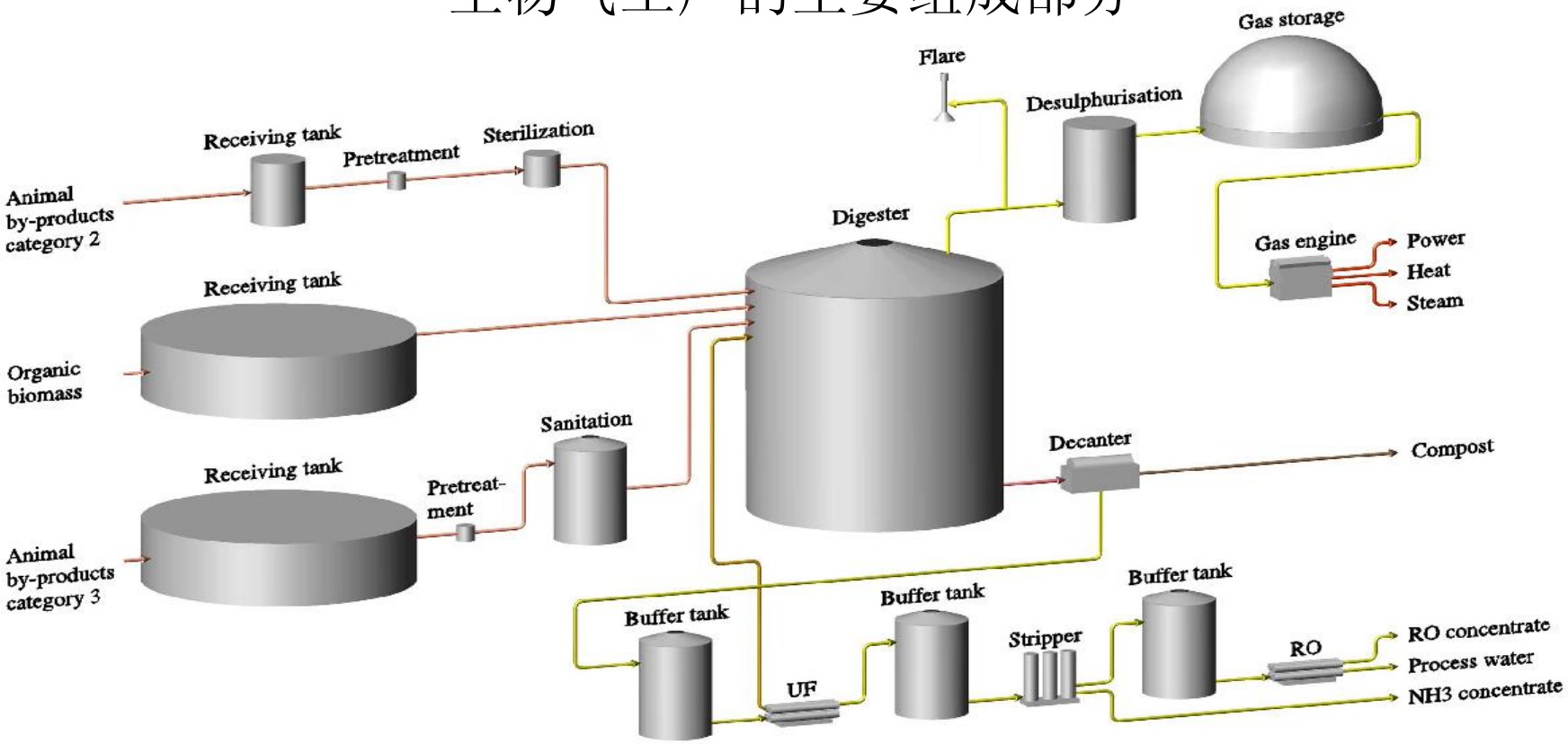
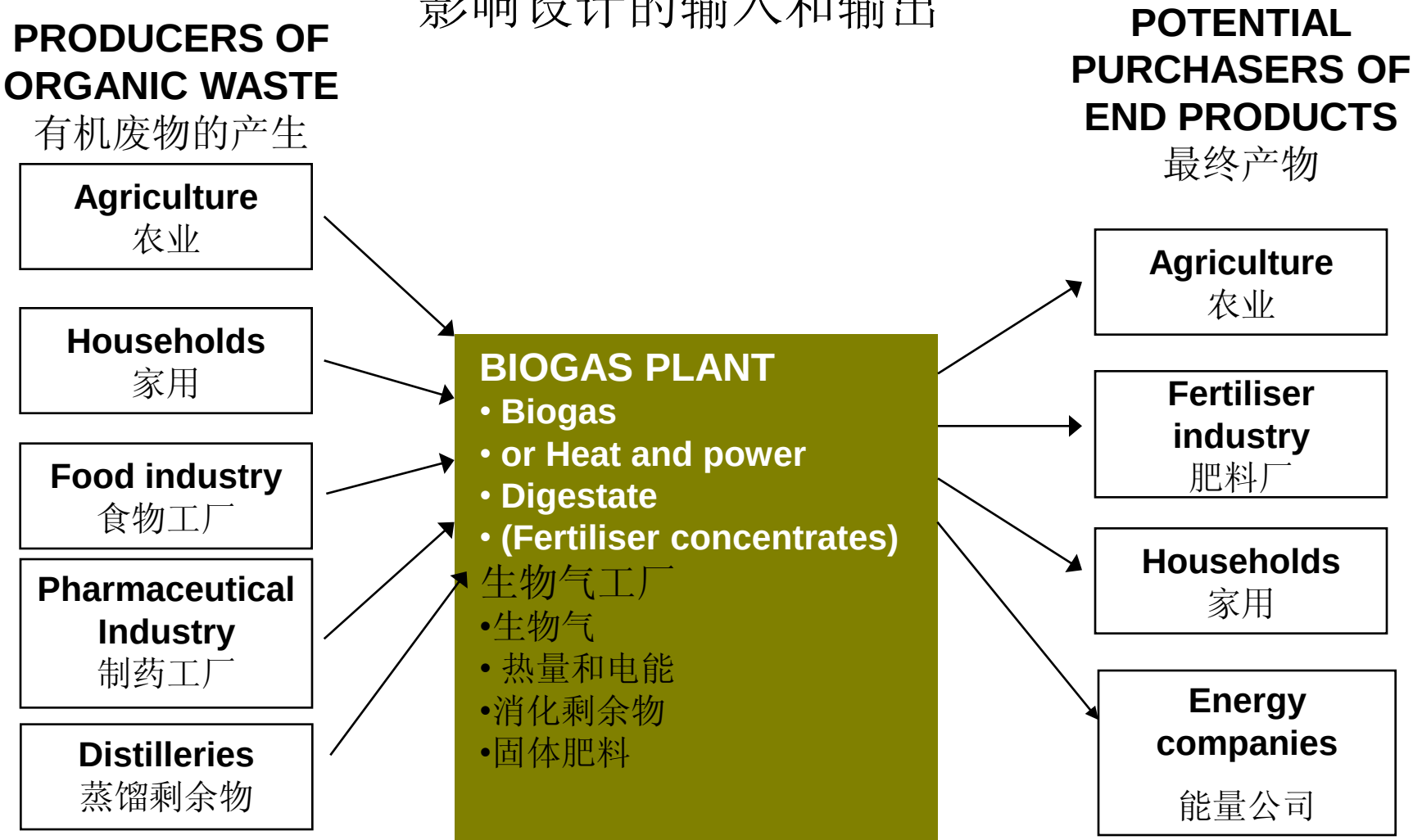
Per Thostrup – 30 years in Biogas – Ms. Ag. Engineer
30年生物气研究历程

