NIBIO
NORWEGIAN INSTITUTE OF BIOECONOMY RESEARCH

Sustainable Recycling of Bioresources

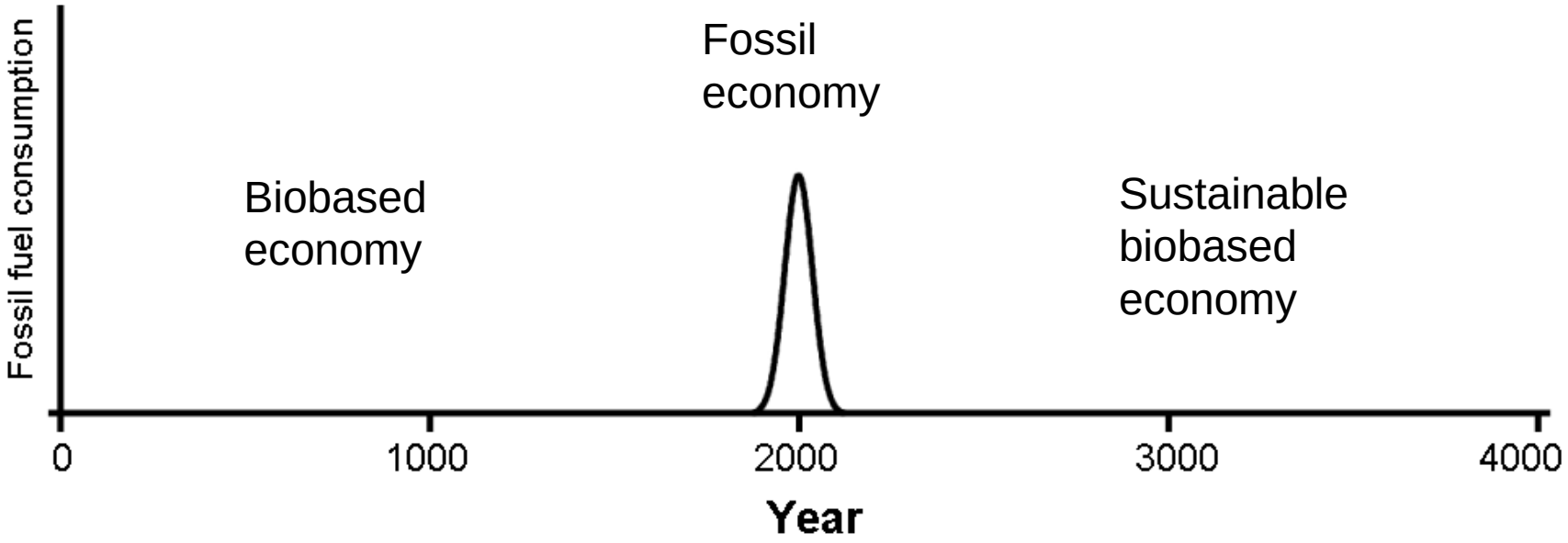
Dr. Trine Eggen, Dr. Roar Linjordet, Dr. Ove Bergersen

