Aalto University
School of Chemical
Engineering

CHEM-E0115 Planning and Execution of a Biorefinery Investment Project (5 cr)

Lecture 4
Investment implementation phase - Sustainability
September 28, 2023
Erika Koskinen

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I. Work Experience

- AFRY, Finland: Technology Manager sustainability 8/2021 –
- Valmet Technologies Oy: Product Manager Environmental System Services 4/2015 – 7/2021
- Valmet Power Oy: product Engineer flue gas cleaning 01/2011 – 03/2015

II. Education

- Environmental Technology, Master, Lappeenranta University of Technology (LUT) 2010
  - *Exchange student: ESSCA de'Angers Hungary Spring 2009*
  - *Master thesis: Operating Cost Optimization of Flue Gas Cleaning Downstream of a Multifuel Boiler –Case Study.*

- Environmental Technology , Bachelor, Lahti University of Applied Sciences 2007
  - *Bachelor Thesis: Landfill Gas Recovery Case Townlands. Rustenburg Local Municipality, Waste Department in South Africa*

Agenda

I. AFRY sustainability services
II. Why Sustainability?
III. Environmental Sustainability in Process design
IV. Sustainability part of the project
V. What next?

Learning Objectives

I. Sustainable development is and will be a megatrend

II. To understand how the process design impacts on environmental sustainability

Environmental Sustainability Core Services

DECARBONIZATION AND CLIMATE CHANGE MITIGATION

Carbon footprint related studies

Decarbonization studies

Energy efficiency related studies/projects

Renewable fuel related studies

CCS related studies

SUPPORTING CIRCULAR ECONOMY

Material use efficiency review

Water use reduction

Water footprint

Sludge management studies

Sustainable raw material use related

Waste and side stream management

POLLUTION PREVENTION AND ENVIRONMENTAL PERFORMANCE SERVICES

Sustainability scanning

Environmental Impact Assessments

Permitting related studies

Wastewater treatment

Lowering production emissions

Improving efficiency

PROJECT & MANAGEMENT SUPPORT

Audits & reviews

Risk analyzes

Evaluations

Managing risks

Benchmarking studies

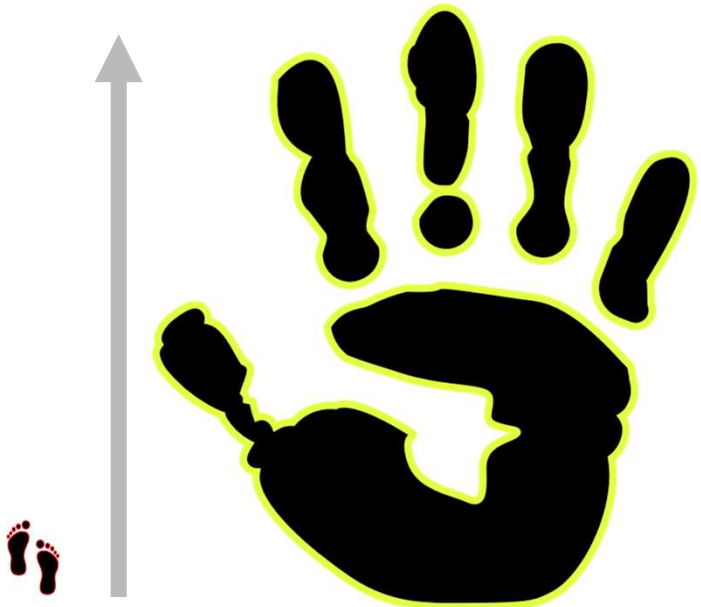
Process optimization

Workshops & trainings

AFRY
ÅF PÖYRY

Consulting’s every-day legacy through foot- and handprints

Each SKOL consultant is part of a handprint 1300 times bigger than footprint!



Why sustainability?

Megatrends 2023

The big picture of future opportunities

The Finnish Innovation Fund Sitra
https://www.sitra.fi/en/topics/megatrends/#make-the-most-of-megatrends-1

The UN's 17 Sustainable Development Goals for 2030

Sustainability in Pulp and Paper

II. Environmental Sustainability in Process Design

1. Decarbonization
2. Water reduction
3. Material recycling and circular economy

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Decarbonization

How energy is produced in pulp mill?

Fossil fuels

- Natural gas
- Heavy fuel oils
- Coal

Biofuels

- Black liquor
- Bark, chips, wood powder
- Tall oil and pitch, turpentine
- Bio-methanol
- Biogas
- Hydrogen

Sustainability targets for the year 2030:
"Fossil free production including scope 1 & 2 emissions"

"50 % reduction of GHG gases from 2019 level including scope 1,2 & 3 emissions"