- 1978 – 82 Research and technical development (RTD)
  1978-82 研究和技术发展（RTD)
- 1882 – 92 Planning of Biogas Plants and RTD
  1882-92 生物气工厂和RTD的规划
- 1992 – 97 Design of Biogas plants (and RTD)
  1992-97 生物气工厂的设计（和RTD)
- 1997 – 02 Build of Biogas Plants
  1997-02 生物气工厂的建造
- 2002 – 09 Operation of Biogas plants and repowering
  202-09 生物气工厂的运行和改扩建
- Present: CEO of www.NordicBioEnergy.dk
  现在： www.NordicBioEnergy.dk CEO

Main components of a Biogas Plant
生物气工厂的主要组成部分



Input and output influences the design
影响设计的输入和输出



Input material and normal conversion efficiency

输入原材料和正常转化效率

Type of material 原材料的类型	Conversion efficiency 转化效率
• Fatty material 脂肪类原材料	>90 %
• Sugar 糖	>90 %
• Proteins 蛋白质	50 – 70%
• Cellulose 纤维素	30 – 50 %
• Mixtures 混合物	40 – 75 %

The input matrial can be anything from solid to liquid which has great infuence on the pretreatment and the energy efficiency.

输入材料可以是从固体到液体的任何物质，而输入物质对预处理和能量效率有很大影响。

Pretreatment of input versus energy efficiency
输入物质的预处理和能源效率

- Mechanical treatment: mazerators, shredders, hammermills, blenders, squeezing
  机械处理：研磨，打碎，搅拌，榨取
- Temperature / pressure treatment
  温度/压力处理
- Enzymes
  酶
- Hydrolyses
  水解
- UV,IR,magnetic,ultrasound
  UV,IR,磁，超声波

Gives normally a good effect and is needed but must be compared to the energy consumption

预处理能产生积极的效果，但是必须考虑能源消耗

Is a question because of the high energy consumption

因其能源消耗量大， 因而这还是一个问题

Is still in development

仍在研究中

Biological acidification is the most efficient and should nearly alwas be considered

生物酸化反应是最有效的，必须给于考虑

For all methods the capability of physical handling is more important – also the impurity handling for the selection.

