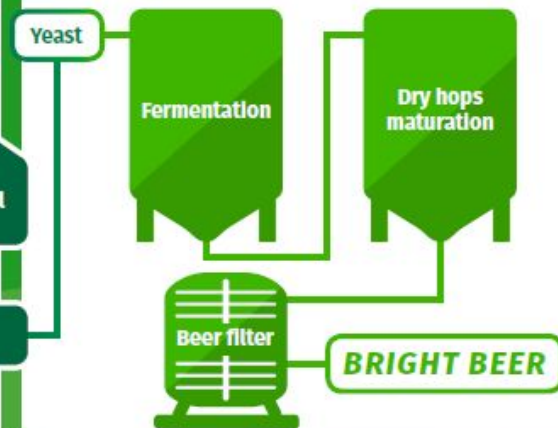
- Amlgase®
- Mycolase®

Effects

- Improve fermentability (fermentable sugars)

Benefits

- Improve yield



BRIGHT SCIENCE. BRIGHTER LIVING.™

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Min. malt% in beer – regulatory

Country	Standard of identity for beer? YES/NO	% of malt compared to barley?
France	YES	Minimum 50% of the weight of the starch or sugars. No minimum % for barley.
Spain	YES	Minimum 50% by mass of the total raw material used to produce beer. No minimum % for barley.
UK	NO	-

Country	Standard of identity for beer? YES/NO	% of malt compared to barley?
Brazil	YES	Part of the barley malt may be replaced for other brewing related ingredients. The use of the other beer related ingredients cannot be above 45% in relation to the primitive extract. Primitive or original extract is the extract of malt must.
Canada	YES	-
South Africa	YES	-
USA	YES	-

Milling advice depends on barley level in recipe

Hammer mill for recipes > 30% barley in grist bill: improves brewhouse yield and performance

The financial benefit of using raw barley justify the investment in specific hammer milling system which is not always in place and makes a difference in terms of brewhouse yield performance as well.

Roller mills suitable for recipes < 30% barley

For breweries equipped with roller mills for example they better invest in hammer mill when going over 30% barley in the grist bill. For breweries already equipped with hammer mill and limited by their milling capacity, extra milling capacity can be installed and paid back after 2-3 years by the saving on malt.

Assumptions CO2 reduction adjunct brewing

- Malting = 15-20% of total beer carbon footprint
- Agriculture = 15 - 18 % of total beer carbon footprint

Switching to 100% adjuncts

- Agriculture carbon foot print reduced by 7%
- Total reduction on agriculture 1 - 1.3%
- Reduction on malting process 17.5%
- Total reduction on total beer carbon footprint 16 - 19.3%

Reflection on figures

Example:

Savings for a single 5 mln Hl brewery using 100% barley with Brewers Compass and stabilizing with Brewers Clarex compared to 100% malt and classical beer stabilization)

- Saving: 4.7 kg CO₂ / hl beer (field to beer ex packaging)
- Total annual saving: 23.500 ton CO₂ per 5 million hl
- Energy savings dependent on energy price
- Additional to energy savings, extra €329.000 value (savings) in carbon credits (carbon credit: €14 / ton CO₂)
- Carbon savings equal to average annual carbon footprint of 2.200 people in Western Europe
- Carbon savings equal to emissions for 4200 world trips (40.000 km/trip)

Barley brewing: recommended mill settings

Milling equipment	Recommended roller clearances		
	1st pair	2nd pair	3rd pair
2 roll wet mill	0.3 - 0.4	N.A.	N.A.
4 roll mill	1.0 - 1.2	0.3 - 0.4	N.A.
6 roll mill	1.3 - 1.1	0.9 - 0.8	0.5 - 0.4

Rate of milling is reduced (typically 20-25%)
 Energy requirement for milling increased
 (depending type of mill)
 Mechanical wear on rollers is greater

Typical industrial milling results (6 roll mill) GRIST COMPOSITION 100% BARLEY	
SIEVE SIZE (mm)	TARGET WT (%)
1.250	55
1.000	15
0.500	15
0.250	5
0.125	5
< . 125	5

Barley brewing with *Brewers Compass*TM

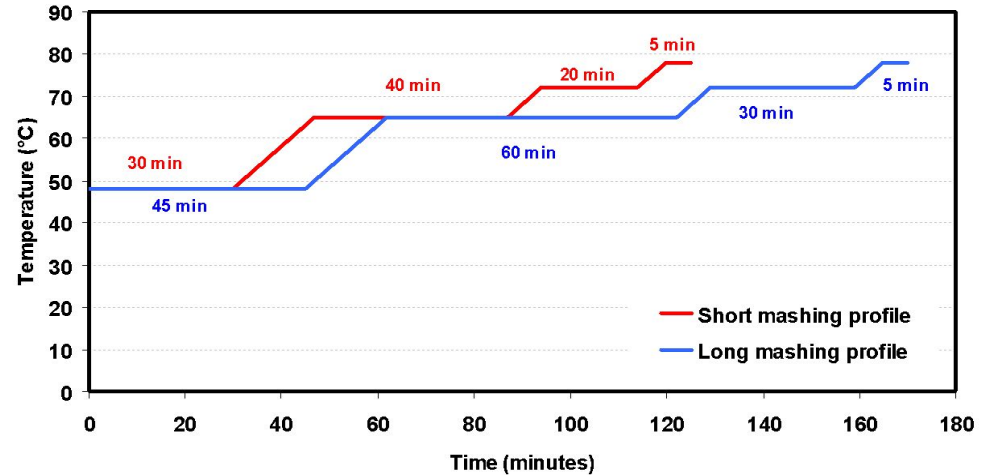
Stand at 48°C to ensure proper proteolysis

Stand at 65°C for optimal activity endogenous β -amylase + α -amylases

Stand at 72°C to achieve starch negative

Use of maximum available brewhouse time -> optimum economic efficiency

Brewhouse mashing profile can be modified according to brewery equipment and needs



