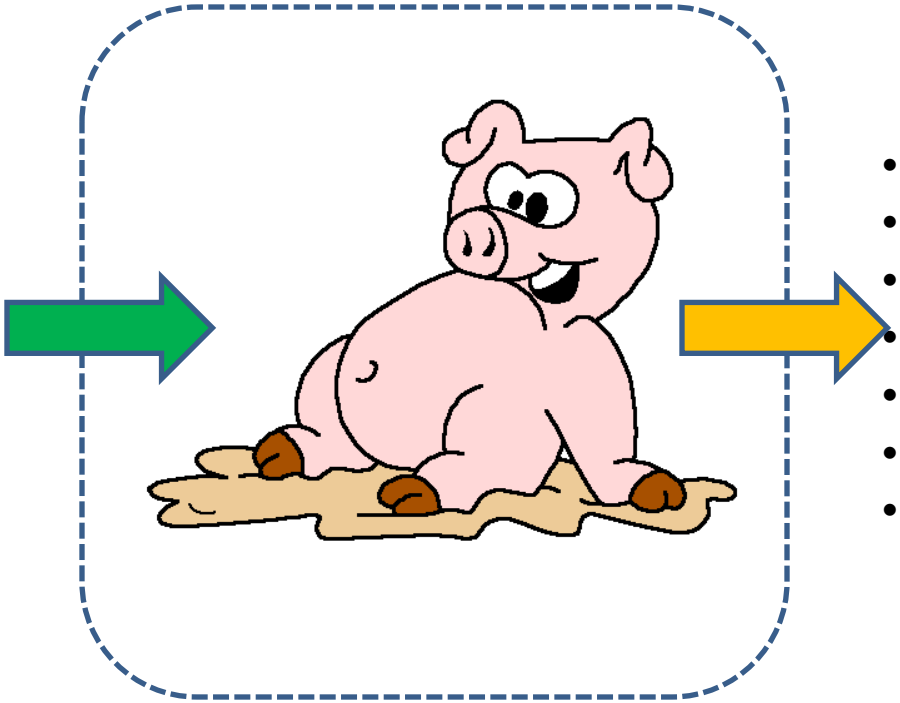
Direct energy consumption and measurements in cattle houses

Consumption source: M.Posio Master Thesis

Energy use

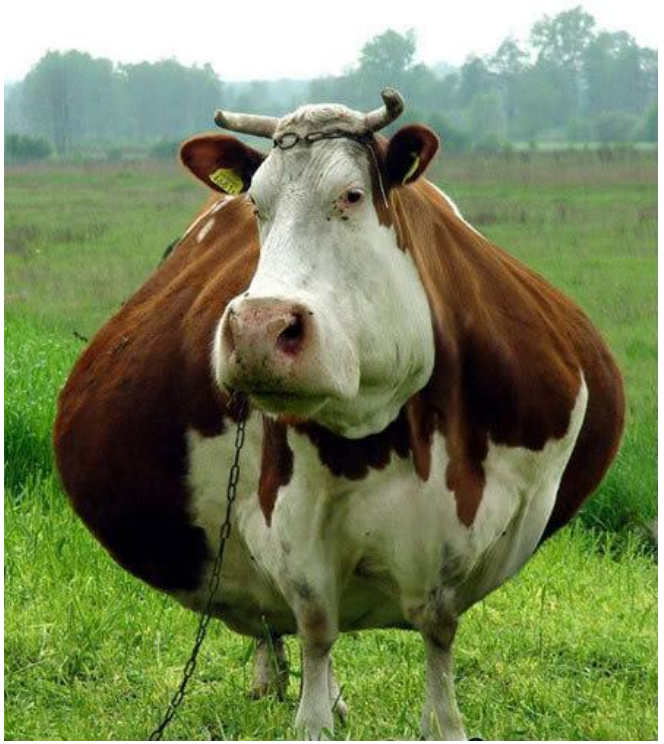
- Feed
- Water
- Concentrates
- Shelter
  - Heat
- Care
  - Ventilation
  - Illumination