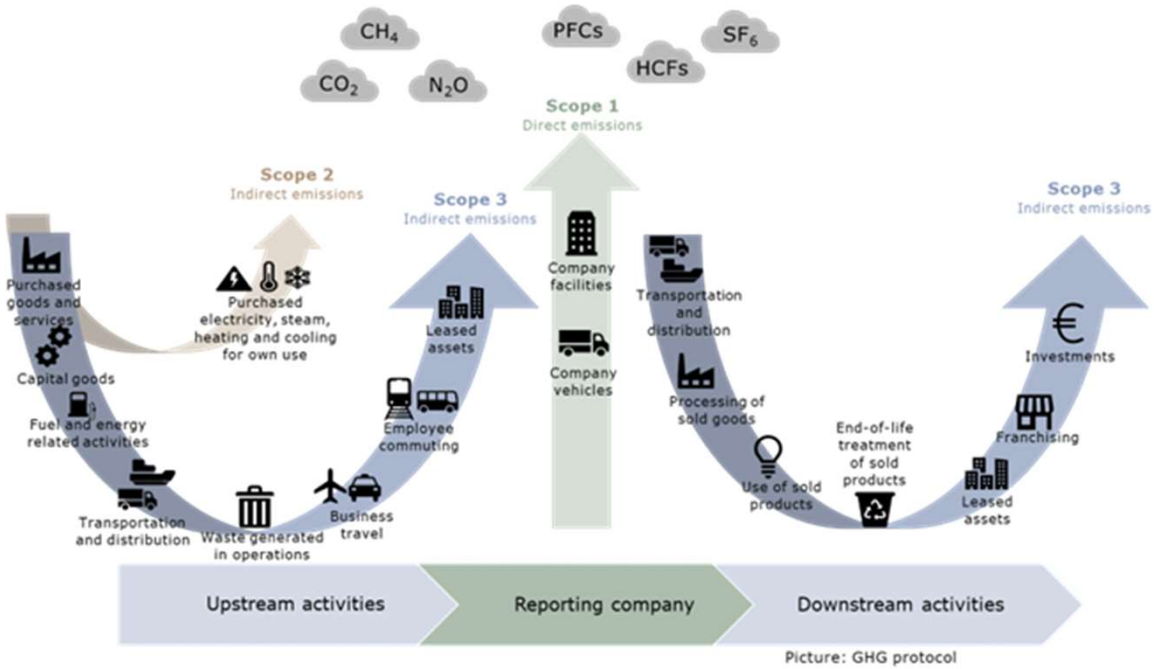
"65 % reduction of GHG gases from 2019 level including scope 1 & 2 emissions"

Source: Sustainability reports 2021 from Metsä Group, UPM, Stora Enso

Other greenhouse gas emission sources

- Purchased electricity, internal logistics
- Direct emissions f.ex. Waste water treatment, landfills, odorous gas incineration, manufacture of precipitated calcium carbonate (PCC)

Greenhouse gases are emitted from many sources

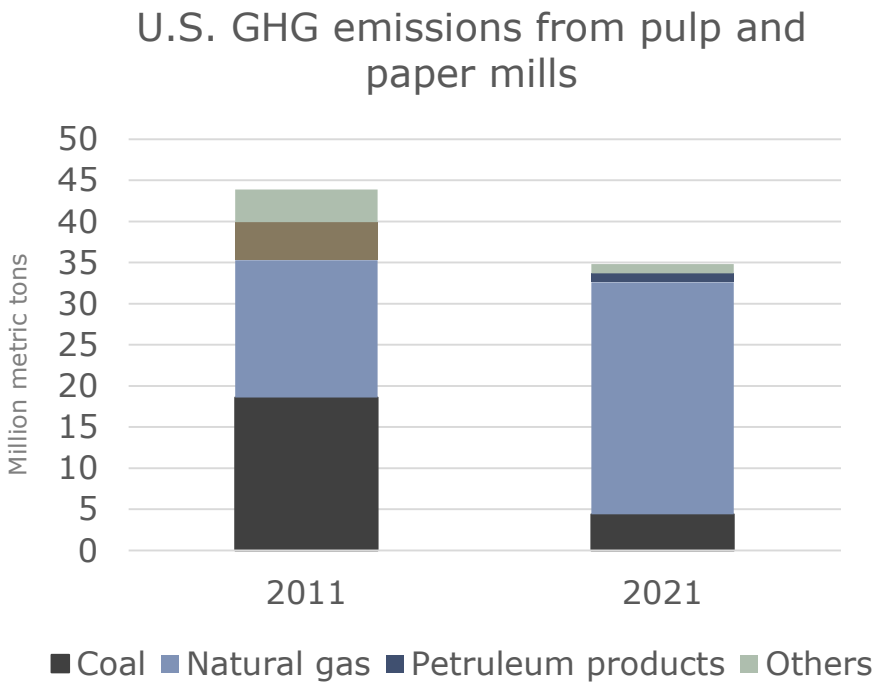


Picture: GHG protocol

GHG emissions in pulp and paper

Share of biofuels

- in Finland the share of biofuels in P&P industry is in average 88 % 2021
- in Sweden 96 % 2020
- US?



