

Member Country Summary: Norway

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SINTEF Energy Research

IEA Task 33 meeting

Denver

Gasification in Norway

- Still no economic advantages or incentives for biomass gasification in Norway:
 - Fundamental research at Universities
 - Applied research
 - No large scale gasification facilities
- Small scale waste-to-energy applications
- Some interested larger companies :
 - Statkraft
 - Akershus Energi
 - Avinor

Small scale applications

- In Norway both the people and the biomass are spread
- The distances are large, hence high transportation costs



- Small scale applications

Energos: Development History



Developed in Norway during the 1990's. The design remit was to deliver:

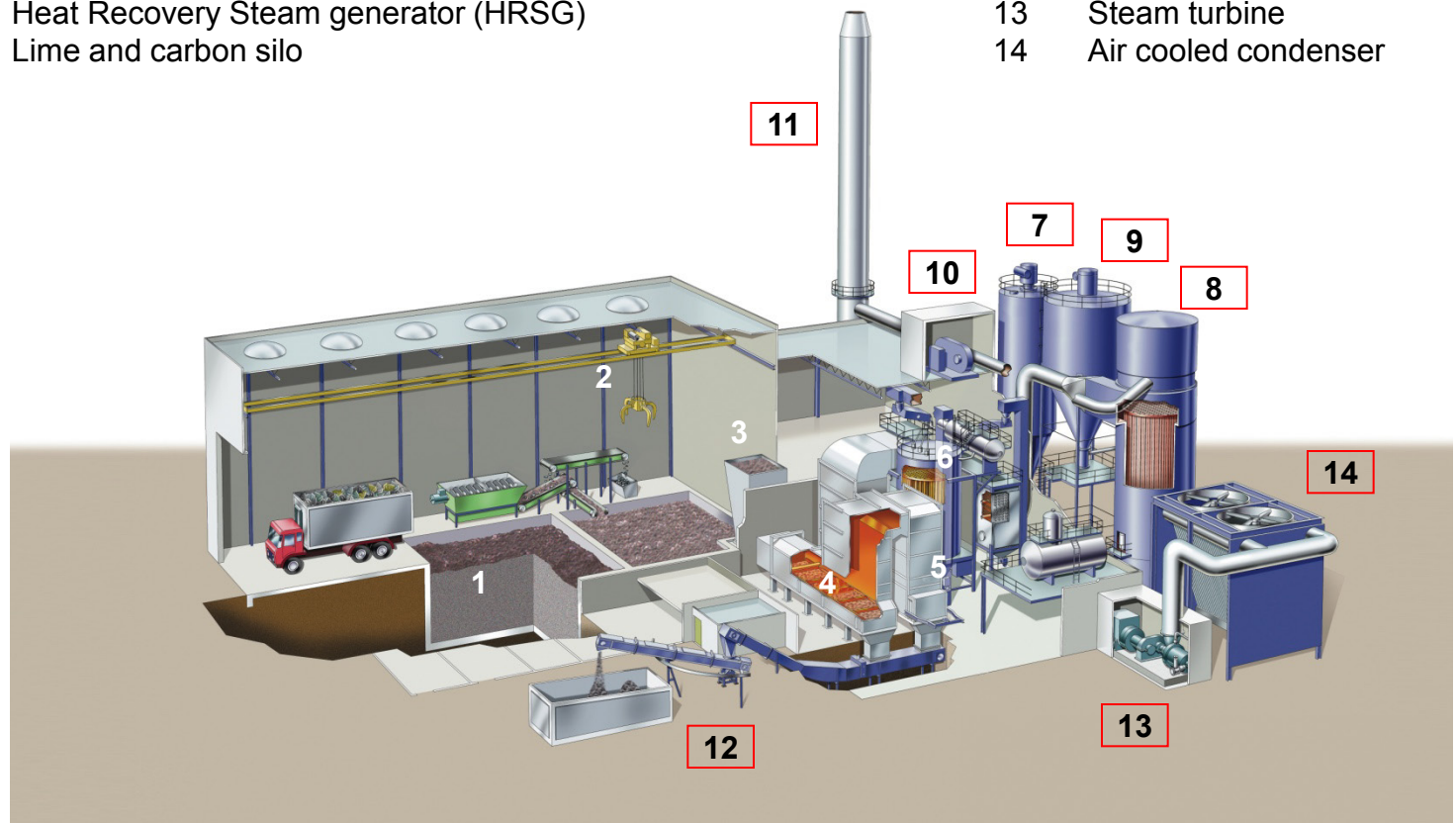
- A small-scale energy from waste plant which could provide;
- Communities with a cost effective alternative to mass-burn incineration with
- Minimal emissions to atmosphere
- High flexibility in handling different waste types and CVs