- Meat
- Fat
- Bones
- Skin
- Manure
- Heat
- Water

Direct energy in cattle houses

1. Feed
2. Heating
3. Hot water
4. Lightning
5. Ventilation
6. Water pumping
7. Manure removal
8. Milking
9. Feeding system



Feeding material

- Feeding material is either from own field productions or it is bought
- Feeding material energy input figures can be:
  - heating values
  - production energy consumption figures
  - for concentrates figures found in literature
- Fereding material is measured with bookkeeping

Heating

- Heat energy consumption model
  - In order to be able to compare energy consumptions we must have a model with which we can calculate different animal houses
  - For this model we need information:
    - structures and heat insulation materials
    - doors and windows
    - number of animals
- Annual heat energy need is explained in another presentation

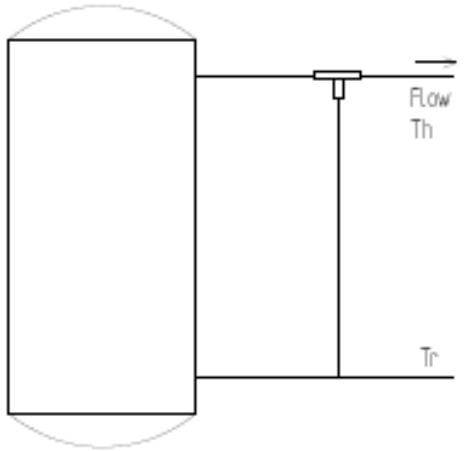
Heating power measurement

- Needed for warm cattle houses, ie houses which have heating devices
- Cold cattle houses have milking room, which must be heated
- Besides the heating system all machinery and animals inside the building produce more or less heat
  - Heating is needed after a certain balance temperature

Heating power in water heating system

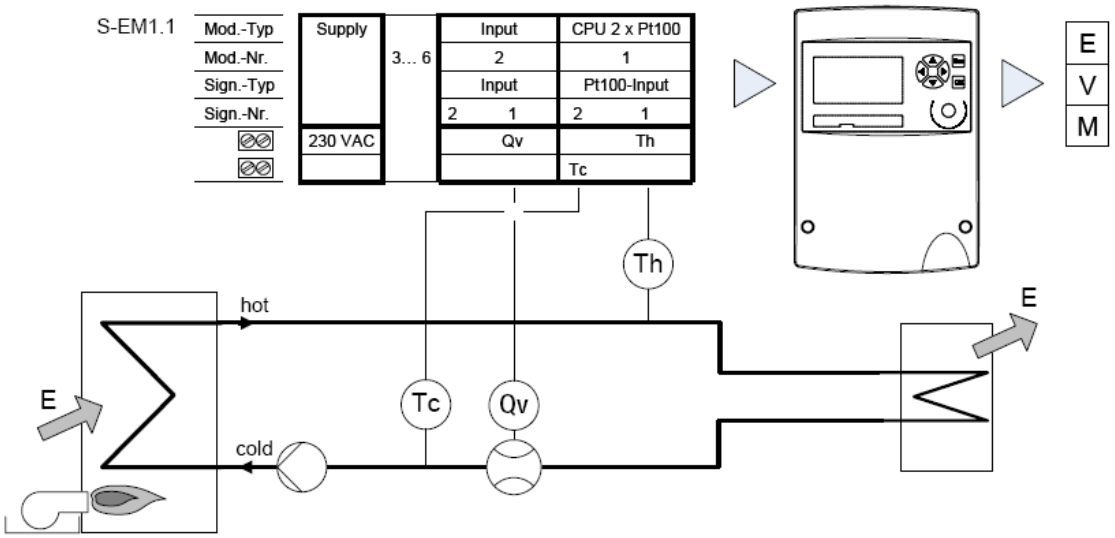
- When water is used to transfer heat to the building either the total heating power or each separate heating circuits are measured
- The measurement includes the water flow and temperature measurements
- Hot water measurement systems or district heating system energy consumption meters can be used for the measurements
- For the measurements the pipelines have to be cut in ordet to assemble the flow meter
  - Best to do this during summer
- Heating energy is heating power multiplied by time

$$P_h = c_w \cdot m_w \cdot \Delta T$$



P_h heating power
c_w specific heat value of water, 4,18 kJ/kg/K
m_w water mass flow
ΔT temperature difference between heating and return water temperatures