Norwegian Institute of Bioeconomy, NIBIO

Department Bioresources and Recycling Technology

ICCE 2017 18-22.06.2017

Transitions to bioeconomy – some lessons to learn

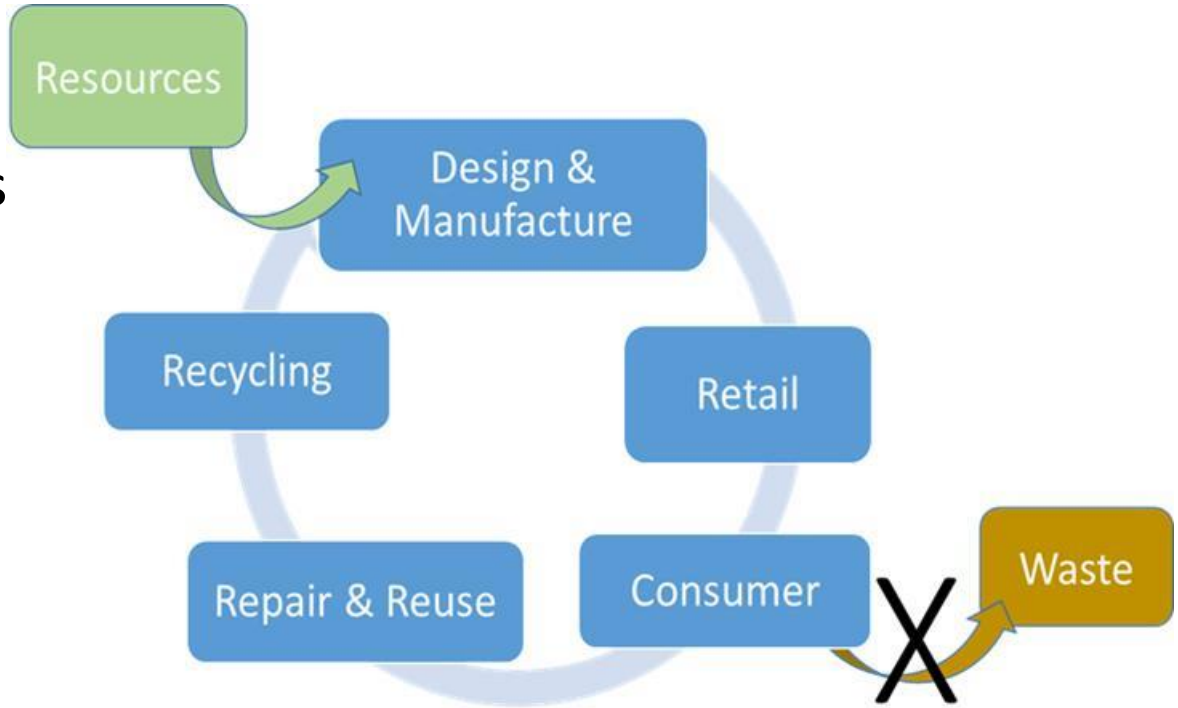


Circular economy

The value of products and materials is maintained for as long as possible

Waste and resource use are minimised.