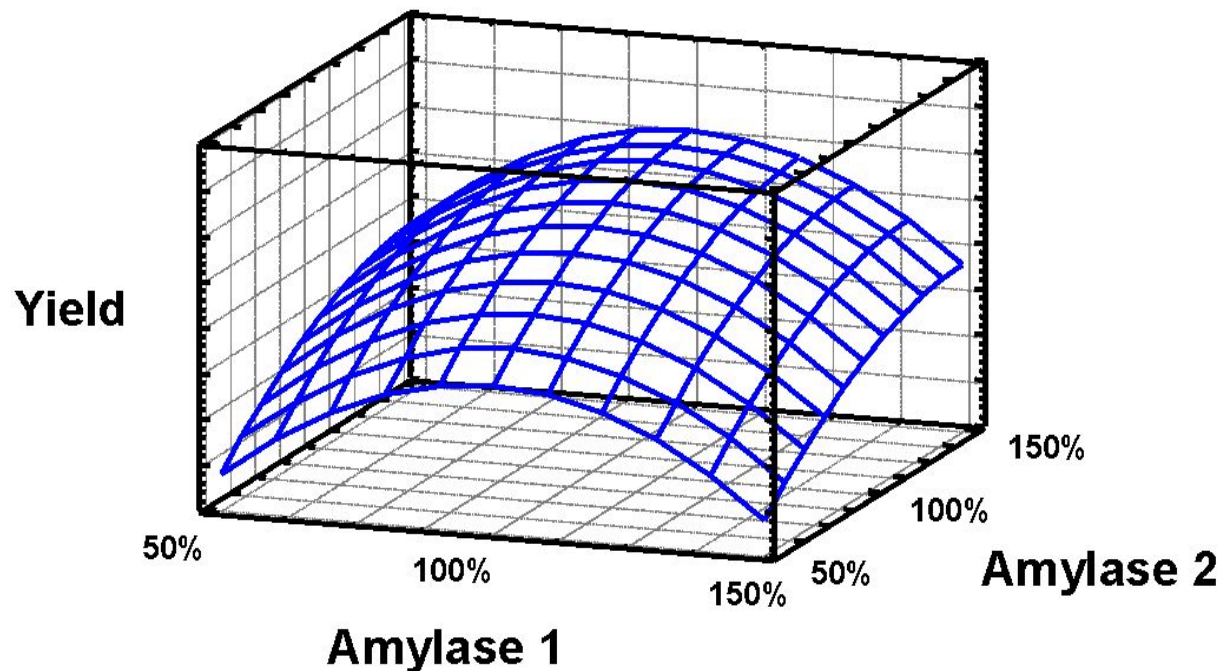
Barley brewing with Brewers Compass™

- Brewers Compass™ is a natural mix of enzyme activities, complementing and working synergistically with barley enzymes
- Brewers Compass™ added at mash-in
- Total mash profile time can be reduced as the percentage of malt in the grist increases
- Dose rate dependent on mash cycle time available, raw material quality (malt and barley) and economics

Dose rate recommendations

Barley (%)	Malt (%)	Dose rate (kg/T grains)
100	0	2.0 - 4.0
80	20	1.3 - 3.0
60	40	0.5 - 1.0
40	60	0.3 - 0.6
30	70	0.2 - 0.4

The effect of α -amylase composition on yield



Brewers Compass has an optimized composition of α -amylases to maximize the yield

Brewers Compass: industrial results

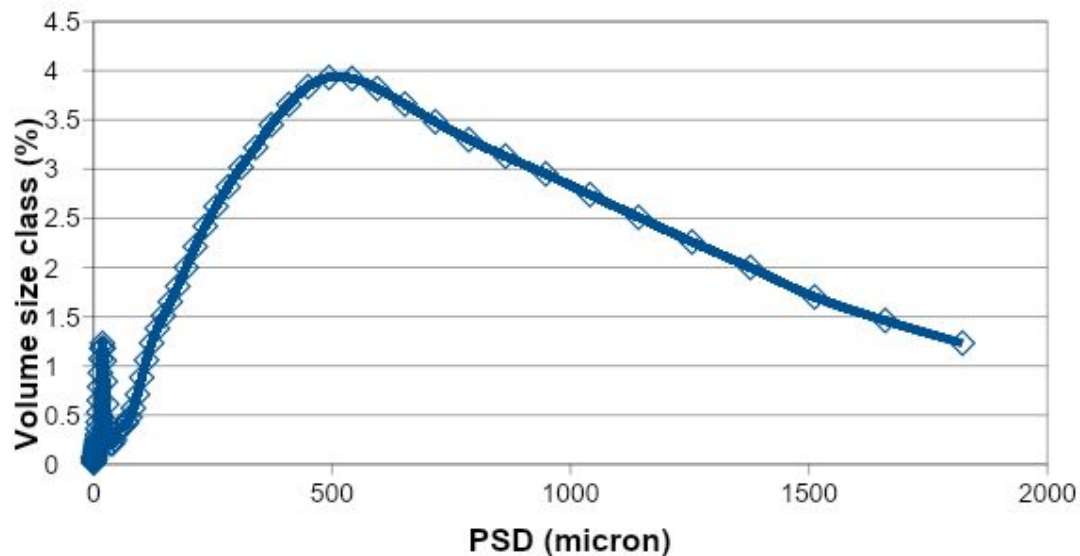
- Data were generated at commercial scale
- 10 Ton brewhouse
- Fermentation vessels 2000 HL
- Cereal fraction = 100% barley
- Data serve as examples of DSM experience in barley brewing