Source 2022: https://ghgdata.epa.gov/

GHG reduction measures in P&P mills

What this means in P&P mills:

- Replace coal, natural gas, peat and oil with renewable fuels
  - Use of bio-based fuels in lime kilns
  - Power boiler conversions and renovations due to fuel changes
  - Change of auxiliary fuels and renewal of burners
- Utilization of tall-oil pitch
- Internal logistics review and optimization, such as electrical vehicles and automatic conveyers
- Heat recovery and energy efficiency
- Purchase green electricity
- Use of new technologies
  - Carbon dioxide capture and utilization
  - Electricity use for ex. paper machine drying section

In addition:

- Tightening of emission limits and improving flue gas cleaning

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Water reduction

Water scarcity – a rising tide of risks for process industries

- In the coming years, availability of fresh water will affect many industries.
- The process industry, specifically pulp and paper, selected chemical industries, and mining sectors are all significant users of fresh water and are directly exposed to the risk of water scarcity.
- In areas with limited available fresh water resources, there may be sufficient water to meet human and environmental needs, but for industry the access may be limited at least during certain seasons.

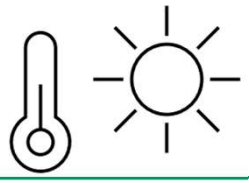
Sustainability targets for the year 2030:

"25 % reduction of the use of process water / produced ton"

"Effluent flow < 26 m^3/t / sold products"

"Waste water reduction 30 % from 2008"

Source: Sustainability reports 2021 from Metsä Group, UPM, Stora Enso



Water reduction in P&P mills

What does this mean in P&P mills:

- When water usage is decreased, concentrations are increasing (special materials) and scaling is increased
- Wastewater limit values are getting stricter
- Water treatment technologies are becoming more multi-stage and complex

- Recycling of water in mill internal processes
- Membrane technologies are becoming more common
- Attention is paid to sulfate concentrations

- Treatment of sludges and filtrates
- Use of recycled nutrients

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Material efficiency part of the circular economy

Material efficiency part of the circular economy

Nature carrying capacity eroding

- Loss of biodiversity and ongoing 6th Mass Extinction
  https://www.worldwildlife.org/stories/what-is-the-sixth-mass-extinction-and-what-can-we-do-about-it

- The limited nature of non-renewable natural resources and the environmental effects caused by growing production and consumption demand

- Material efficiency plays an important role in the circular economy, where materials and value remain within the economy for as long as possible and are utilized efficiently

Sustainability targets for the year 2030:

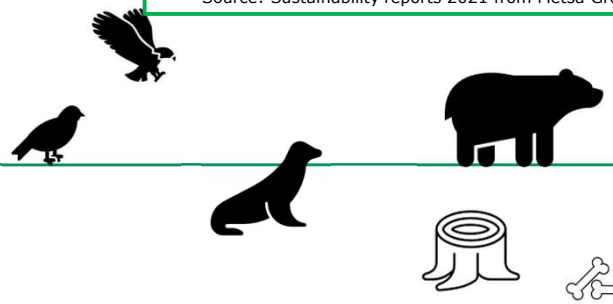
"100 % utilization of sidestreams"

"98 % recycling for waste"

"No landfill waste"

"100 % of nutrients are recyclable used in waste water treatment"

Source: Sustainability reports 2021 from Metsä Group, UPM, Stora Enso



Material efficiency and circular economy

What does this mean in practice, for example:

- Development of recycling and recovery technologies, e.g. sulfuric acid plant
- Ash recycling and utilization
- Development of ash handling technologies
- Utilization of sludge
- Processing of green liquor sludge and lime and utilization possibilities
- The risk is the concentration of impurities (e.g. NPEs, Ca, Cl) in the process

If side streams cannot be avoided:

- Side streams can be utilized in different industrial sectors
- New business models from side streams
- “Eco” industrial parks – boosting industrial symbiosis

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IV. Sustainability in projects

Sustainability part of the project

In addition to process design

- Understanding the opportunities from new technologies
- Energy efficiency (f.ex. HVAC)
- Sustainability indicators to design tools
- Correct process measurements for sustainability KPIs
- Energy and chemical optimization via process control and automation

Layout and mechanical engineering

- Optimal distances and locations in layout design
- Correct material selection in mechanical design
- Maintenance and life cycle aspects

Procurement

- Responsible supply chains

Project management

- Realistic project schedule and focus on quality
- HSE
- Most sustainable way in project is to done **engineering properly at once**

Sustainability part of the project

- Companies are setting different sustainability targets
- Environmental targets are typically science-based targets (SBTi) within timeline, typically year 2030 and 2050
- Examples of environmental sustainability targets:
  - Decarbonization and energy efficiency
  - Water reduction
  - Circularity and zero landfill waste
  - Land use and biodiversity
- These targets at minimum shall be implemented in new investment projects

Course assignment sustainability evaluation/inspection:

- Use one of the big Finnish forest company's sustainability report and think them as Hanko pulp mill Oy sustainability targets
- What should be included in sustainability evaluation of tall oil plant?

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V. What next?

Nature positive and carbon neutral world

- International agreements and protocols will create new legislation and reporting obligations for companies
- Voluntary carbon and ecological compensation to reach the sustainability targets

Only sustainable companies will perform in future

- Sustainability will not be separate department but it is integrated in all part of company functions up to operate level
- Sustainability will be prerequisite for a companies to operate
- Sustainability key performance indicators are needed for management to be able to lead the transition

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Thank you!

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