在所有的方法中，物理处理是最重要的，选择过程中要注意分离杂质

Digester efficiency, process temperature and heat loss
消化效率，过程温度和热量损耗

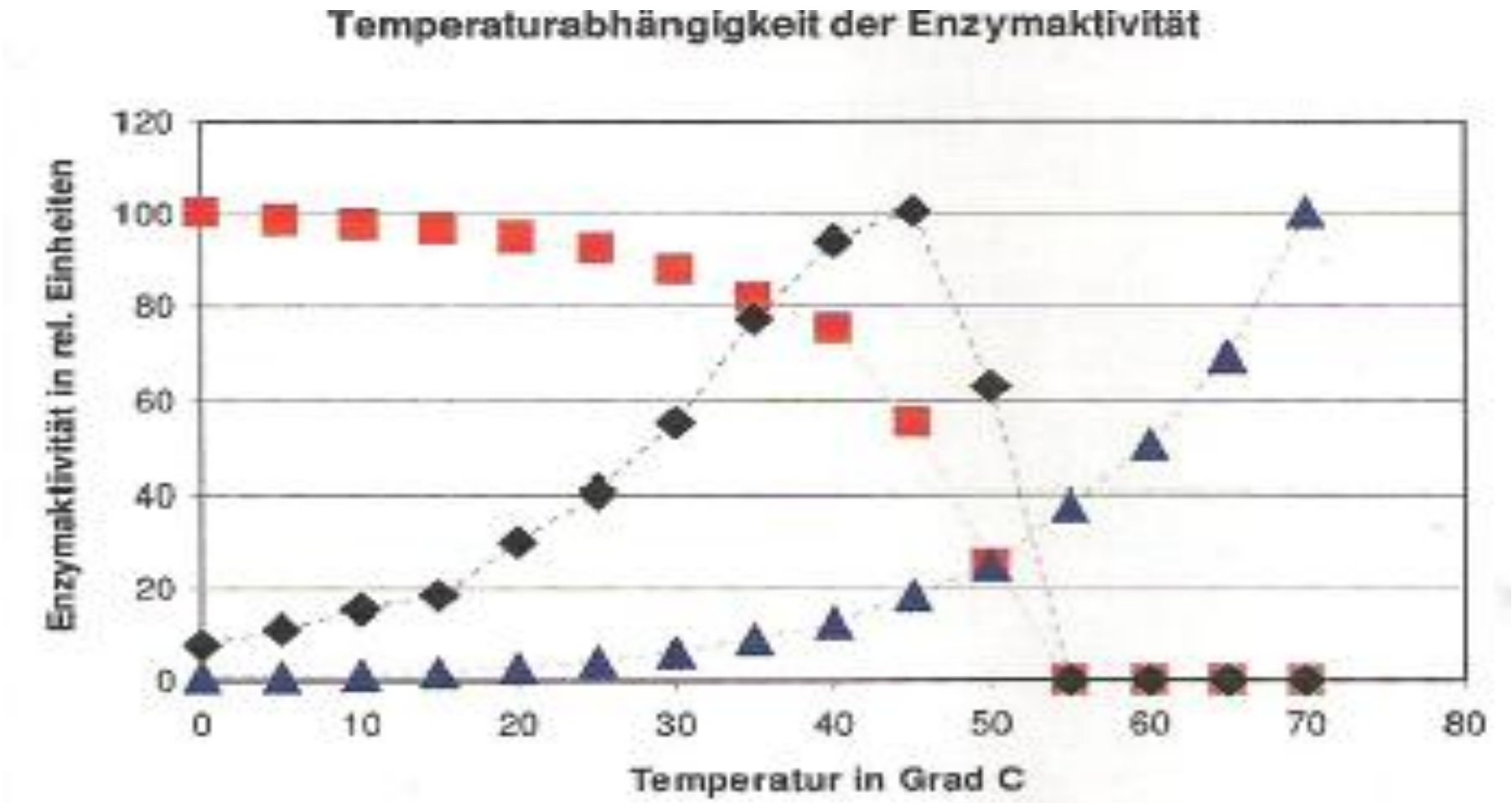
- Process temperature: open question but latest investigation shows a range 42 – 44 *C, see next slide.

  过程温度：常见的问题，最新的研究表明是42-44 ℃，见下一页幻灯片。
- Heat loss:

  热量损耗：
  - Transmission from digesters: No general rules as it depends on the cost of the heat but in all casses an insulation is needed in order to achieve a stabel process. Year variation

    消化液传递：没有固定的规则，因为它取决于加热的费用，但是为了实现过程的稳定性，需要一定的隔热设备。每年不同。
  - Heat exchangers: heating without recovery simpel, especiale at mesophile temperature. With recovery it becomes complex – separate attention needed.

    热量交换：加热但无热量回收，特别是在中温条件下。如果进行热量回收，情况就变得复杂-需要区别对待。



rot = Enzyminaktivierung, blau = Arrhenius-Abhängigkeit der Reaktionsgeschwindigkeit, schwarz = daraus errechnete Enzymaktivität

Hygienization – heat demand increases

卫生化处理-提高加热需求

- General EU rule: 1 hour at 70*C – higher heat demand
  大致欧盟的规则是：70 ℃ 1 小时 - 较高的加热需求
- Pre – or after hygienization?
  是先卫生化处理还是后卫生化处理
- 3 tank -, 2 tank-, 1 tank system or continious?
  3个容器，2个容器，1个容器系统还是连续系统？
- Alternatives to 1 hour 70*C: thermophillic process, long retention time or lang after storage.
  不采用1个小时70 ℃，而可以采用：高温过程，较长的停留时间或较长的贮藏时间。