Long-lasting design, maintenance, repair, reuse, remanufacturing and recycling

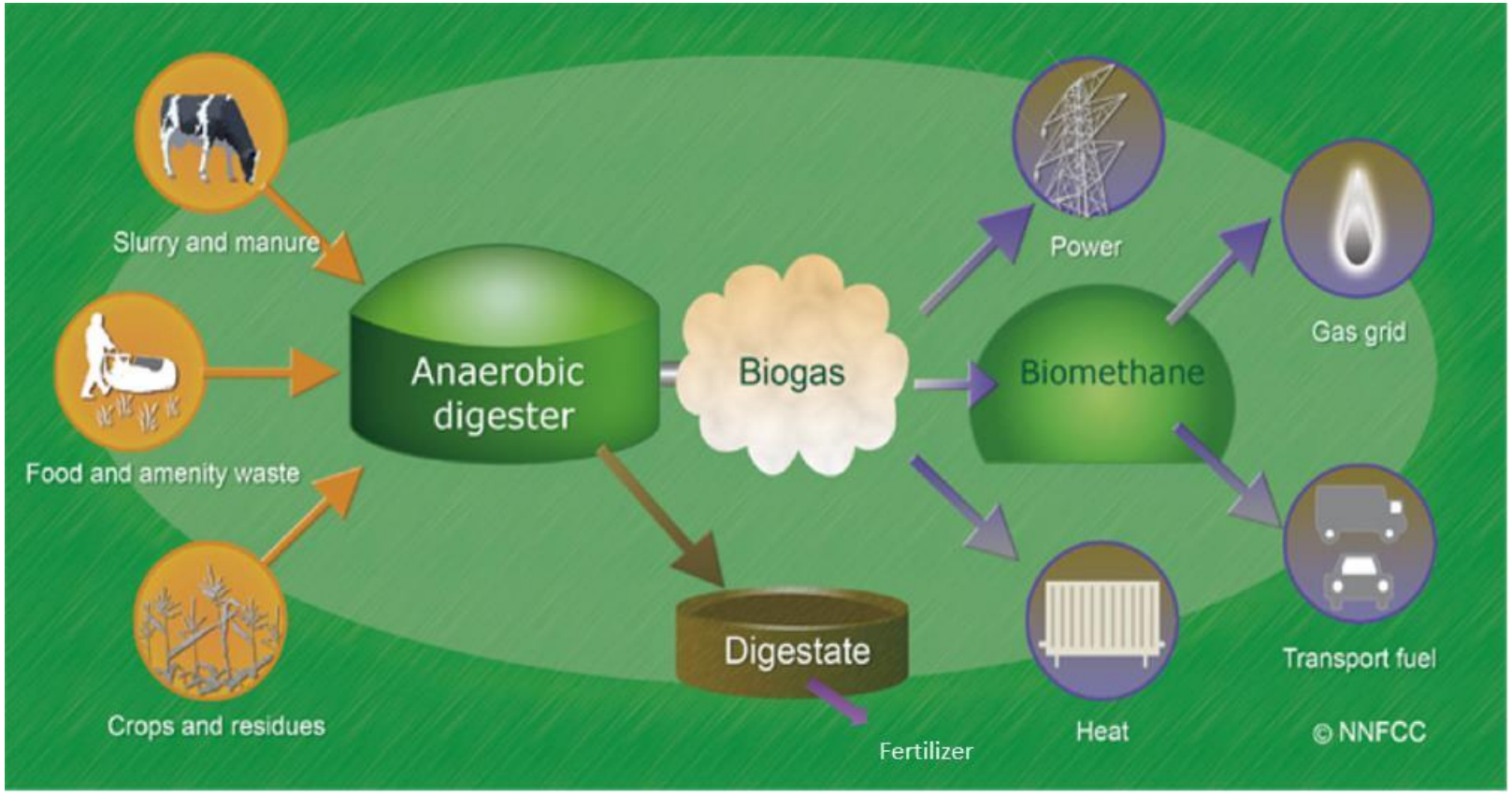


Circular economy

- Sustainable in terms of
  - energy production
  - transport solution
  - material/product production (Green chemistry and design of chemical products and processes to reduce/eliminate generation of hazardous substances)
  - water management
- Conserve/protect the environment and resources