Brewers Compass: industrial results

Particle size distribution after hammer milling

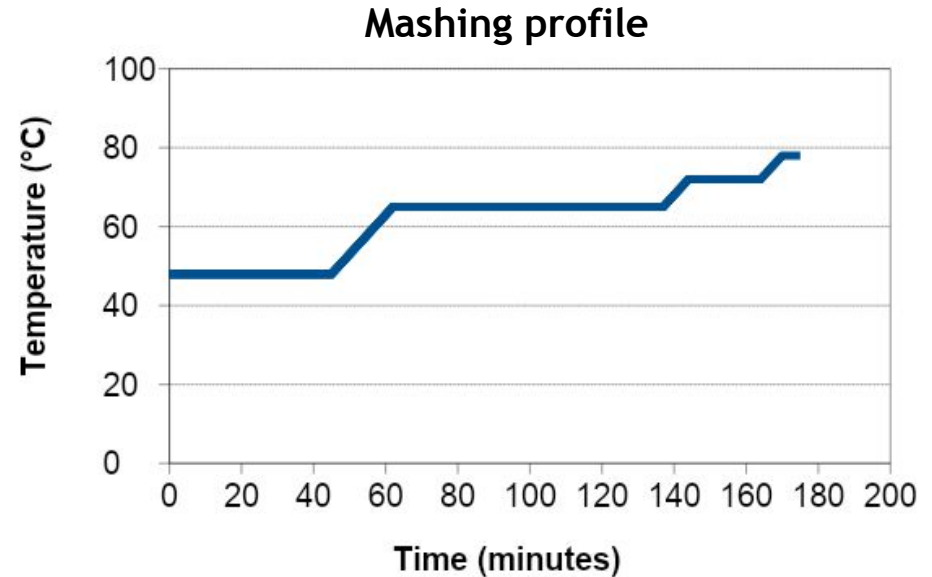
Typical PSD for Hammer Mill



Brewers Compass: industrial results

In this case a 175 minute mash scheme was used (2 mash vessels supplied one mash filter, i.e. use of turn-around time available)

Mashing time can be varied according to brewhouse requirements



Brewers Compass: industrial results

*Two hour empty-to-empty turn-around
time on the mash filter*

Mashing filtration - good mash filterability

Mash filtration results (Meura 2001)

Step	Time (minutes)
Filling	21
1st compression	5
Sparge	57
2nd compression	5
Drain	3
Decompression	4
Emptying	17
TOTAL	112

Brewers Compass™: industrial results

- Brewers Compass™ dose rate: 2.75 kg/T barley
- Resulting wort rich in maltose
- Low β -glucan wort levels for efficient mash and beer filtration
- FAN levels sufficient for standard RDF beers
- For highly attenuated beers additional yeast nutrient (yeast extract) and amyloglucosidase can be used

Wort analysis - good fermentability

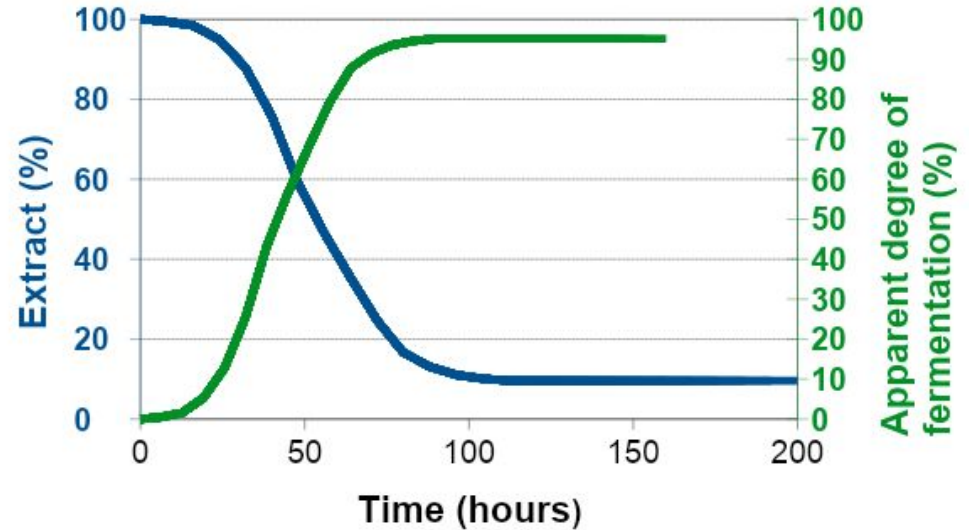
Sugar profile	
Glucose	8%
Maltose	61%
Maltotriose	16%
Dextrins \geq DP4	15%

Wort composition (12 °P)	
Property	Content
β - glucan level (PPM)	20 - 40
Wort viscosity (mPas)	1.3 - 1.5
FAN level (PPM)	130 - 150

Brewers Compass™: industrial results

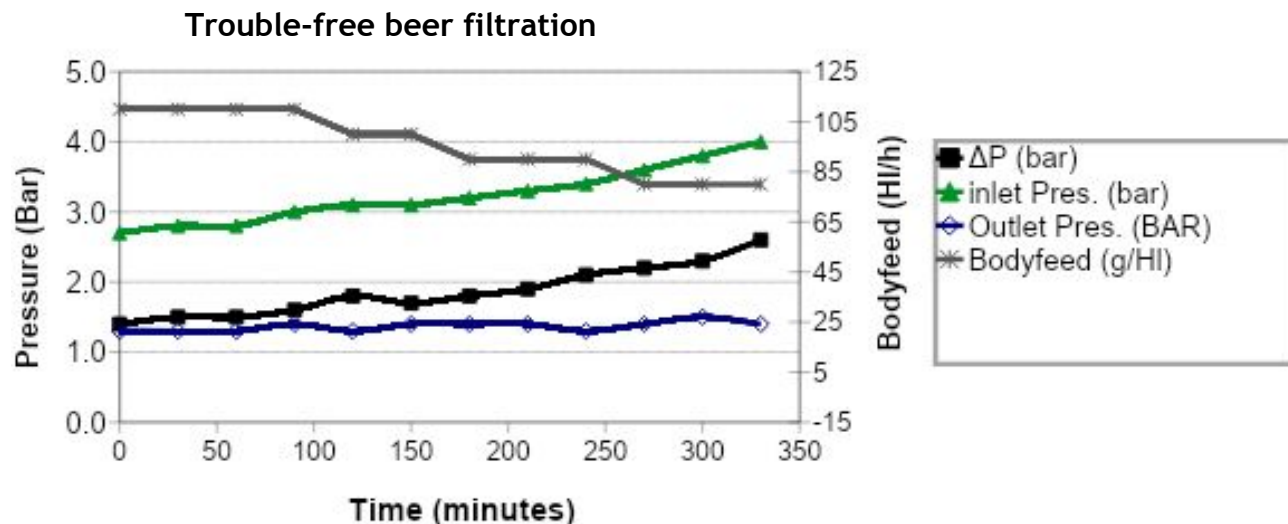
- Target gravity achieved in 112 hours (2000 Hl fermentations)
- Time to <50 PPB Diacetyl: 135 hours

