»ALECTIA in brief

- Founded in 1912
- 700 employees, globally
- Consulting engineering services in connection with buildings, process industries, water, energy, environment, occupational health and safety
- Strong cross-disciplinary competencies
- HQ in Virum close to Copenhagen, Denmark
- Permanent offices in England & Australia
- 20 % of our turnover is international
- Gross turnover 2015 - 90.2 mill. Euros
- Joined the UN Global Compact

»Beer & Beverage Business Unit

Beer & beverage business unit's consultancy and project execution capabilities based on:

- Danbrew (Founded in 1979, DK)
- PTS - Penborn Technical Services (Founded in 1976, UK)
- AJL - Alfred Jørgensen laboratories (Founded in 1881, DK)

ALECTIA's Beer & beverage business unit has conducted

- More than 2.000 beer and beverage projects in 75 countries over the last 35+ years
- More than 50 Greenfields and large CAPEX expansions delivered

Approx. 90 specialists that work with Beer & beverage projects across the world

»Energy Neutral Brewing

ALECTIA

Nordic meeting on Brewing Technology
Mariehamn 2016

Hans Jørgen Stephansen, Utility Specialist
Christian Luxhøj, Global Account Manager

How to reach the Energy Neutral Brewery?

Today's and future KPIs

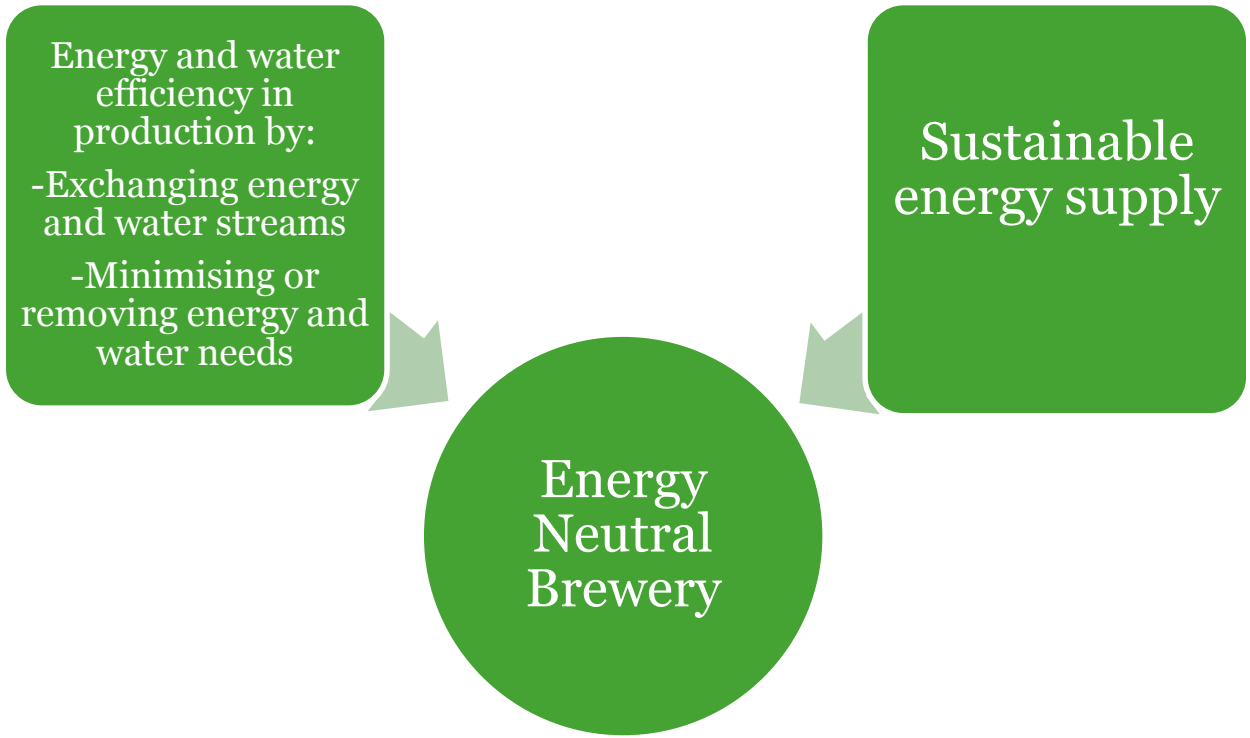
Energy efficiency in production

Sustainable energy supply

Energy Neutral Brewery?

