19. Seminar of raw materials Weihenstephan

A Question of Varieties -
how much potential for sustainability lies in a malting process?

Karl Weigt, 4. April 2022

Overview

- sustainability - ambiguous
- significance in beer production – a trial of placement
- factor energy & sustainability in malting processes
- differences of malting barley varieties in malting processes
- methods for the analysis
- energy consumption in dependence of steeping degrees
- conversion in CO_2 output
- malting loss in dependence of steeping degrees
- summary of the evaluation
- outlook
- literature

Sustainability

WIKIPEDIA

Sustainability is a normative concept that stresses intergenerational equity and is commonly considered to have three dimensions (also called pillars): the environmental, economic and social dimension. The concept can be to guide decisions at all scales: at the global, national and individual consumer level scale. A closely related and overlapping concept is that of sustainable development. Both terms are often used synonymously.[2] UNESCO formulated a distinction as follows: "*Sustainability* is often thought of as a long-term goal (i.e. a more sustainable world), while *sustainable development* refers to the many processes and pathways to achieve it."[3]

For many people, sustainability is closely associated with environmental issues, in which case it is referred to as "environmental sustainability". In fact, the modern environmental movement gave rise to a higher prominence o concept of environmental sustainability.[2] The public is concerned about human impacts on the environment.[4]:21 The most dominant issues since about the year 2000 have been climate change, loss of biodiversity and environmental pollution and land degradation (such as deforestation and general degradation of ecosystems).[5][6] These issues are also included in the concept of planetary boundaries.[7]

Das Prinzip der Nachhaltigkeit wurde erstmals 1713 von Hans Carl von Carlowitz schriftlich formuliert

Feuerzeug mit „lebenslanger Garantie"

Bayerischer Brauerbund
seit 1880
Ihr kompetenter Partner

"To operate more sustainability means to take more responsibility for human beings and nature of corporate and production level – from sites of companies to the value chain to society. And including the interests of employees, customers, trade, NGOs and other affected groups."

Carbon Footprint of Beer Production

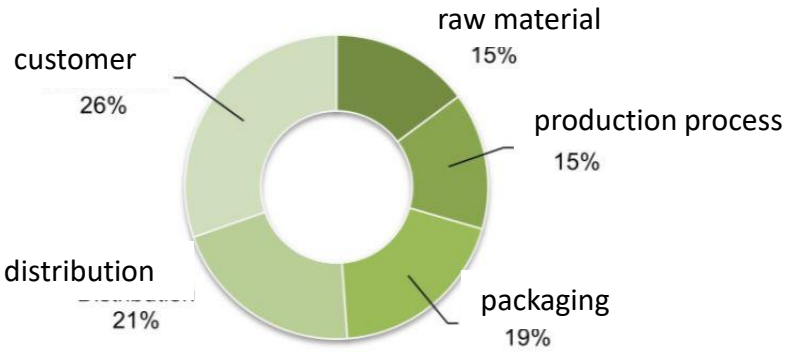
many sources – many different figures!

depending on definition, scope 1, 2 or 3, brewery specific factors, time period, etc.

BITBURGER BRAUGRUPPE

sustainability report 2020:

Bitburger Radler 0,0% in 0,33 l Longneck-
returnable bottle: percentages on emissions

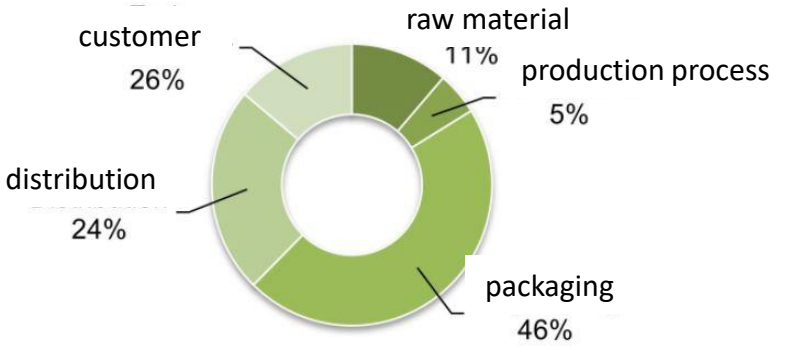


green house gas emission total: 69,8 kg CO_2e/hl

therefrom: packaging: 13,3 kg CO_2e/hl

raw materials: 10,5 kg CO_2e/hl

Bitburger Premium Pils in 0,33 l Longneck-
disposable bottle: percentage on emissions