Circulating Bioresources

– energy & new products



Recycling of Bioresources

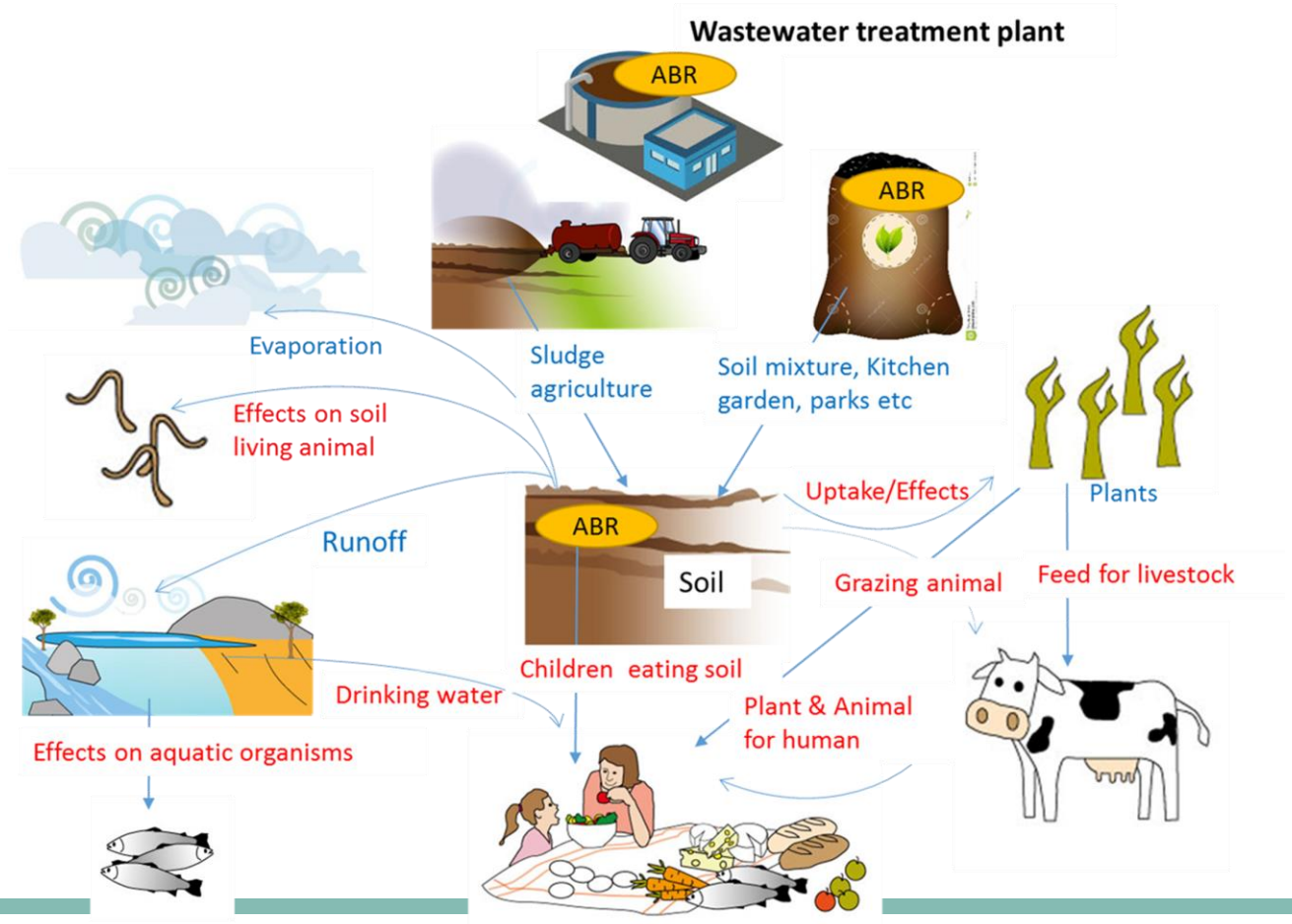
- Recovery of nutrients - production of soil improvers/fertilizers – composting
  - Recovery nutrients
  - Prevent losses to water bodies $\Rightarrow$ eutrophication
- Reduce climate gas emission
- Awareness regarding application of bioresources
  - hazardous substances
  - pathogenic microorganisms
  - microbial antibiotic resistance