Quick fermentation and diacetyl reduction



Brewers Compass™: industrial results

- 2000 Hl 100% barley trial, filtration 350 Hl/h
- Body feed and increase in differential pressure in line with 100% malt beers



Brewers Compass: beer analysis

Fresh and force aged beers produced using 100% barley and Brewers Compass™ subjected to chemical and organoleptic analysis at:

**International Centre for Brewing and
Distilling**

Heriot Watt University

under supervision of Prof. Dr. Paul Hughes



Brewers Compass

physiochemical beer analysis

Conclusion

- Good head retention
- All parameters in normal range

ICBD Data

Property	Units
Bitterness (BU)	17
Diacetyl (µg/l)	21
CO ₂ (g/l)	4,1
Haze (20 °C) 90 ° (EBC)	0,7
Haze (0 °C) 90 ° (EBC)	1,1
Colour (EBC)	6,5
Total soluble nitrogen (mg/l)	620
Polyphenols (mg/l)	185
Head retention (NIBEM, s)	274
DMS (µg/l)	27

ICBD Data

Beer volatiles	Units
Ethyl acetate (mg/l)	16
Isoamyl acetate (mg/l)	1,2
Ethyl hexanoate (mg/l)	< 0.1
Ethyl octanoate (mg/l)	< 0.1
2-Methylpropanol (mg/l)	3,4
2 and 3-Methylbutanol (mg/l)	57



**Good flavor stability with
Brewers Compass (100% barley)**

**Low ageing aldehydes after
forcing 28 days at 30°C**



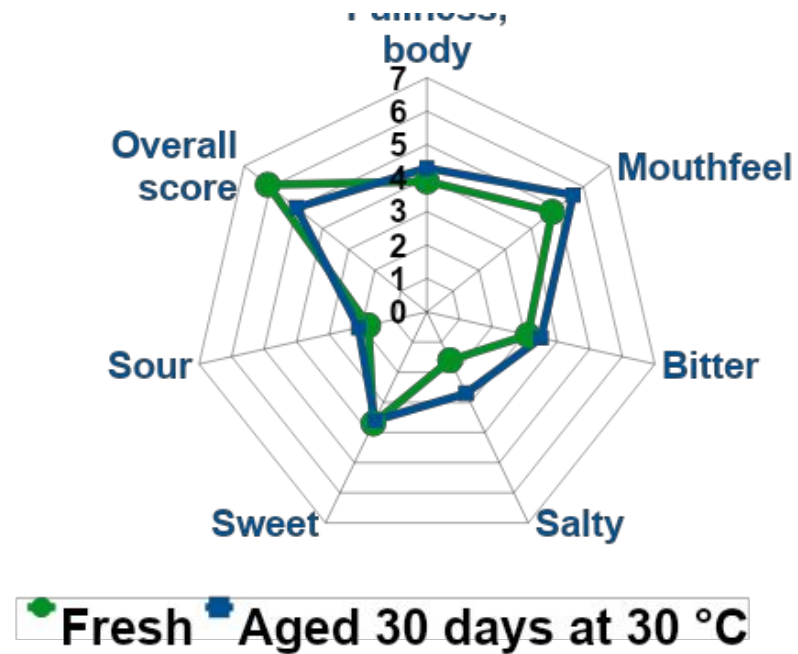
***Meilgaard (1981) Doctorial theses
"Beer Flavour"
Technical University of Denmark**

IMCD DATA	Beer		Meilgaard*	
Analyte (units)	Fresh	Aged*	Typical	Treshld
- SO ₂ (mg/l)	6,0	2,4	0.2 - 20	25,0
- Diacetyl (µg/l)	21	73	10 - 400	70 - 150
- Acetaldehyde (mg/l)	3,1	3,6	2 - 20	25
- DMS (µg/l)	27	24	10 - 200	33
- E-2-Nonenal (ng/l)	40	280	10 - 2000	110
- Nonenal potential (ng/l)	360	375	200 - 2000	na
- Methional (µg/l)	1,2	3,5	<50	250, 40
- 2-Methylpropanal (µg/l)	3,2	15,1	20 - 500	1000
- 2-Methylbutanal (µg/l)	1,9	4,4	10 - 300	1250
- 3-Methylbutanal (µg/l)	5,7	8,9	10 - 300	600
- Phenylacetaldehyde (µg/l)	5,6	17,1	5	1600
- Furfural (mg/l)	0,07	0,35	0.01 - 1	150
- 5-Hydr.met.lfurfural (mg/l)	0,52	1,85	0.1 - 20	1000
- Ethyl nicotinate (µg/l)	81,0	310	1400	2000
- Benzaldehyde (mg/l)	1,2	1,1	3 - 50	2000
- Ethyl acetate (mg/l)	16	17	8 - 42	30, 21
- Isoamyl acetate (mg/l)	1,2	1,2	0.6 - 4	1.2, 0.6
- Ethyl hexanoate (mg/l)	< 0.1	< 0.1	0.1 - 0.5	0.21
- Ethyl octanoate (mg/l)	< 0.1	< 0.1	0.1 - 1.5	0.9 , 0.4
- 2-Methylpropanol (mg/l)	3,4	3,4	5 - 20	100 - 200