green house gas emission total: 156,7 kg CO_2e/hl

therefrom: packaging: 72,1 kg CO_2e/hl

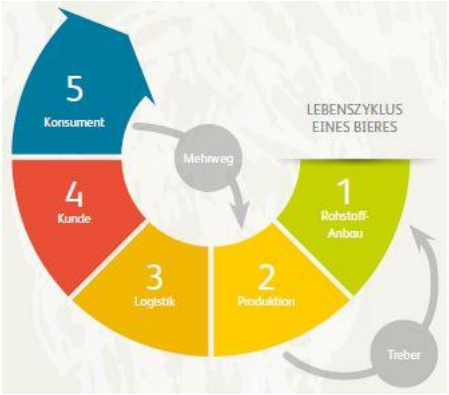
raw materials: 17,2 kg CO_2e/hl

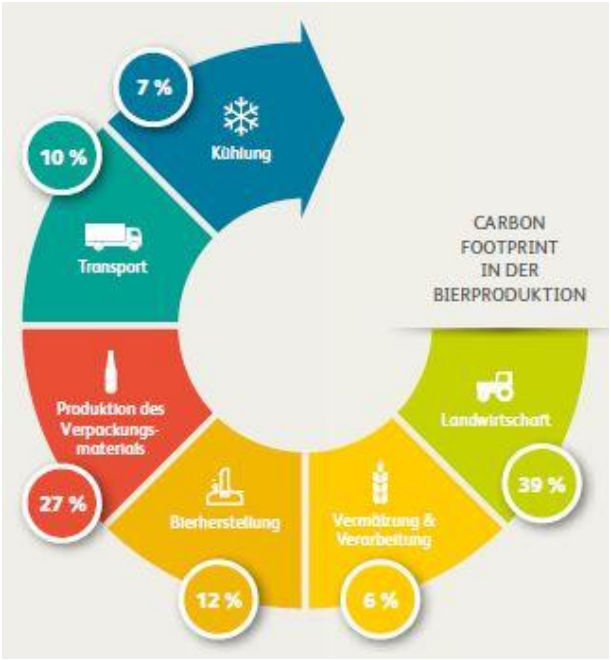
Carbon Footprint of Beer Production

BRAUUNION ÖSTERREICH

sustainability report 2020:

holistic approach:
“from field to customer”





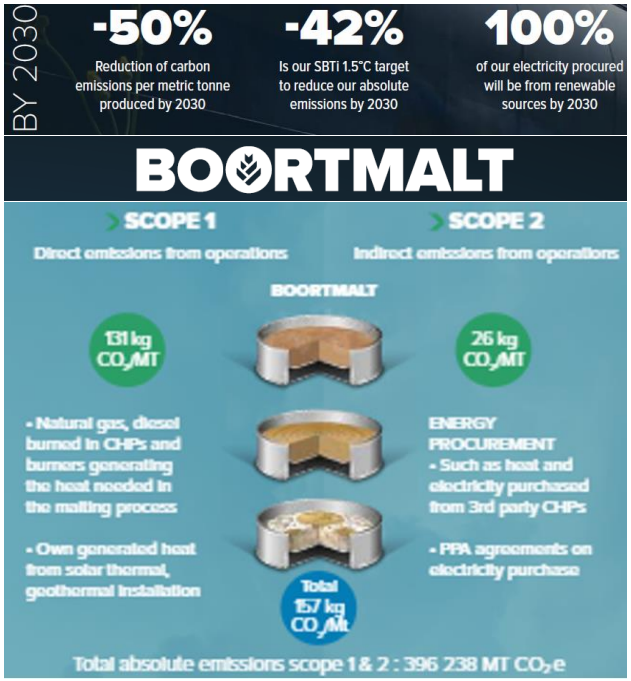
Green house emission total: BUÖ: 40,7 kg CO_2e/hl
(comparison to Heineken-group: 66,2 kg CO_2e/hl)
raw material 45%: 18,3 kg CO_2e/hl
therefrom:
- agriculture 87%: 15,9 kg CO_2e/hl
- **malting, processing 13%: 2,4 CO_2e/hl**
respectively **6% of total beer production**