Example


S-EM1.1
Mod.-Typ
Mod.-Nr.
Sign.-Typ
Sign.-Nr.
Supply
230 VAC
3... 6
Input
2
Input
2 1
Qv
Input
CPU 2 x Pt100
1
Pt100-Input
2 1
Th
Tc
E
V
M
Th
hot
E
Tc
Qv
E
cold

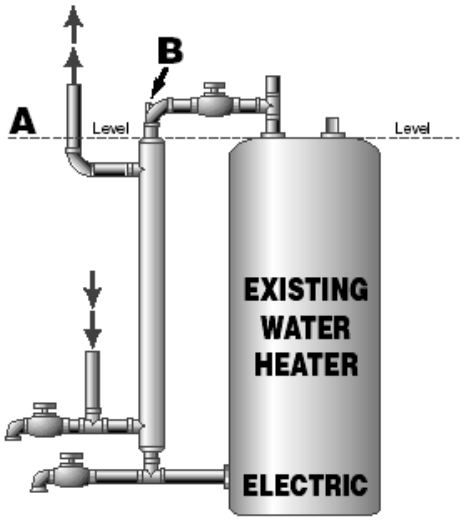

Functions and features
Modular design
• For optimum settings to the application
• Modules for mounting in protective housing or standard rail
Applications
• Heating or cooling meter and combined functions
• Flow processor or transmitter
Temperature measurement
Highly accurate temperature measurement from -50 to +550 °C with Pt 100 sensors or temperature transmitters with 0/4 - 20 mA signal
Calculation functions
Heat energy (enthalpy differential), volume, mass, power, flowrate, density, K-factor, temperature difference
CALEC® energy master
Tariffs
• Max. 12 registers for tariffs/ premium meters, e. g. related to return temperature
• Calculating the return energy or deviation from agreed return temperature
Special functions
• Air conditioning (combined heating/cooling meter with automatic changeover)
• Low-flow suppression when falling below the minimum temperature difference
• Flow inversion
• Parallel-switched flow transmitter (e.g. summer / winter operation)
• Measurement in open systems (return flow different from forward flow)
• Special functions when using up to three calculating units
Heat transfer data
• Flow measurement for water to EN 1434
• List of common heat transfer media (glycol) and one specific (programmable) heat transfer fluids, running calculation of values including special heat transfer media
• Selection of heat transfer media and on site adjustment of concentration

Example

- Water flow measurement shows 35 l/min flow and the output temperature is 55 C and the return temperature is 40 C. What is the heating power and how much energy is consumed in one day?

Hot water measurement

- Heating of hot water can be measured with water meters. The principle is the same as in heating energy meters.
- Because the hot water temperature is in most cases regulated and the cold water temperature change is small only the cold water consumption used in hot water needs to be measured.
- The temperatures should be checked periodically.
- Hot water is used during milking and also for washing
  - In milking systems hot water energy consumption is 90 - 180 kWh/cowplace/year
  - Besides milkin hot water is used 120 – 240 kWh/cow/year



Lightning (Illumination)