Brewers Compass beer flavor profile

- Major flavor attributes match standard for this beer type
- Small differences between fresh and aged beers
indicating good flavor stability



Conclusion from commercial production (100% barley)

With Brewers Compass™:

- Mash profile was optimized for brewhouse time available
- Wort high in fermentable sugars, good FAN levels, low in β -glucan
- Excellent mash filtration rate (<2 hours empty-to-empty)
- Fermentation efficiency comparable to all malt beer (time to RDF target 112 H, time to diacetyl specification: 135 H)
- Standard physiochemical properties
- Good head retention and flavor stability

Scope of the LCA Study

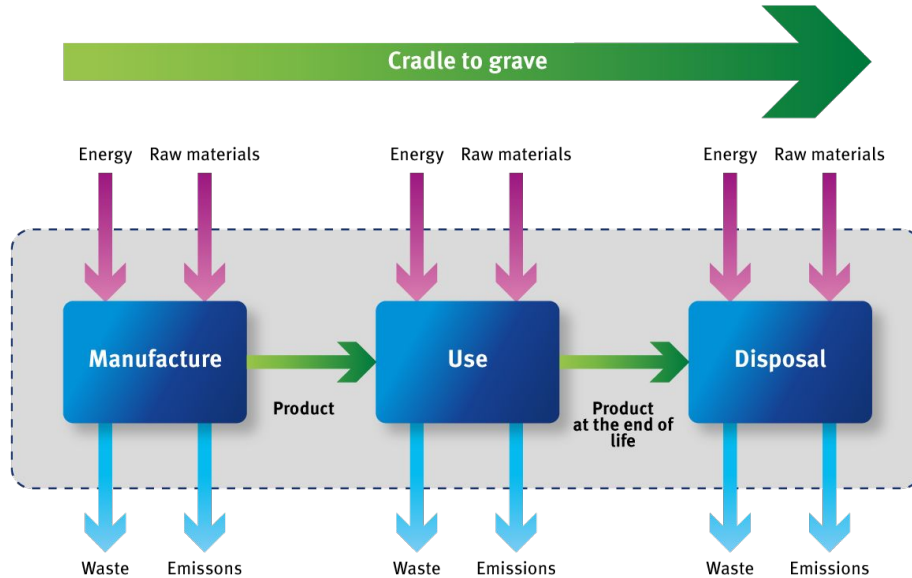
Parameters:

- Use of an **Brewers Compass** together with unmalted barley
- Use of a **Brewers Clarex** for colloidal stabilisation which enables the use of modified maturation conditions



What is LCA?

Identifies the material, energy and waste flows associated with a product over its entire life cycle to determine environmental impacts and potential improvements



Summary of LCA methodology

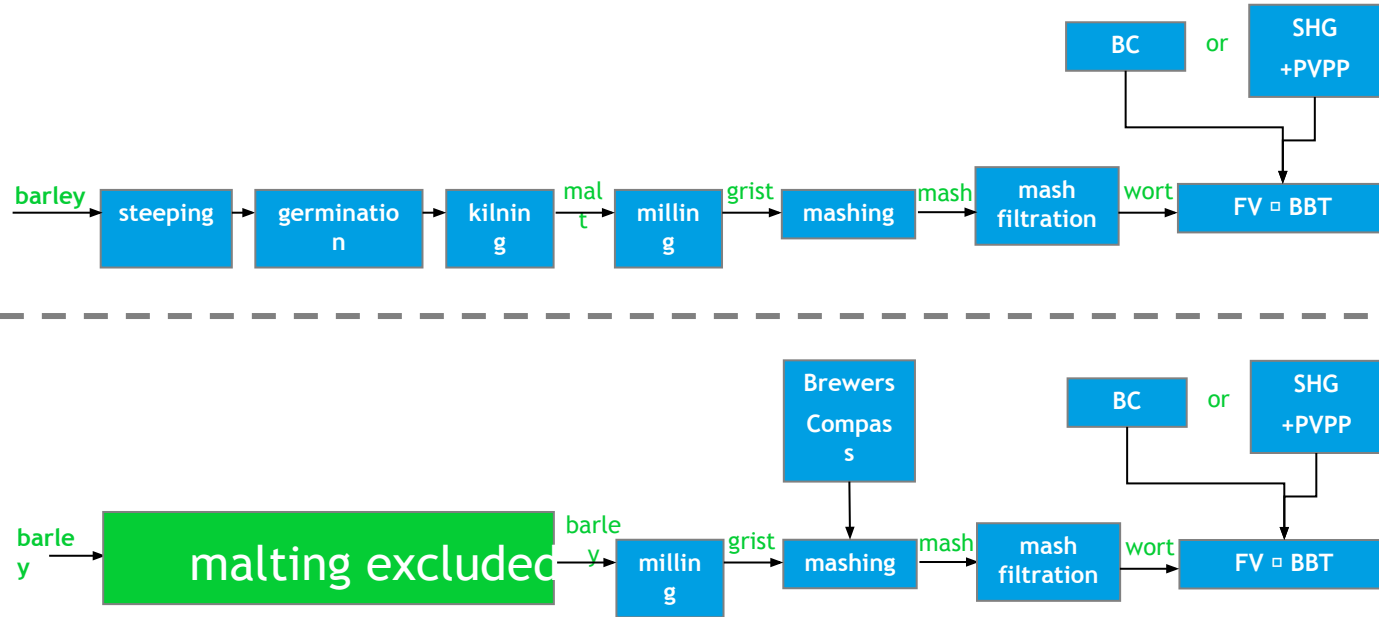
- 2 Methods used for standard assessments:
 - ✓ IPCC GWP 100a
 - ✓ Eco-indicator 99
- SigmaPro software used for the LCA's,
- EcoInvent databases used for reference
- The methods assign impacts to the raw materials (and their production processes), energy sources, emissions, wastes and by-products
- IPCC GWP 100a data presented