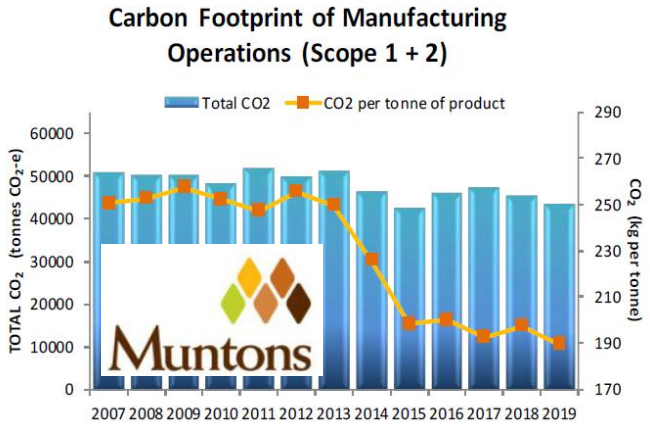
Carbon Footprint in Malting Process

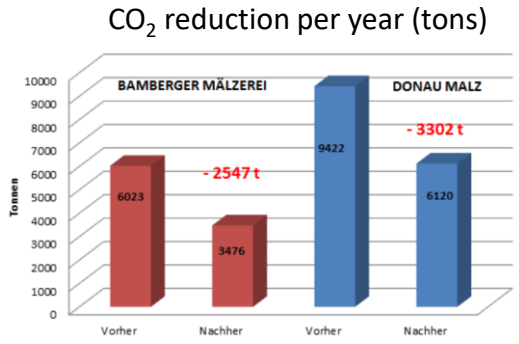
many sources – many different figures!

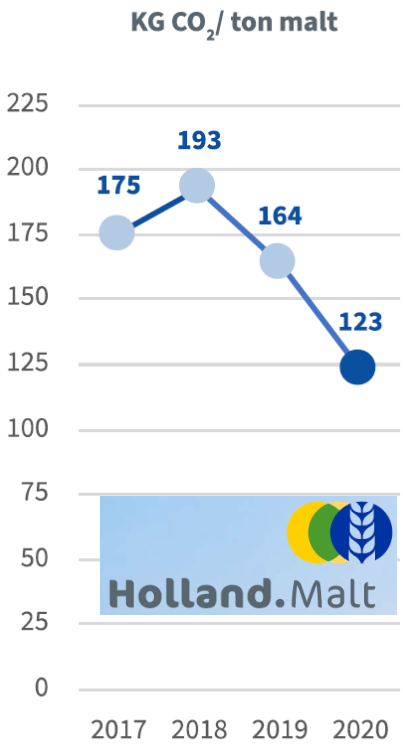
Depending on definition, malt house specific factors, heating at kilning, **Varieties**, etc.
recognizably many efforts and dynamics in terms of sustainability

Examples:









Carbon Footprint in Malting Process

theoretical consideration:

specific CO_2-emission		
natural gas caloric value H_i	201	g/kWh
electricity: German elec. Mix	380	g/kWh

CO_2-emission malting process per ton of malt			
step	type	kWh/ton	**kg CO_2/t**
steeping, kilning	electricit	20	7,6
cooling per year	electricit	15	5,7
kilning	heat	730	146,7
kilning	electricit	45	17,1
waste water plant	electricit	20	7,6
transport, machinerie & others	electricit	20	7,6
sum			**192**

Reduction of Carbon Footprint:
Examples for possibilities:

- usage of biogas
- usage of green electricity
- regenerative heat (wood)
- photovoltaics
- combined heat and power plant
- heat pump
- high efficient heat recovery
- and more …

All possibilities reduce the impact of energy consumption but not the origin!