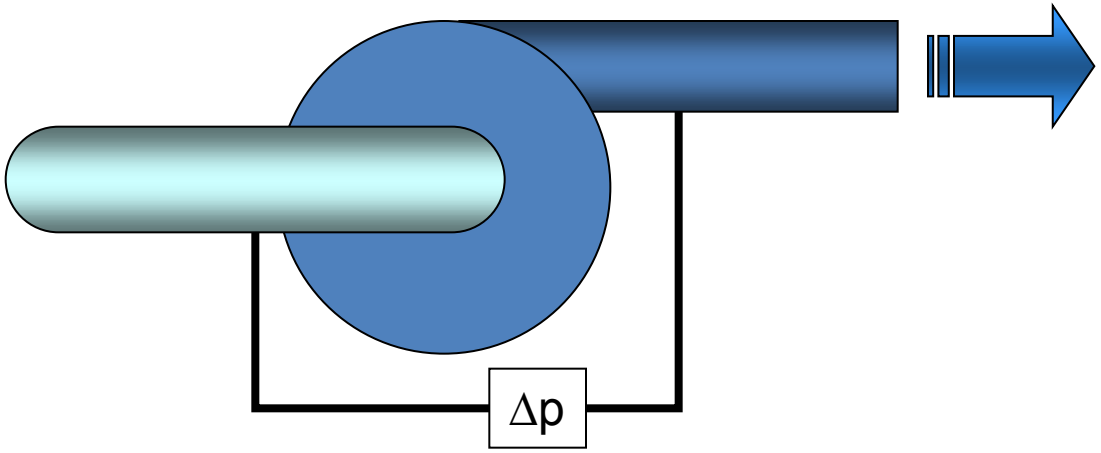
- The tabel beneath shows the illumination recommondations and the lamps needed to achieve this
- Energy consumption depends on how long time during the year illumination is on
- The energy used for illumination should be measured seperately with an kWh meter or the time they are switched on should be recorded
- Calculated energy consumption is 70 – 70 kWh/a (fluorescent lamps, 8 months/a)

Building	Illuminance [Lx]	Fluorescent lamps [W/m^2]	Window/floor area
Cowhouse			
- general illumination	60 - 100	3.6 - 6.0	1:10 - 1:20
- milking parlour	200 - 250	12.0 - 15.0	1:8 - 1:15
- calves	40 - 60	2.4 - 3.6	1:10 - 1:20
Pigsty			
- pork production	40 - 60	2.4 - 3.6	1:20 - 1:30
- farrow, general illum.	40 - 60	2.4 - 3.6	1:20 - 1:30
- farrowng pen	60 - 100	3.6 - 6.0	
- sleeping berth	20 - 30	1.2 - 1.8	
Henhouse	10 - 20	0.6 - 1.2	
Stable	60 - 100	3.6 - 6.0	1:20
Sheep barn	20 - 50	1.2 - 3.0	1:30 - 1:35
Office and service rooms	150 - 300	9.0 18.0	1:8 - 1:15

Table 5.1: Recommended illumination levels in cattle houses [MMM RMO-C3 2002]

Blower

- A blower moves (blows) air from one place to another
- The power in the flow depends on volume flow and pressure
- Pressures in ventilation are quite low, normally < 100 Pa
- Blower efficiencies are 40 – 60 %



v

$$P_f = \dot{V}\,\Delta p$$

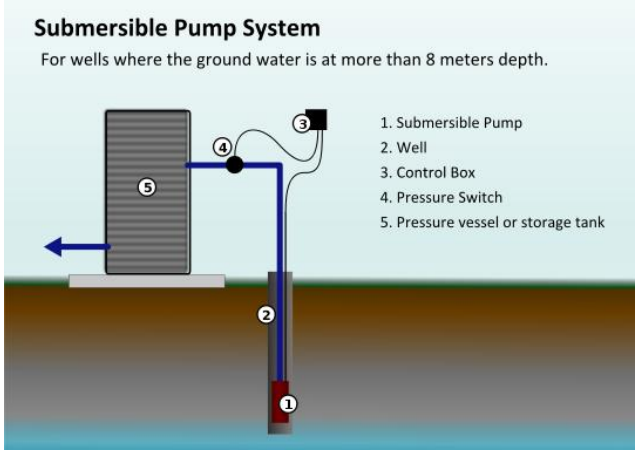
$$P_a = \frac{P_f}{\eta}$$

Ventilation

- Blower flow depends on the pressure difference between input and output of the blower
- Blower energy need depends on the flow and pressure difference
- Nominal electrical motor power is not the consumed eletrical power
- Nominal power is
  - the power with which the motor can run for long time
- The true power can be less or more than the nominal power
- Blower energy consumption should be measured separately from other electrical consumption
- Electricity consumption is 1 – 80 kWh/cowplace/year