$\Rightarrow$ disseminated to environment

$\Rightarrow$ be exposed towards humans or livestock

Resource management

Environmental and human health risk assessment



Resource management & safety

Risk a

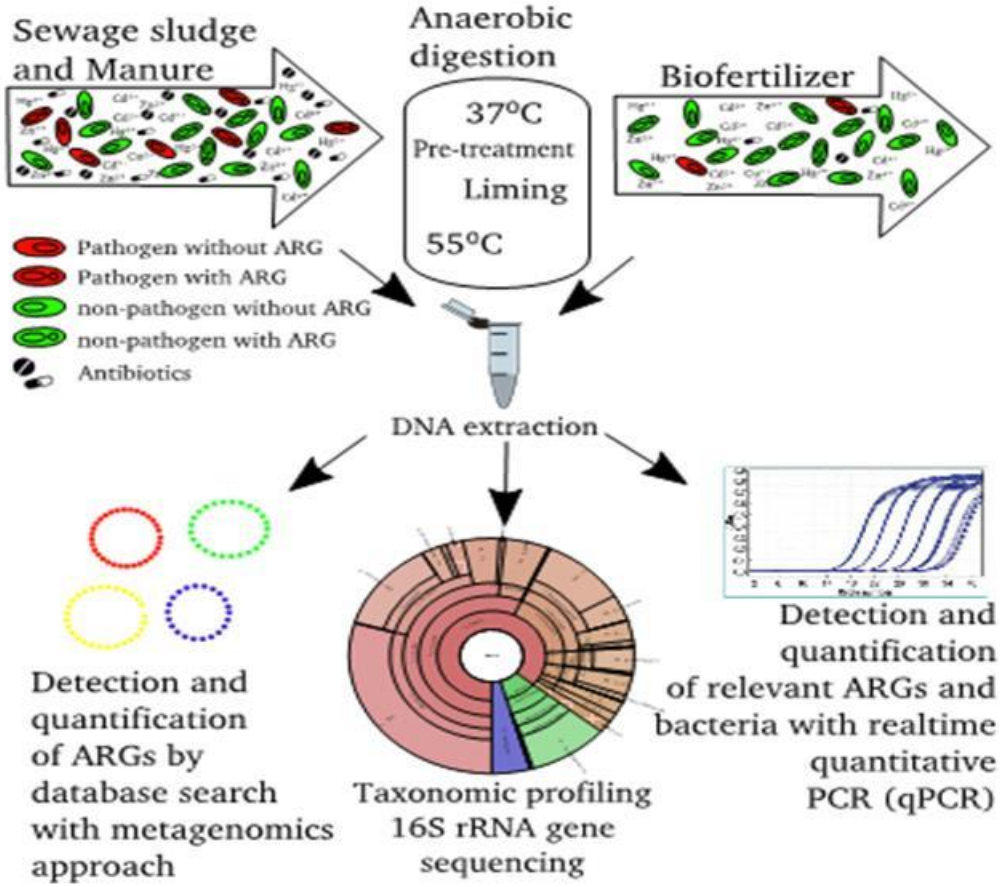
Risk assessment of bioresources

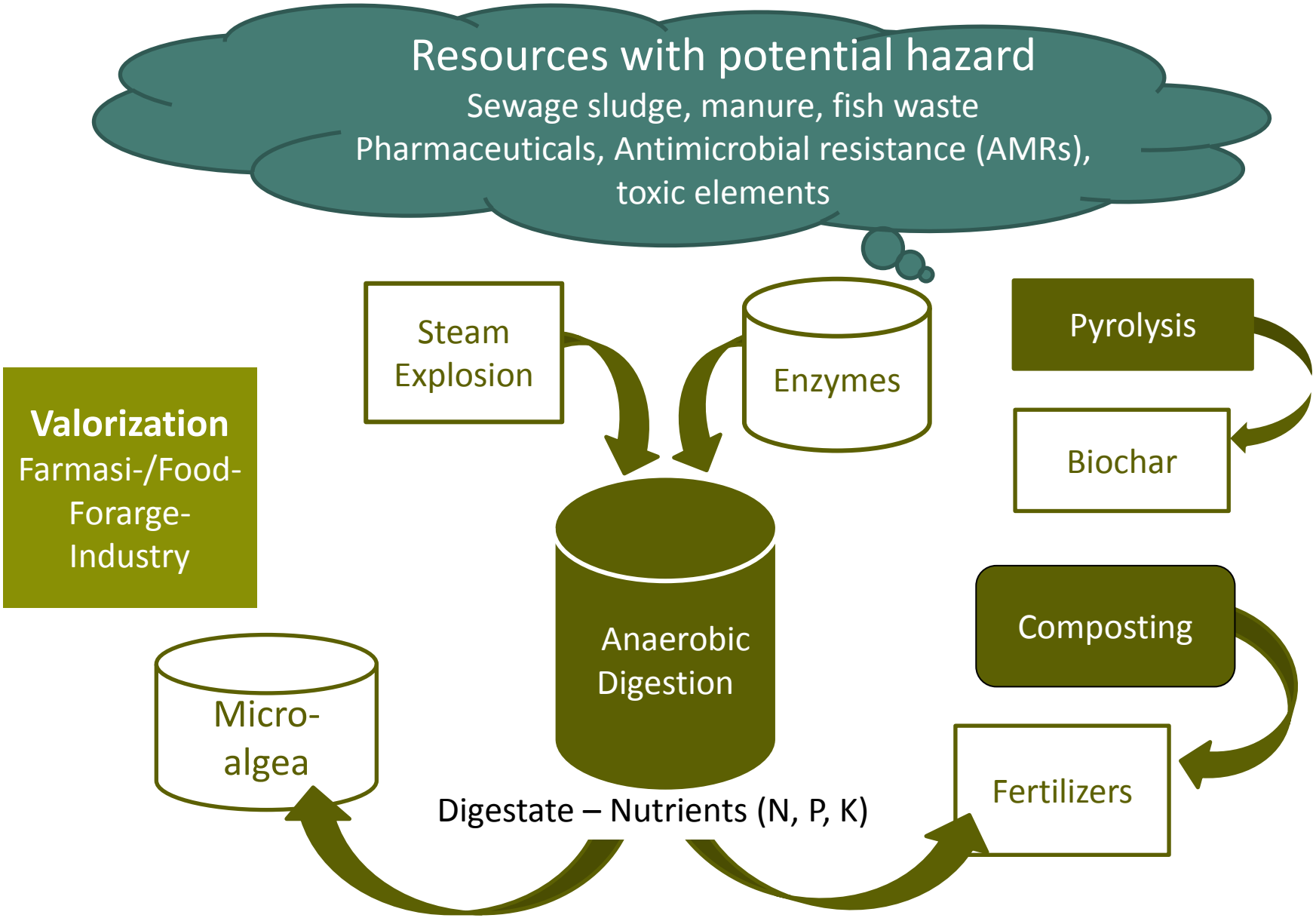
- Performed
  - Heavy metals (Cd, Pb, Hg, Ni, Zn, Cu, Cr)
  - Selected organic compounds (phthalates, Octyl/nonylphenols, alkylbenzenesulfonate, PCBs, PAHs)
- Not performed for many legacy and emerging pollutants due to knowledge gap
    - Present concentration in bioresources and background
    - Fate kinetics in the environment
    - Transfer to food & forage
    - Exposure concentration
    - Toxicity / Cocktail effects
    - Endpoints such as predicted no effect concentration (PNECs), tolerable daily intake (TDl) etc