How to reach the Energy Neutral Brewery?

»How to reach the Energy Neutral Brewery?



Today’s and future KPIs

»Today's and future KPIs

	Today	Future
Heat	80 MJ/hl	50 MJ/hl
Electricity	9 kWh/hl	6 kWh/hl
Total energy	112 MJ/hl or 31 kWh/hl	72 MJ/hl or 20 kWh/hl

Energy efficiency in production

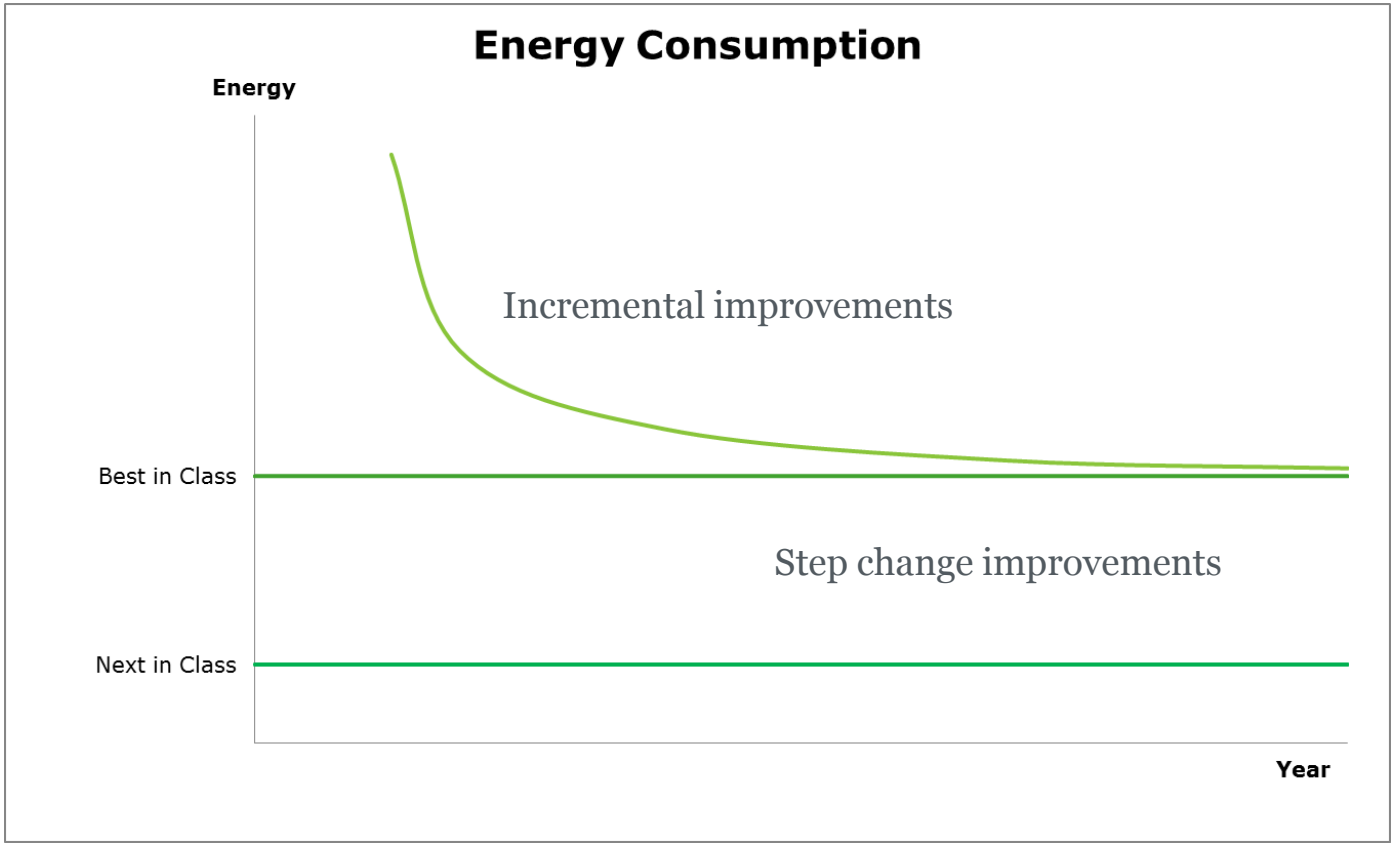
»Energy efficiency in production

Current state

- Many standard solutions/best practices for energy and water savings implemented
- Most low hanging fruits have been harvested
- Heat recovery in the brewhouse has been evaluated and implemented if feasible
- Co-generation has been considered for many locations
- Process plant and utility plant upgrades have resulted in a lowering of consumption figures due to more efficient equipment
- Waste water treatment plants installed if feasible, required by authority or corporate polices
- Legislation forces improvements