Water pumping

- The basic power need is calculated in the same way as with ventilation, insteadt of air water is moved
- Energy need depends on the well placement and depth (= suction heigth and transfer length)
- Water pump electricity consumption should be measured separately
- Electricity consumption is 13 – 35 kWh/cowplace/year



Rasmussen & Pedersen

	Galaxy	Lely Astronaut	DeLaval VMS	Gascoigne Melotte	Strangko 2×12 herringbone	DeLaval 26-stalls rotary milking parlour	DeLaval 40-stalls rotary milking parlour
Vacuum Pump	20,0	18,7[1)]	27,6	40,4[1)]	44,3	52,0	58,7[2)]
Compressor	17,1	17,8	22,2	13,4			
Water heater	30,3		14,7			9,9	83[3)]
Control current					8,6	0,4	
Milk pump	2,85		0,8		0,75	1,1	
Air drier/freeze drier				0,5			
Automatic washing system					43,7	8,7	
Flushing pump + Transmission engine for fast exit					1,4		
Crowd gate					0,5		
Total[4)] kWh	**70,25**	**36,5**	**65,3**	**54,3**	**99,25**	**72,1**	**141,7**

1) Total milking unit consumption.

2) Vacuum pump, automatic washing system, milk pump.

3) Crowd gate, water heater, flushing pump.

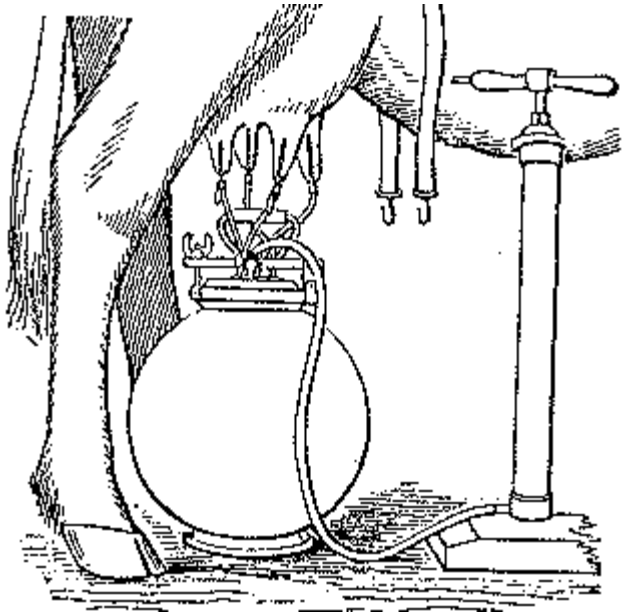
4) Total consumption per milking unit should be viewed in relation to the cap

Manure removal

- Manure removal and mixing can be done with many different ways
- Mostly they are run by electricity but part of the handling can be done by tractors
- Manure removal system electricity consumption should be measured separately from the other consumption
- Dry manure removal systems consume 22 – 40 kWh/cowplace/year
- Pumping of slurry consumes 6,3 – 43,6 kWh/cowplace/year

Milking equipment

- Electricity consumption of milking equipment should be measured separately
  - milking machine
  - milking machine washing machine
  - milk cooling system
- Total energy consumption is 180 – 735 kWh/cowplace/year. Robot milking consumes a little higher amount energy than traditional milking



Feeding systems

- Feeding systems are run by electricity or tractors and selfpropelled machinery are used
- Feeding system consumption should be measured separately
- Measured energyh consumption is for the whole feeding chain 160 – 650 kWh/cowplace/year

Other equipment

- Any other equipment if the estimated energy consumption is higher than 2 % of the total consumption should be measured separately

This material has been produced in ENPOS project. ENPOS is acronym for ***Energy Positive Farm***.

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• Estonian University of Life Sciences

Project home page is at http://enpos.weebly.com/

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