Sustainability in Malting Process

Focus on 2 factors of sustainability:

- **Carbon Footprint by heat and electricity energy**
- **Economical sustainability (malting loss)**

Energy in malting process:

- approx. 75% of variable costs in malt production (until Feb. 2022)
- after 1st crisis of energy 1973: using all potential energy reductions consequently
- today only humble energy reduction possible

- **New detectable potential: new barley varieties**

Impact of Varieties in Malting Process

Evaluation of varieties in the Berliner Programm concerning malt characteristics

- micro malting by standardized processes
- adjustment of standards because new varieties malted with old intensive method will be over-modified
  -> impossible to do differentiations
- additional differentiations of malting characteristics by further technological alternatives:

What VLB, Berlin, do in Berliner Programm:

Comparison of malting parameters of new varieties under the influence of varying malting conditions

Variation of steeping degree (ceteris paribus): 45% 43% 41% 39%

Results in general: different malting barley varieties get malt specifications with different steeping degrees – a lot of new varieties with more and more reduced steeping degree

Impact of Varieties in Malting Process

Logical conclusion:
lower steeping degree -> less water evaporation during kilning
-> saving energy (heat and electricity)

In practice: differences/savings recognizable, but overlayed by changing of boundary conditions!

- targeted green malt moisture content differs before kilning
- targeted end moisture content differs in malt
- targeted kilning time differs
- permanent changes of fresh air conditions: temperature, air moisture and air pressure

-> concrete impacts on energy demand and therefore sustainability with model calculations

Model Calculation of Kilning Process

Objective quantification: theoretical model calculation with standardized kilning program and constant external air conditions
-> annual mean of external fresh air: 10°C, 80% relative humidity, 1013 mbar

assumptions:
- fixed kilning program for withering, heating, final kilning
- fixed moisture content in malt: 4,5%
- fixed kilning rhythm: 24h
- depending on green malt moisture content: water must be removed during withering until breakthrough – heating and final kilning until end moisture content of malt are the same
- heat consumption during withering is proportional to removed water volume
- electricity consumption is exponential proportional to flow rate of air

Model Calculation of Kilning Process

Usage of the calculation model:

- for every steeping degree variation of the VLB experiments
- as a comparison standard the version with 43% steeping degree is set

45% final steeping degree are already mostly unusual nowadays

Plausibility of the calculation model:

drying of the green malt 43% to malt with 4,5% moisture content
would lead according to the calculation model for a single deck kiln to:

- heat demand 730 kWh/t
- electricity demand 45 kWh/t

note: calculations were done with the **Mollier-Diagramm**!

Energy Demand depending on Steeping Degrees

subsequent applies: **green malt moisture content and steeping degree are synonyms for variety characteristics!**

value from model calculation for 1 ton malt during kilning					
green malt moisture content		39%	41%	43% Standard	45%
water removal to 4,5%	kg/t	481	534	590	681
heat demand total	kWh/t	631	679	730	786
heat demand rel. to 43%	%	**86,4**	93,0	100,0	**107,7**
electricity demand total	kWh/t	30	37	45	57
electricity demand rel. to 43%	%	**66,7**	82,2	100,0	**126,7**

conclusion: The potential for saving energy by 13 % in heating and by 33 % in electricity during kilning process, and by evaluation the variety, is exceeding the potential of classic optimization methods extremely.

Carbon Footprint and Variety

Carbon Footprint for 1 ton malt at kilning					
green malt moisture content		39%	41%	43% Standard	45%
heat demand total	kWh/t	631	679	730	786
CO_2 by gas: 201 g/kWh	kg/t	**127**	136	147	**158**
electricity demand total	kWh/t	30	37	45	57
CO_2 by electricity mix: 380 g/kV	kg/t	**11**	14	17	**22**
sum CO_2-emission	kg/t	**138**	151	164	**180**
sum CO_2-emission (rel)	**%**	**84**	92	100	**110**

Note: Potential for saving of 100% heat production generated by gas and electricity mixture:
Even through there are huge effects made in malting industry to switch to renewable energies, there is still a remaining fossile part which will be reduced by the variety effect.

Malting Loss and Variety

Basis of data: Partly evaluation of variation maltings 2019 – 2021, VLB, Berlin
Checking of 18 variety experiments with 4 kilning variants each for compliance with the malt specification within the tolerance range in determing the total malting loss.