The result was:

- A two-stage thermal process which enabled extremely good combustion control, eliminating the need for complicated and expensive flue gas treatments

ENERGOS Energy From Waste Plant

- | | | | |
|---|--|----|-----------------------|
| 1 | Fuel bunker | 8 | Bag house filter |
| 2 | Fuel crane | 9 | Filter residue silo |
| 3 | Hopper | 10 | Flue gas fan |
| 4 | Primary chamber (Gasification) | 11 | Chimney |
| 5 | Secondary chamber (High temperature oxidation) | 12 | Bottom ash extraction |
| 6 | Heat Recovery Steam generator (HRSG) | 13 | Steam turbine |
| 7 | Lime and carbon silo | 14 | Air cooled condenser |



Operational Energos plants



Ranheim Plant
 Location: Norway
 Commissioned: 1997
 Fuel capacity: 10,000 tonnes/year
 Energy production:
 25 GWh (thermal)/year



Forus Plant
 Location: Norway
 Commissioned: 2002
 Fuel capacity: 39,000 tonnes/year
 Energy production: CHP
 105 GWh (thermal)/year



Hurum Plant
 Location: Norway
 Commissioned: 2001
 Fuel capacity: 39,000 tonnes/year
 Energy production:
 105 GWh (thermal)/year



Isle of Wight Plant
 Location: United Kingdom
 Commissioned: January 2009
 Fuel capacity: 30,000 tonnes/year
 Energy production:
 (electrical) 1.8MW



Averøy Plant
 Location: Norway
 Commissioned: 2000
 Fuel capacity: 30,000 tonnes/year
 Energy production: CHP
 69 GWh (thermal)/year



Sarpsborg1 Plant
 Location: Norway
 Commissioned: 2002
 Fuel capacity: 78,000 tonnes/year
 Energy production:
 210 GWh (thermal)/year

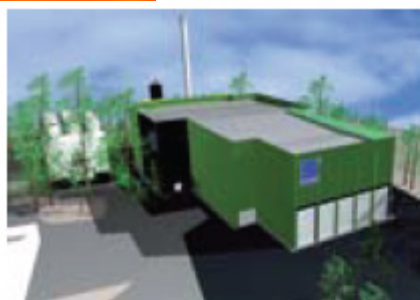


Minden Plant
 Location: Germany
 Commissioned: 2001
 Fuel capacity: 39,000 tonnes/year
 Energy production:
 105 GWh (thermal)/year



Sarpsborg 2 Plant
 Location: Norway
 Commissioned 2010
 Fuel capacity: 78,000 tonnes/year
 Energy production:
 256 GWh (thermal)/year