LCA's prepared for 4 cases

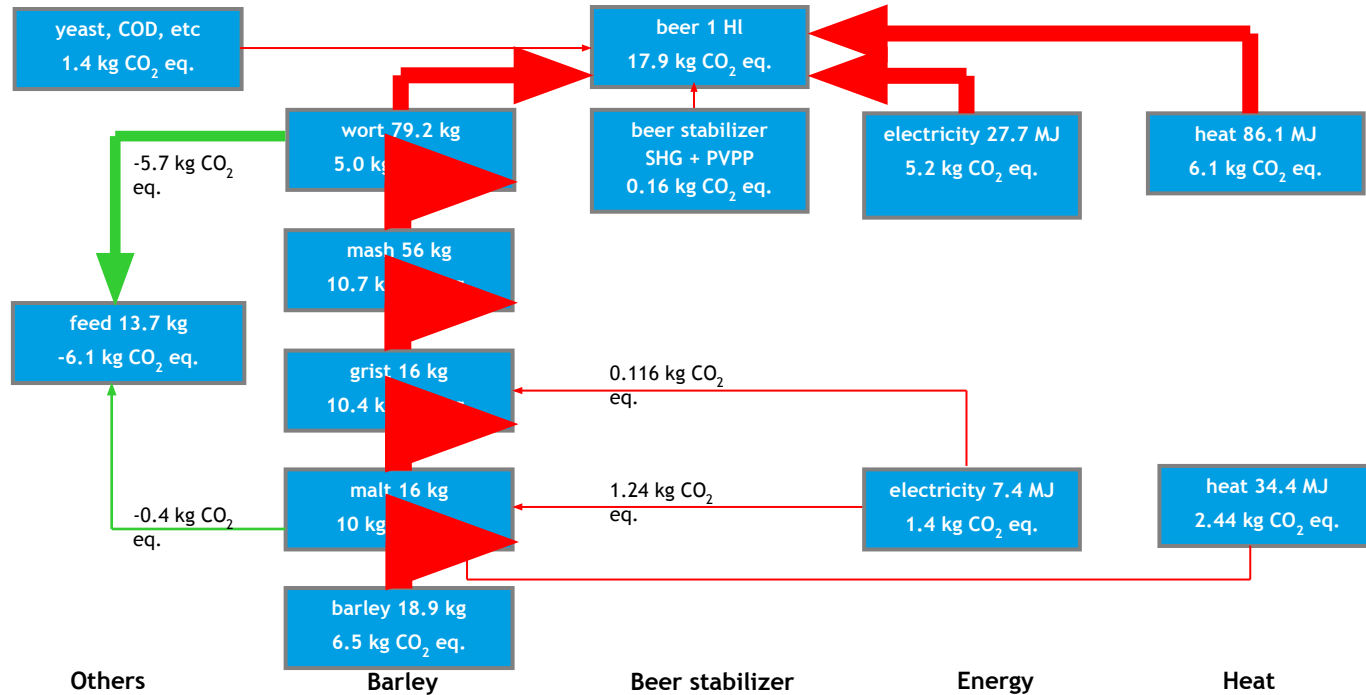
- Beer produced with **100 % malt** and stabilised with a combination of **silica gel and single-use PVPP**
- Beer produced with **100 % malt** and stabilised with **Brewers Clarex** employing modified maturation time and temperature
- Beer produced with **100 % barley** and **Brewers Compass**, stabilised with a combination of **silica gel and single-use PVPP**
- Beer produced with **100 % barley** and **Brewers Compass**, stabilised with **Brewers Clarex** employing modified maturation time and temperature