Result: in malt specification are

- 4 experiments with steeping degree **45%,** malting loss approx. **9,5%**
- 10 experiments with steeping degree **43%** malting loss approx. **7,2% -> standard**
- 2 experiments with steeping degree **41%** malting loss approx. **6,3%**
- 2 experiments with steeping degree **39%** malting loss approx. **5,8%**

Assessment of the malting loss savings:
Theoretically: In production of aimed malt amount using less
-> Saving of costs
Practically: With the same amount of additional malt, for which indeed also – reduced – additional energy is needed
-> revenue increase

Economical sustainability malting and agriculture

Malting Loss and Variety

Assessment of malting loss numbers softing, germinating, kilning					
green malt moisture content		39%	41%	43% Standard	45%
total malting loss dry matter	%	5,8	6,3	7,2	9,5
related to the **use of barley** 14% H_2O:					
for 1 ton malt standard	kg/t	1179	1186	1197	1227
saving of barley	kg/t	**18**	11	0	**-30**
related to **malt** 4,5% H_2O:					
with constant use of barley	kg/t	1197	1197	1197	1197
malt volume	kg/t	1015	1010	1000	975
winning volume of malt	kg/t	**15**	10	0	**-25**
change of heat demand	kWh/t	9,5	6,6	0,0	-19,5
change of electricity demand	kWh/t	0,5	0,4	0,0	-1,4
change of CO_2-emissions	kg/t	2	1	0	-4

Sustainability & Costs in a Malt House - until Feb. 2022

costs of malting until February 2022 estimation							
gas price calorific value (H_i)	20 €/MWh	energy price	50 €/MWh	malting barley price harvest 22 Bayern	320 €/t	price malt harvest 22 Bayern	510 €/t

costs and carbon footprint for 1 ton malt until Feb. 2022					
green malt mositure content		39%	41%	43% Standard	45%
sum CO_2-emissions	kg/t	138	151	164	180
savings in opposite to standard	%	16	8	0	-10
gas costs kilning	€/t	12,62	13,58	14,60	15,72
electricity costs kilning	€/t	1,50	1,85	2,25	2,85
sum of energy costs kilning	€/t	14,12	15,43	16,85	18,57
difference to the standard	€/t	**-2,73**	-1,42	0,00	**1,72**
malting loss Var. 1: savings barley	€/t	**-5,69**	-3,52	0,00	**9,60**
sum of savings: electricity and malting loss	€/t	**-8,42**	-4,94	0,00	**11,32**
malting loss Var. 2: win of malt energy corrected	€/t	**-7,89**	-4,95	0,00	**12,29**
sum of savings: electricity and malting loss	€/t	**-10,62**	-6,37	0,00	**14,01**
in comparison to malting fees 90.- €/t	%	**-11,8**	-7,1	0,0	**15,6**

Sustainability & Costs in a Malt House – from 24. Feb. 2022

cost of malting until February 2022 roughly estimated							
gas price calorific value (Hi)	100 €/MWh	energy price	200 €/MWh	malting barley price harvest 22 Bayern	420 €/t	price malt harvest 22 Bayern	700 €/t

costs and carbon footprint for 1 ton malt from Feb. 24th 2022					
green malt moisture content		39%	41%	43% Standard	45%
sum CO_2-emissions	kg/t	138	151	164	180
savings in opposite to standard	%	16	8	0	-10
gas costs kilning	€/t	63,10	67,90	73,00	78,60
electricity costs kilning	€/t	6,00	7,40	9,00	11,40
sum of energy costs kilning	€/t	69,10	75,30	82,00	90,00
difference to the standard	€/t	**-12,90**	-6,70	0,00	**8,00**
malting loss Var. 1: savings barley	€/t	**-7,47**	-4,62	0,00	**12,60**
sum of savings: electricity and malting loss	€/t	**-20,37**	-11,32	0,00	**20,60**
malting loss Var. 2: win of malt energy corrected	€/t	**-9,46**	-6,27	0,00	**15,27**
sum of savings: electricity and malting loss	€/t	**-22,36**	-12,97	0,00	**23,27**
in comparison to malting fees 150.- €/t	%	**-14,9**	-8,6	0,0	**15,5**