»Energy efficiency in production

The way forward – incremental - and step change improvements



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»Energy efficiency in production

Process related

- Continuous brewing
- Fermentation at high temperature, say 20°C
- More use of enzymes
- Very high Plato
- Late brewing
- Flash pasteurisation

Source Meura

»Energy efficiency in production

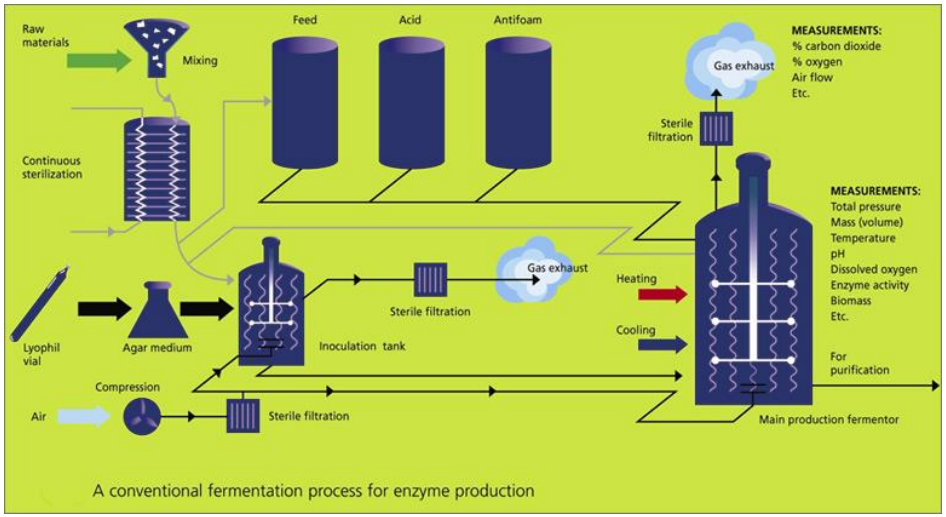
Utility and building related

- Heat pumps
- Tri-generation – power, heat and absorption chilling
- Process integration – use of low grade heat
- Green certified production buildings – energy efficient buildings e.g.
    - natural light
    - natural ventilation
    - high insulation standards
    - LED light
    - solar cells
    - ground water cooling

»Energy efficiency in production

Use of enzymes to reduce energy consumption

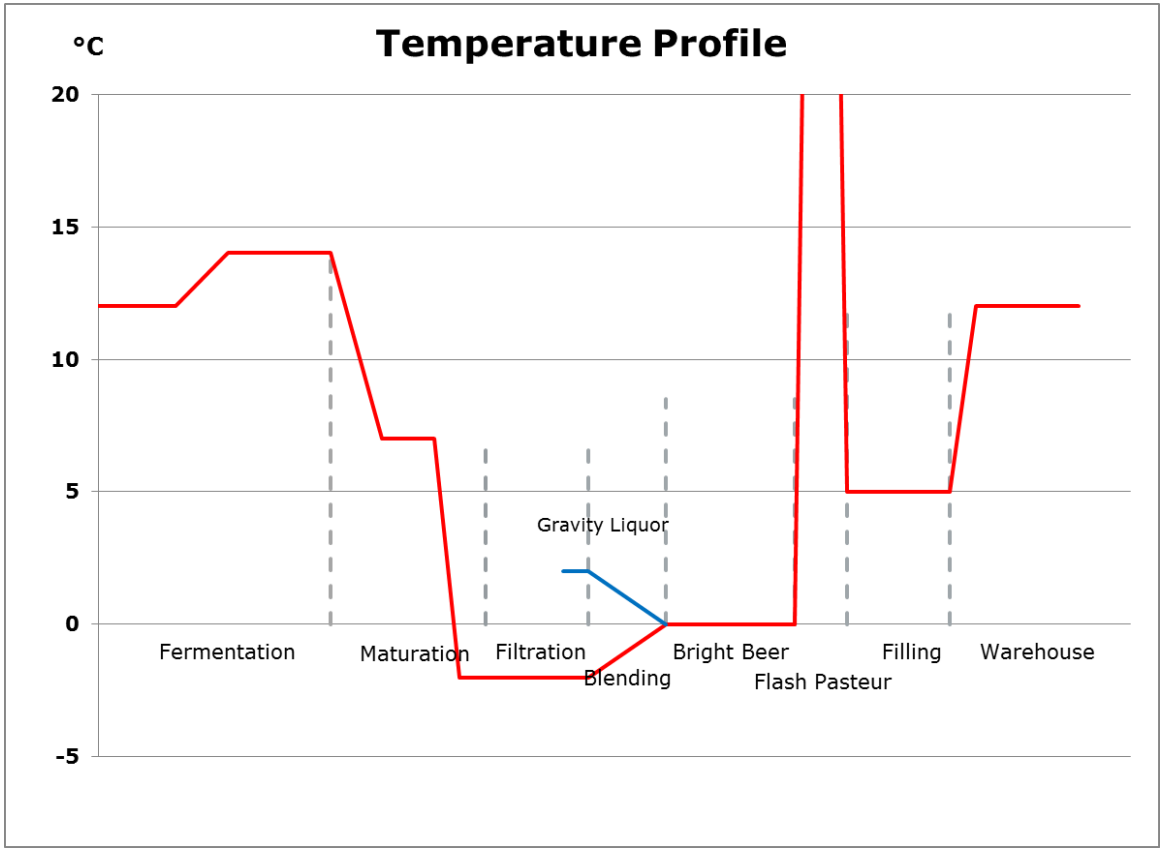
- Flexible use of raw material e.g. barley brewing
- Shorter cereal cooking cycles – lower temperatures
- Warm maturation and filtration