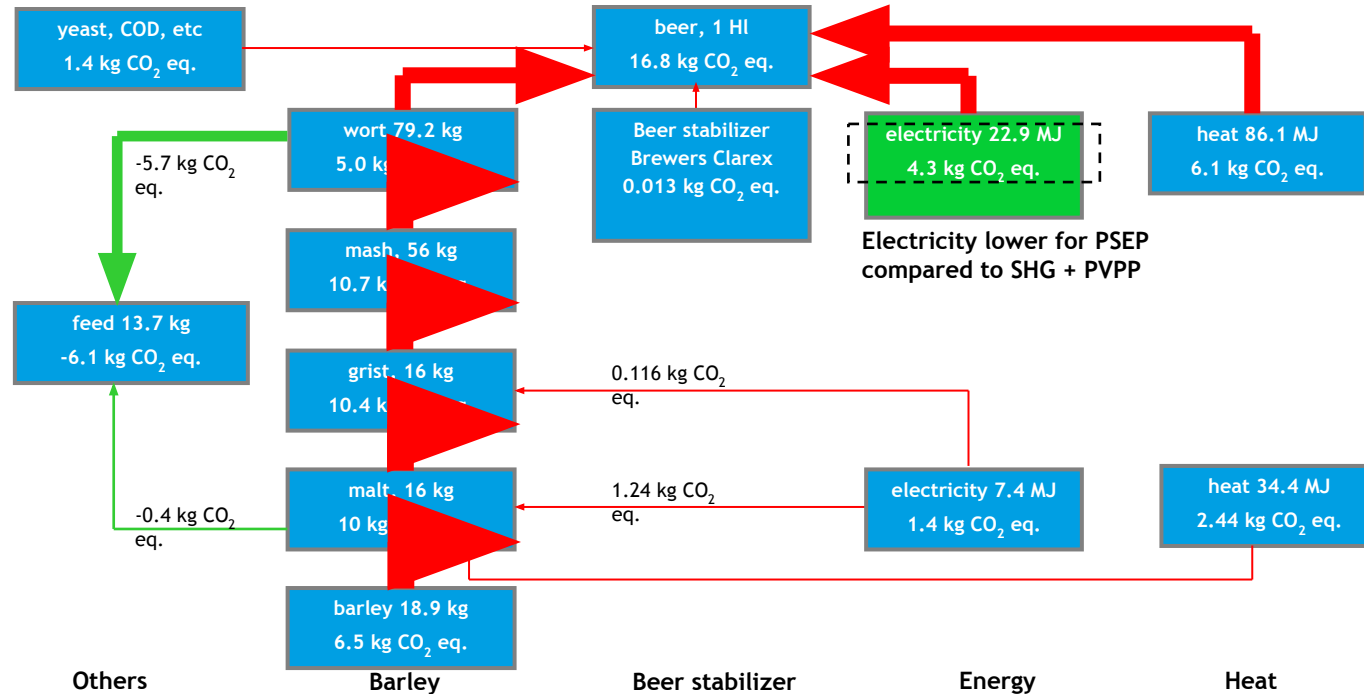
Comparison of brewing methods



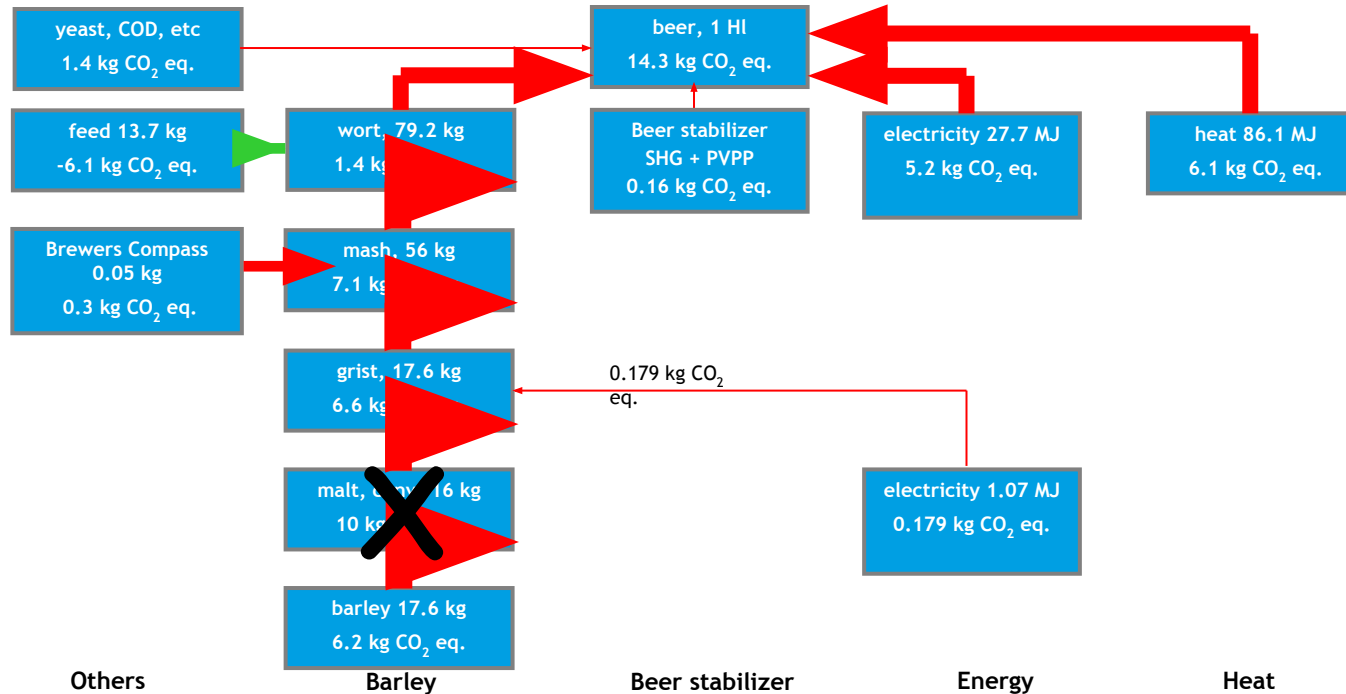
LCA Output summary, 100 % malt, stabilised with SHG + PVPP



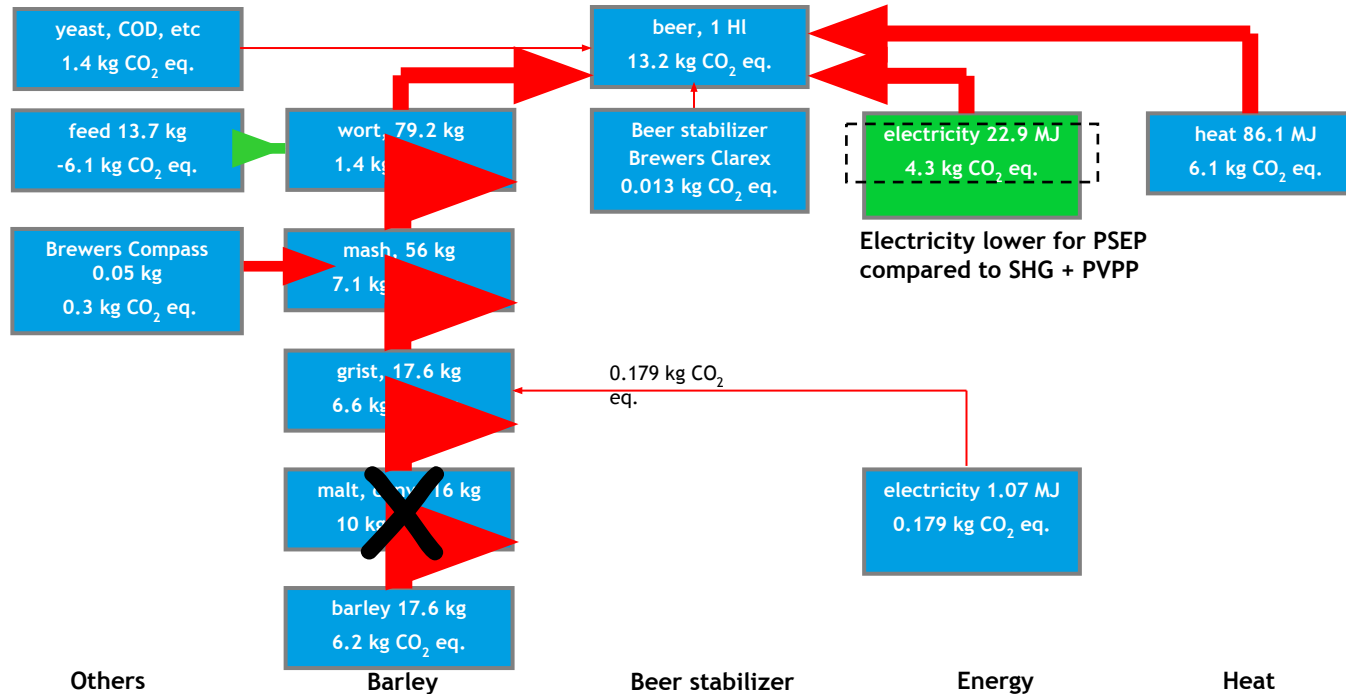
LCA Output summary, 100 % malt, stabilised with Brewers Clarex®