Conclusion and Highlights

- Carbon Footprint part in malting process is small in comparison to the total beer production process
- Potential for saving energy in malting process is largely exhausted
- New considerable saving potentials with new malting barley varieties
- Achievement of malt specifications with less germination moisture
- Energy and cost savings within kilning and decrease of CO_2-emissions
- Far higher savings by decrease of malting loss

saving potential up to	per ton malt	part in process	malting house 50.000 t/a	potential in GER (2 Mio t/a)
CO2- emissions	26 kg	16%	1.300 t	52.000 t
energy costs	12,90 €	16%	645.000 €	26 Mio. €
malting costs with malting loss	22,36 €	15%	1,12 Mio €	45 Mio. €

“just like that!”

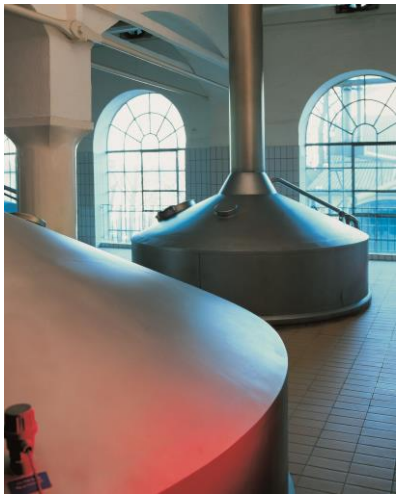
outlook: New Varieties

- ✓ Significant potential for improving the sustainability during the malting process
- ✓ CO_2-emissions in agriculture within cultivation of brewing barley in a similar magnitude
- ✓ New criteria in the validation of new malting barley varieties

-> Adjustment / Expansion in the “Berliner Programm”

….all right ?

Thank you for your attention!



Any Questions?

Download:

www.bmt-weigt.de

Literature

- Folie 1 Bild Karl Weigt
- Folie 3 Wikipedia
  Walter König, Präsentation: Nachhaltigkeitsmanager des Bayer. Brauerbunds 2022
- Folie 4 Bitburger Braugruppe, Bericht zur Nachhaltigkeit 2020
- Folie 5 Brauunion Österreich, Der Nachhaltigkeitsbericht 2020
- Folie 6 Boortmalt, Sustainabilty Report 2021
  Muntons, Sustainability Report 2020
  Holland Malt, CSR Report 2020
  Bamberger Mälzerei-Gruppe, Homepage: “Nachhaltigkeit”
- Folie 7 Bundesamt für Wirtschaft und Ausfuhrkontrolle: Informationsblatt CO_2-Faktoren
  Umweltbundesamt: Strom- und Wärmeversorgung in Zahlen
  Karl Weigt, Eigene Erhebung
- Folie 9 Henrike Vorwerk, VLB,Berlin
- Folie 11-14 Modell-Rechnung: Karl Weigt
- Folie 15 Auswertung “Vergleich der Malzparameter neuer Sorten unter dem Einfluss variierender Mälzungsbedingungen”, Henrike Vorwerk, VLB, Berlin
- Folie 17,18 BAFA, UBA, Karl Weigt, Eigene Erhebung
- Folie 20 PD Dr. Kurt Möller, LTZ Augustenberg, CO2-Abdruck konventioneller Ackerbau
- Folie 21 Bilder Bayerischer Brauerbund

Curriculum Vitae (short version)

Karl Weigt, Dipl.-Ing., Dipl.-Wirtsch.-Ing.

- 1974 – 1979 Weihenstephan, Brauwesen und Getränketechnologie
- 1979 – 1984 Air Fröhlich AG, Projektierung, Entwicklung
- 1992 – 2002 Weissheimer Malz, Betriebsleiter
- 2002 – 2017 Malteurop Deutschland, Geschäftsführer
- Seit April 2017 bmt Weigt, Handelsvertreter Malteurop

Technische Universität München
Wissenschaftszentrum Weihenstephan für Ernährung, Landnutzung und Umwelt

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