Source Anil Group

»Energy efficiency in production

Case - Warm maturation and filtration



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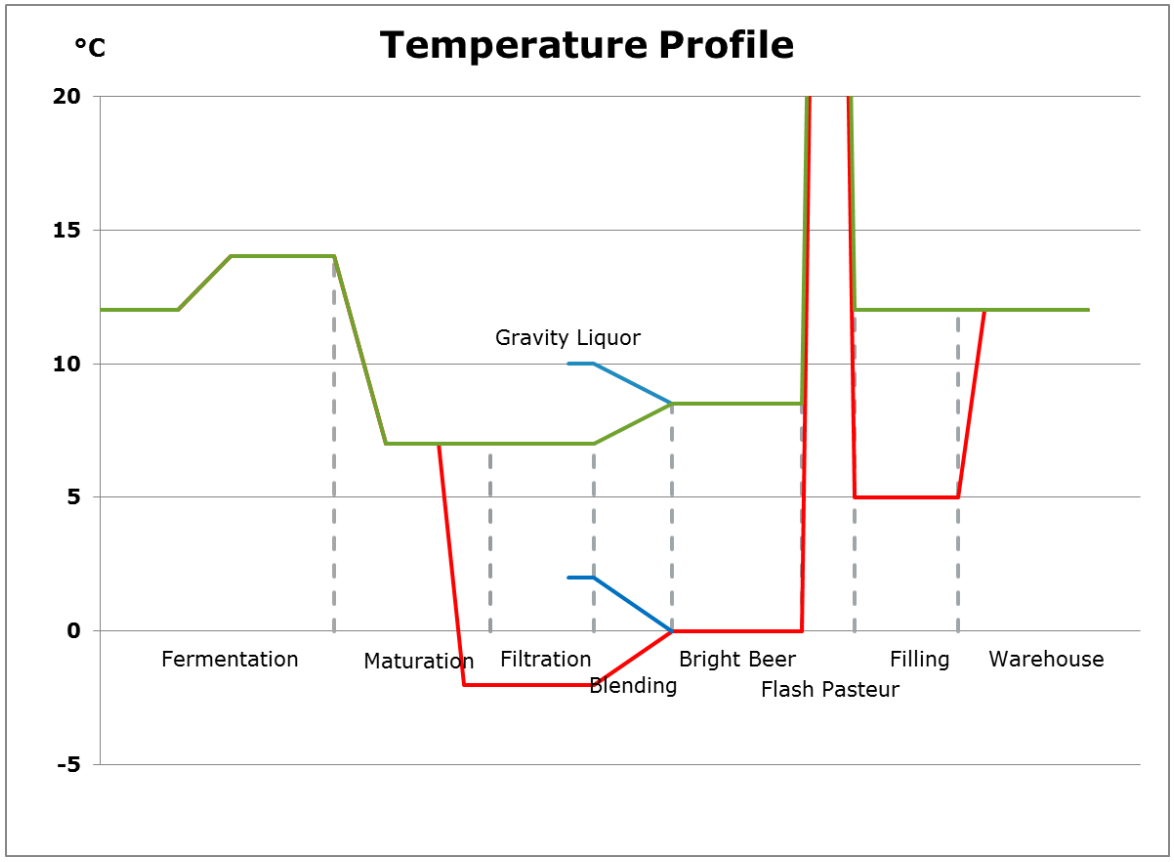
»Energy efficiency in production