LCA Output summary, 100 % barley brewed with Brewers Compass, stabilized with SHG + PVPP



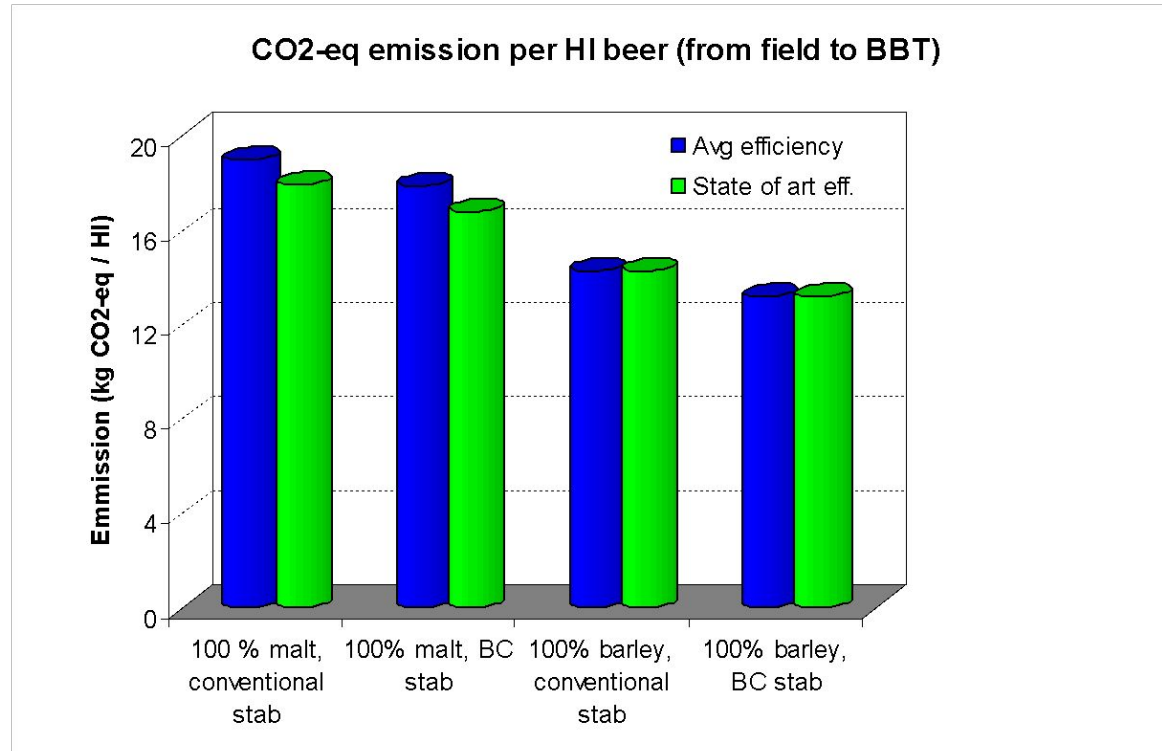
LCA Output summary, 100 % barley brewed with Brewers Compass, stabilized with Brewers Clarex®



Summary of CO₂ equivalent savings

	Kg CO ₂ eq / Hl	% reduction
Beer production 100 % malt with SHG + PVPP	17.9	-
Beer production 100 % malt with Brewers Clarex stabilisation	16.8	6.1
Beer production 100 % barley with Brewers Compass, SHG + PVPP stabilisation	14.3	20.1
Beer production 100 % barley with Brewers Compass, Brewers Clarex stabilisation	13.2	26.3

Summary of LCA results kg CO₂ equivalent



Reflection on figures

Example:

Savings for a single 5 mln Hl brewery using 100% barley with Brewers Compass and stabilizing with Brewers Clarex compared to 100% malt and classical beer stabilization)

- Saving: 4.7 kg CO₂ / hl beer (field to beer ex packaging)
- Total annual saving: 23.500 ton CO₂ per 5 million hl
- Energy savings dependent on energy price
- Additional to energy savings, extra €329.000 value (savings) in carbon credits (carbon credit: €14 / ton CO₂)
- Carbon savings equal to average annual carbon footprint of 2.200 people in Western Europe
- Carbon savings equal to emissions for 4200 world trips (40.000 km/trip)

Conclusions of the LCA Study

- Enzymes are a safe, natural, process aids, facilitating brewers to further reduce their carbon footprint and enhance their sustainability performance
- While doing so, brewers can generate energy savings and benefit from additional advantages (e.g. expansion of maturation capacity without CAPEX need in case of proline-specific protease for beer stabilization)
- Two area's where enzyme technology can bring sustainable savings to the brewing industry are brewing with barley and enzymatic beer stabilization
- From a sustainability point of view, the brewing industry will also benefit from the technological improvements in malting efficiency, in brewery hardware, logistics and packaging.

Summary of benefits with Brewers Compass™

- Brewers Compass™: latest DSM innovation for sustainable barley brewing
- Enables brewing with 100% barley, but can also be applied for any desired mixture of malt, barley and adjunct
- Easy-to-use robust blend of classical enzymes optimized for optimum cost/benefit