Antimicrobial resistance (AMR)

- According to WHO, antimicrobial resistance is an increasingly serious threat to global public health that requires action across all government sectors and society.
- Sewage sludge contains antimicrobials, antimicrobial-resistant bacteria and antimicrobial resistance genes, which can be released into the environment through its land application. This contributes to further development and dissemination of antimicrobial resistance.
- Risk assessment of antimicrobial resistance for the human and environmental health, and ecosystem service is needed.

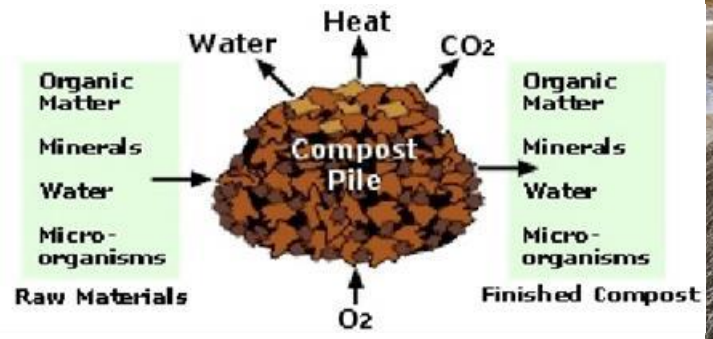
Screening on ARGs in sludge before and after Anaeobic digestion