Energos plants under development



Irvine Plant

Fuel capacity: 78,000 tonnes/year



Newport Plant

Fuel capacity: 120,000 tonnes/year



Barry Plant

Fuel capacity: 80,000 tonnes/year



Knowsley Plant

Fuel capacity: 78,000 tonnes/year



Doncaster Plant

Fuel capacity: 120,000 tonnes/year

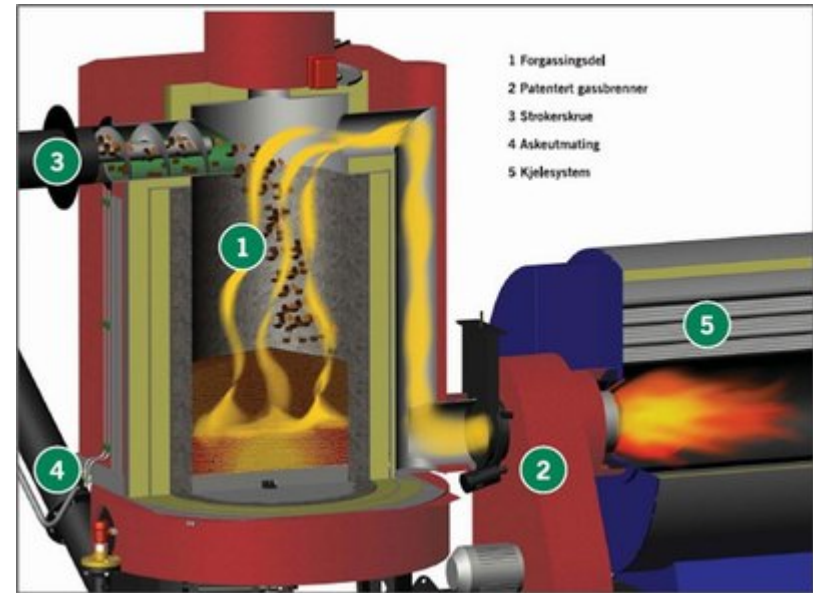


Bradford Plant

Fuel capacity: 160,000 tonnes/year

Agder Biocom

- Plant size: 0.5 MW to 5 MW
- Product: heat
- The technology is based on a two-chamber gasification incinerator with a patented gassburner.
- The result is almost no emissions.
- Features effect regulation, low maintenance costs and a very compact size.



Source: www.agderbiocom.no

Research projects

STOP – STable OPerating conditions for biomass combustion plants

- The main objectives in STOP:

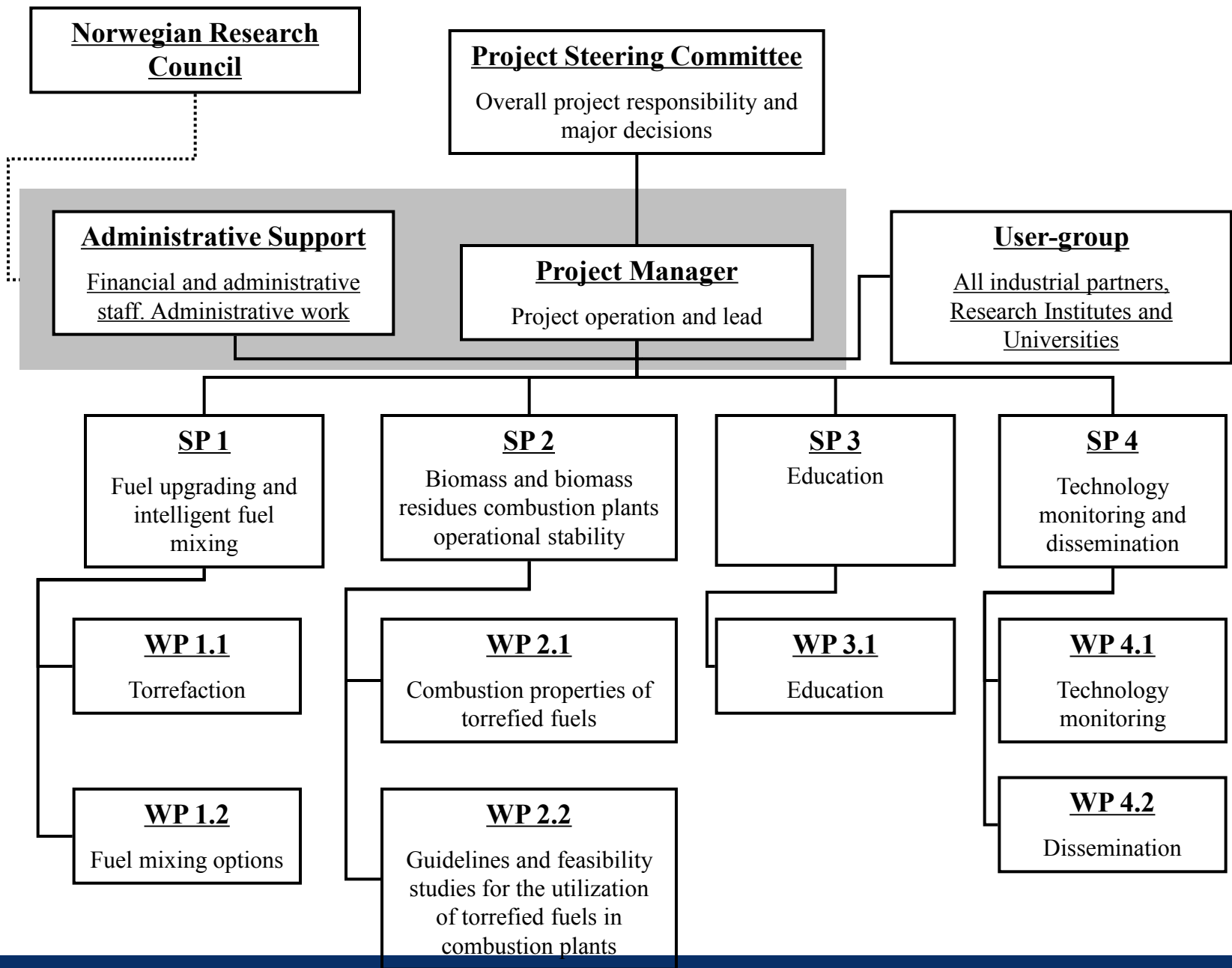
Development of new strategies for improved operating conditions control in biomass and biomass residues combustion plants through:

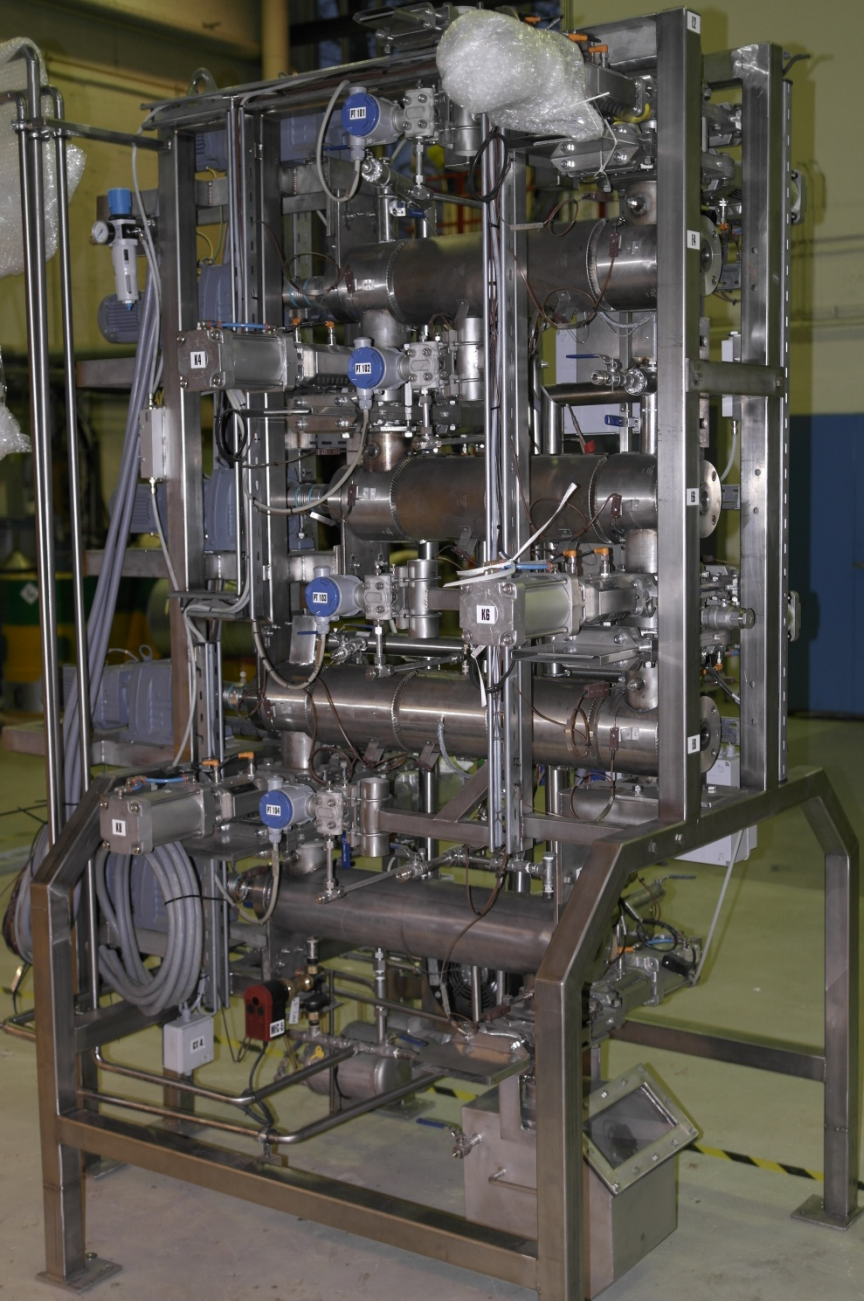
- The utilization of more homogenous fuel with minimized season variation
- Optimized fuel in terms of pollutant emissions
- Improved fuel quality through torrefaction