Case - Warm maturation and filtration



»Energy efficiency in production

Case - Warm maturation and filtration - consequences

New thinking for the refrigeration plant. The refrigeration plant may no longer be the main utility plant.

Overall cooling load will be reduced and at higher temperature.

Reduced load combined with much higher NH_3 suction temperature will significantly reduce power consumption for the refrigeration plant.

- Increase in COP by ~30%
- Reduction in overall electrical power consumption estimated as more than 1 kWh/hl

Very few consumers requiring -4°C propylene glycol or NH_3

- Yeast storage
- Yeast propagation
- CO_2 Recovery plant

»Energy efficiency in production

Case - Warm maturation and filtration - consequences

Traditional NH_3 installation may be substituted by or supplemented by

- Free cooling
- Ground water cooling
- Connection to district cooling, if available
- Absorption cooling

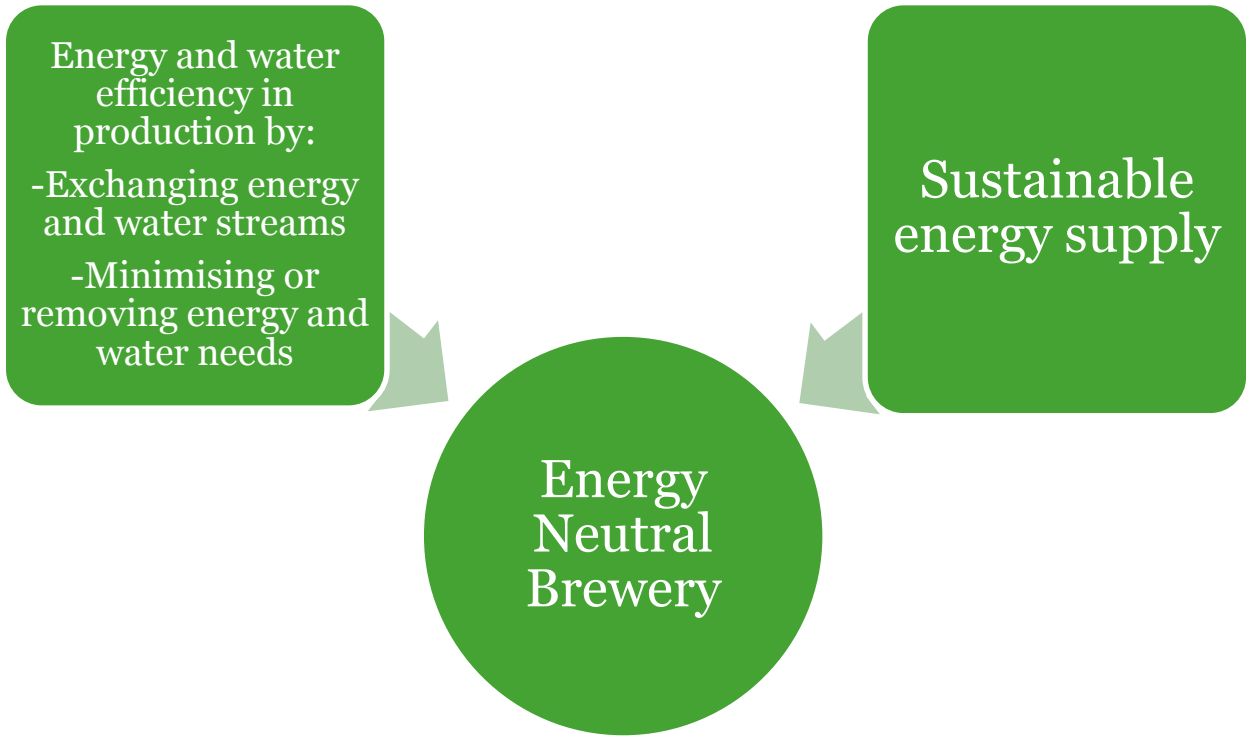
Tri-generation can become attractive

- Power, heat and absorption chilling

Minimal NH_3 charge at the brewery

Sustainable energy supply

»Energy Neutral Brewery



»Sustainable energy supply

- Share utilities (interaction) with community e.g. district heating, district cooling
- Use of biomass e.g. spent grains for the boilers
- Biogas
- Wind turbines
- Solar panels
- Concentrated solar power
- Hydropower