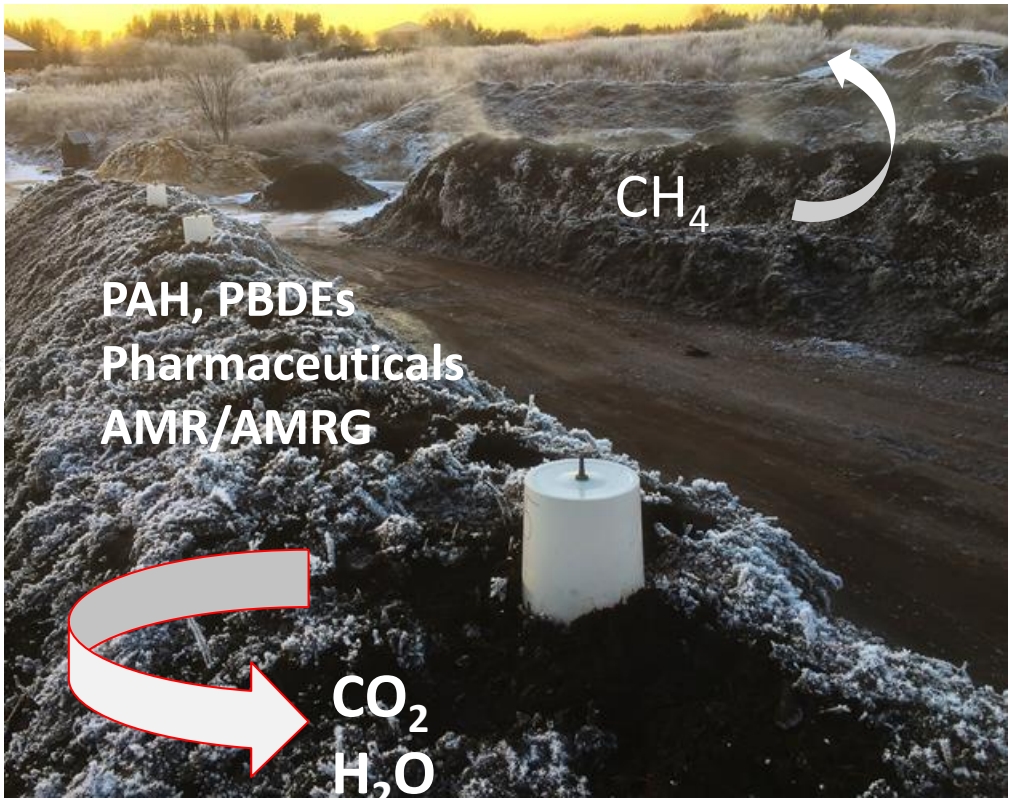



Resources with potential hazard
Sewage sludge, manure, fish waste
Pharmaceuticals, Antimicrobial resistance (AMRs),
toxic elements
Steam Explosion
Enzymes
Pyrolysis
Biochar
Valorization
Farmasi-/Food-
Forarge-
Industry
Anaerobic Digestion
Composting
Micro-algea
Fertilizers
Digestate – Nutrients (N, P, K)

Technologies for recycling bioresources

Composting



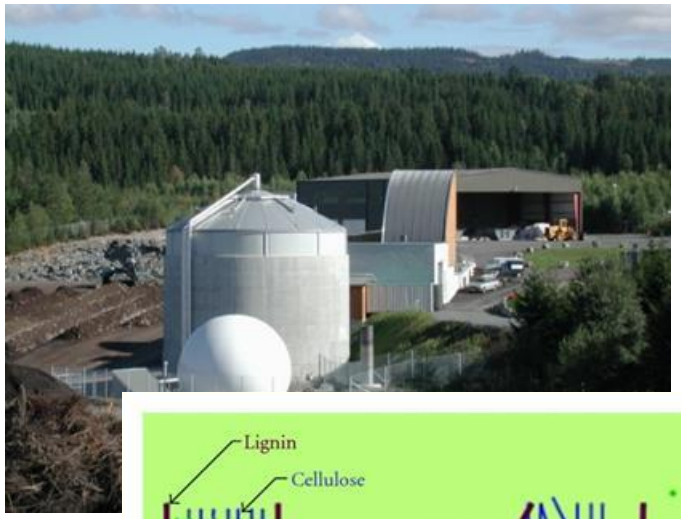


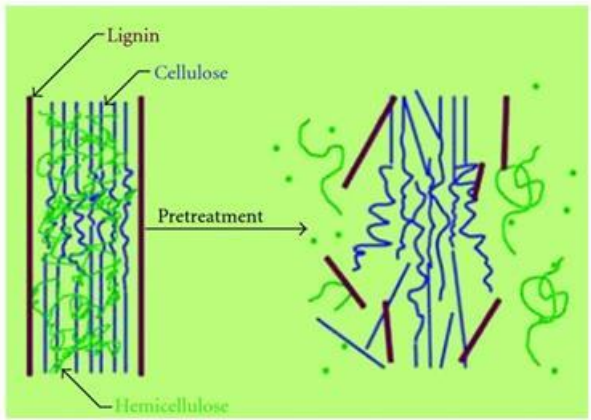
Technologies for recycling bioresources

Anaerobic Digestion

Degradation of organic pollutants

Recovery of N, P, K – other elements





Destruction of antimicrobial resistant organisms or genes

Message to take home

- Circular Economy is the future
- Sustainable Circular Economy is a must
- More attention to the potential problems is needed in order to:
  - Close knowledge gaps
  - Optimize the recycling technologies to ensure safe products from recycled bioresources
- The environmental scientist ……

- Thank you for your attention