Project overview – key data

- STOP – STable OPerating conditions for biomass combustion plants
- **Project type:** KMB (Competance building project)
- **Budget:**
 - Norwegian Research Council: 475 kEuro/a
 - Industry: 70 kEuro/a

Total: 545 kEuro/a
- **Duration:** 4 years





Torrefaction reactor

Characteristics

Feed type	Woodchips, sawdust, straw, pellets, ...
Capacity	0.2 – 7 kg/h
Temperature	200 – 300 °C
Fuel size	1 – 25 mm
Bulk density	100 – 600 kg/m ³

Main Components

- Bin for raw material
- Feeding screw
- Drying conveyor
- Heating conveyor
- Torrefaction conveyor
- Cooling conveyor
- Sliding feeder between conveyors

Project overview – key data

- **New project within thermochemical biofuel production (GasBio)**
- **Project type:** KMB (Competance building project)
- **Budget:**
 - Norwegian Research Council: 675 kEuro/a
 - Industry: 175 kEuro/a
- **Total: 850 kEuro/a**
- **Duration: 4 years**

GasBio
Board and
Project
Management

SP1:
Fuel supply and
fuel knowledge

WP1.1
Biomass
supply

WP1.2
Biomass
pre-treatment

SP2:
Gasification
Technology,
Design and
operation

WP 2.1
Fluidised
Gasification
technology

WP 2.2
Entrained
flow
technology

WP 2.3
Heat recovery

WP 2.4
Product gas
conditioning

SP3:
Laboratory
Experiments and
Modeling for
scale-up

WP 3.1
Fluid bed
experiments

WP 3.2
Entrained flow
experiments

WP 3.3
CFD modeling and
Gasifier Scale-up

SP4:
Gasification
plant analysis and
synthesis

WP 3.1
Gasification
process
integration

WP 3.2
Plant scale-up and
cost-efficiency
analysis

WP 3.3
Plant
feasibility study
(Technology **and**
Economy)

SP5:
Education and
Training

WP 5.1
PhD and MSc
education

WP 5.2
Industrial
seminars and
workshops

SP6:
Technology
monitoring and
dissemination

WP 6.1
IEA and
International
projects

WP 6.2
Nordic
Gasification
Network

WP 6.3
Website,
newsletter and
publishing

Gasification for Biofuels (GASBIO)

- Main objectives:
 - To develop Norwegian competence in the Biofuels area.
 - Emphasis on large-scale production of suitable qualities of synthesis gas
 - To contribute to the reduction of Biofuels production costs.
 - Innovations in gasification processes
 - Focus on low-value biomass fractions
- WHY?
 - Norway has large unused biomass resources.
 - EU legislation mandates substantial increase in the use of biofuels.
 - Biofuels need intensive research to become competitive to fossil fuels on a larger scale

Thank you for your attention