»Sustainable Energy Supply

Internal energy sources

- Spent grains
- Spent yeast - biogas
- Waste water - biogas

External energy sources

- Biomass
- Sun
- Wind
- Hydropower
- Ground water cooling
- Free air cooling

»Sustainable energy supply

Internal energy sources

Requirements		
	Heat	Power
Total	50 MJ/hl	6 kWh/hl

Own Supply			
	Energy	Heat	Power
Spent Grains	40 MJ/hl	30 MJ/hl	2.2 kWh/hl
Biogas	12 MJ/hl	10 MJ/hl	1.0 kWh/hl
Total	52 MJ/hl	40 MJ/hl	3.2 kWh/hl

Remaining		
	Heat	Power
Total	10 MJ/hl	2.8 kWh/hl

»Sustainable energy supply

Internal energy sources

Spent grains

- Pressing
- Drying alternative addition of dry biomass
- Burning in biomass boiler
- Steam turbine or organic Rankine circle to produce electricity
- Condenser for recovery of heat

Biogas

- Use in a gas engine running a generator to produce electricity

»Sustainable energy supply

External energy sources – 1 mill hl Brewery

Remaining		
	Heat	Power
Total	10 MJ/hl	2.8 kWh/hl

1 mill hl brewery		
	Heat	Power
Solar power - 20,000 m^2		2.0 kWh/hl
Wood chip 1,000 tons/yr or 4,200 m^3 or 95 trucks (45 t)	10 MJ/hl	

»Own supply of energy

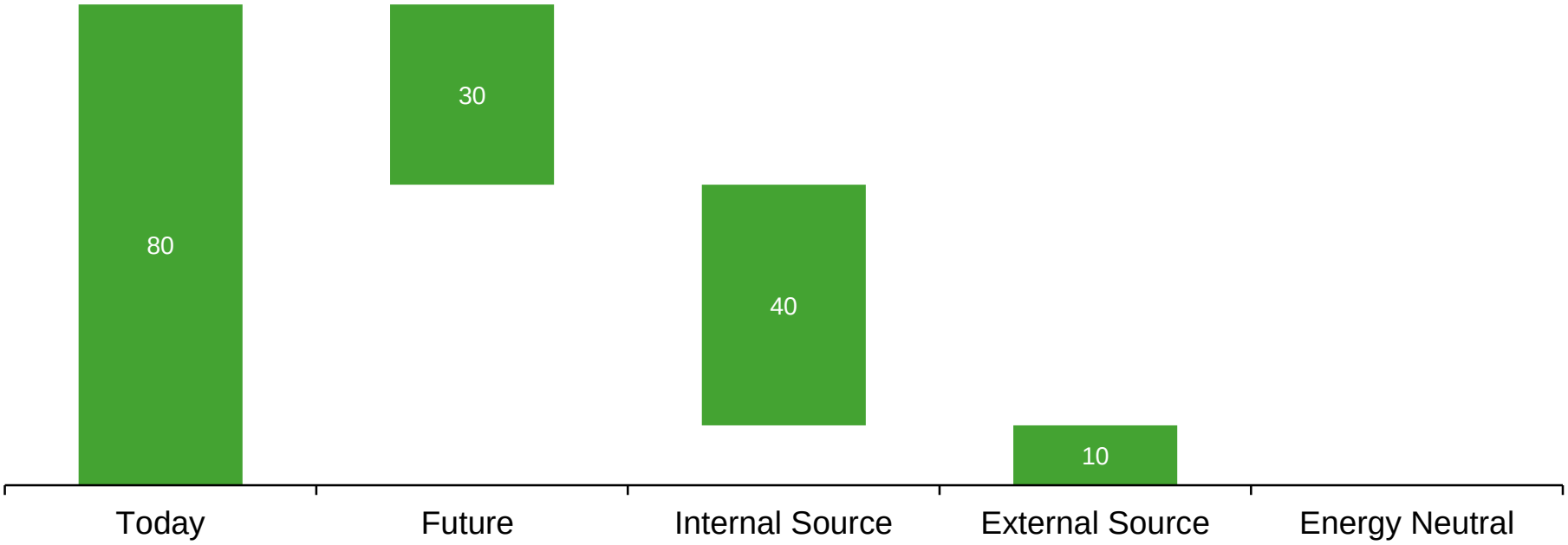
External energy sources – 1 mill hl Brewery