Note 1: today heat exchangers system can be got which reduce the extra heat demand to near zero

注意1：现在可以基本上实现额外加热量为零的热交换系统了

Note 2: before designing a hygienization system it must be fully cleared with the authorities (the vet’s)

注意2：在设计一个卫生化系统之前，必须由专家检查决定。

Heat and electricity demand for 1 MW MLBGB

1 MW中大型沼气厂的 热量和电力需求

feed 10 m^3 per hour and 450 m^3 biogas per hour, 52 *C process

进料10 m^3每小时，生物气450 m^3 每小时，过程温度52 ℃

Heat demand
热量需求

- Transmission digesters
  消化液的传送
  Summer 25*C: 40 kW
  夏天 25 ℃ 40 kW
  Vinter -10*C: 90 kW
  冬天 -10 ℃ 90 kW
- Heating input , pipe loss
  热量输入，管道损耗
  Using recovery T=20 *C
  回收温度T= 20 ℃
  Heat needed: 250 Kw
  热量需求： 250 kW
- Loss in biogas: 25 kW
  生物气损耗： 25 kW
- Heating biogas: 10 kW
  加热生物气： 10 kW
- Total: 330 – 380 kW
  总共：330-380 kW

Electricity demand
电力需求

- Agitators (1 w/m3) 50 Kw
  启动： 50 kW
- Pumps 12 kw
  泵： 12 kW
- Biogas buster 3 Kw
  生物气装置： 3 kW
- Pre-treatment/storage: 10Kw
  预处理/储藏： 10 kW
- Ventilation /biofilter 5 Kw
  通风/生物滤池： 5 kW
- General 5 Kw
  其他 5 kW
- Total: 85 Kw
  总共： 85 kW
- Energy for transport ????
  传递能量？？？？

Energy balance for 1 MW MLBGB
1 MW 中大型沼气厂 能量平衡
feed 10 m^3 per hour and 450 m^3 biogas per hour, 52 *C process
进料10 m^3每小时，生物气450 m^3 每小时，过程温度52 ℃

- Energy content in input material (10 m3/h) 3800 kW
  输入原料的能量含量 （10 m3/h） 3800 kW
- 65% is converted into biogas 2500 kW
  65% 转化成生物气 2500 kW
- Potential to utilize / loss 1300 kW
  利用/损耗的能量 1300 kW
- Electricy produced @ 40% efficiency 1000 kW
  电力产生@ 40%效率 1000 kW
- Heat produced @ 50% efficiency 1250 kW
  热量产生@50%效率 1250 kW
- Loss in cogen unit 250 kW
  Cogen单元的损耗 250 kW
- Electricy consumption 85 kW ~ 8,5 % of produced
  电力消耗 85 kW 产生的8,5 %
- Heat comsumption 380 kW ~ 30 % of produced
  热量消耗 380 kW 产生的30%

Note: example is not a best case scenario
注意：例子不是一个最好的情况

How to improve energy balance
怎样促近能量平衡

1. Highest potential is to increase biological conversion rate
   最好的方法是提高生物转化效率
2. To reduce the losses at the cogen unit.
   降低Cogen单元热量损耗
3. To reduce the elctricity consumption
   降低电力损耗
4. To reduce the heat consumtion.
   降低热量损耗

NOTE 1: which of the 4 gives the best economic effect must be calculated separately

注意1：这4个建议中哪个最有经济效益，必须要单独计算

NOTE 2: Transport to and from is a separate topic and must also be taken up – Energy consumtion and GHG.

注意2：传递过程包括输入和输出过程，必须要考虑进去 - 能量消耗以及温室效应气体

NOTE 3: Greenhouse Gases must also be taken into consideration when taking improving energy efficiency

注意3：提高能量效率，必须考虑温室气体

Thanks for your attention
感谢您的关注