Remaining		
	Heat	Power
Total	10 MJ/hl	2.8 kWh/hl

1 mill hl Brewery		
	Heat	Power
Wind mills - 1.5 MW – 90 m height – 65 diameter m		3.0 kWh/hl
Wood chip 1.000 tons/yr or 4,200 m^3 or 95 trucks (45 t)	10 MJ/hl	

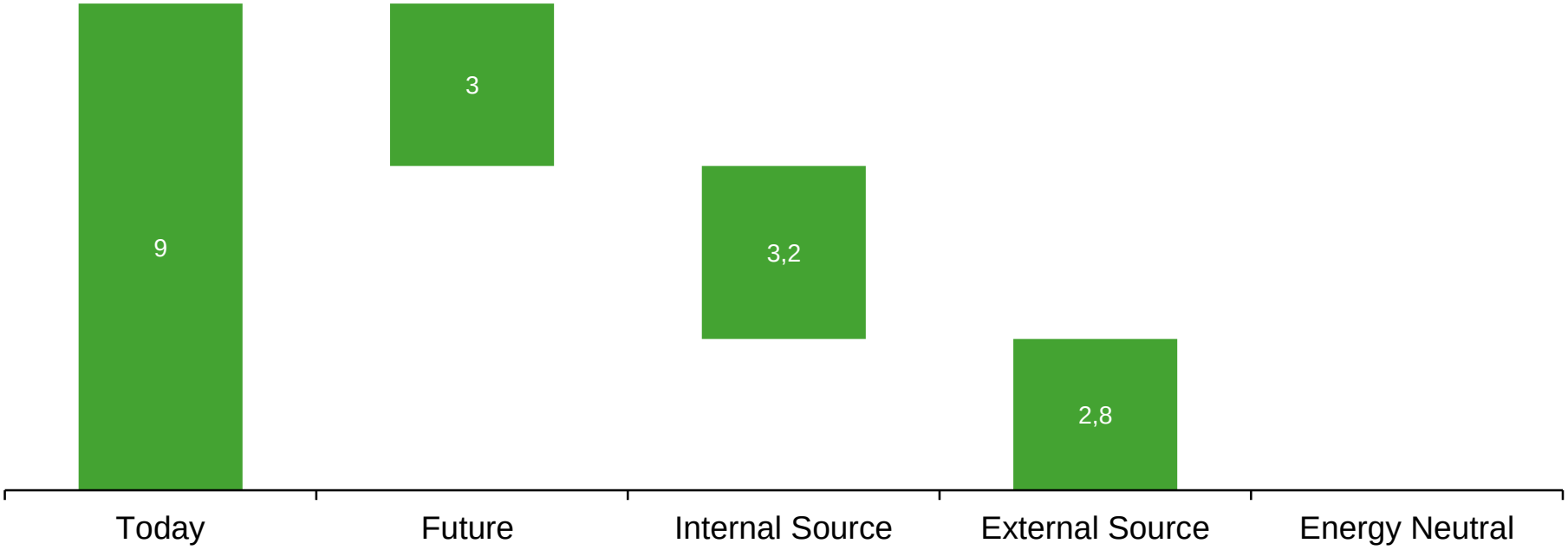
»Sustainable energy supply – Summary

Heat – MJ/hl



»Sustainable energy supply – Summary

Power – kWh/hl



Energy Neutral Brewery

»Energy Neural Brewery

- Yes - it is possible

- Step change technologies are available or are under way in order to build the Energy Neutral Brewery.

- **The future to be based, not only, on ”Best Available Techniques”, but also on ”Next Available Techniques”**

»In conclusion

Building the Energy Neutral Brewery of the Future will require that you are ready for:

- Innovation
- Courage
- Long-term investments

Innovation will require close cooperation between:

- Brewery
- Suppliers of equipment
- Consultants
- Community
- Universities

We look forward to co-innovating the Energy Neutral Brewery of the Future

»Questions

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