

BIOENERGY INNOVATION CENTRE

CenBio

www.cenbio.no

INFORMATION EXCHANGE EVENT
JRC-NORWAY
CIENS, Oslo, 2010-06-18

Øyvind Skreiberg
Centre SP3 leader
on behalf of centre leader Lars Sørum

Bioenergy – The biggest contributor of renewable energy in the world today!

► The world:

- More than 3/4 of all renewable energy is bioenergy
- The second largest renewable power producer (after hydropower)
- 25-33% of the primary energy supply can come from sustainable bioenergy in 2050



► The European Union:

- Contributes with 2/3 of today's renewable energy production
- Bioenergy in the 20-20-20 target: 70%



► Norway:

- 14 TWh bioenergy in 2009 (mainly heat)
- Potential: 45 TWh
- Target 2020: Doubling to 28 TWh!



Why is R&D on bioenergy important?

- ▶ Inefficient heat production is dominating bioenergy today
- ▶ Need for "new" bioenergy
 - Efficient power production
 - Biofuels (liquids)
 - Biogas
 - Clean heat production
 - Sustainable forestry

BioPower



Biofuels



Biogas



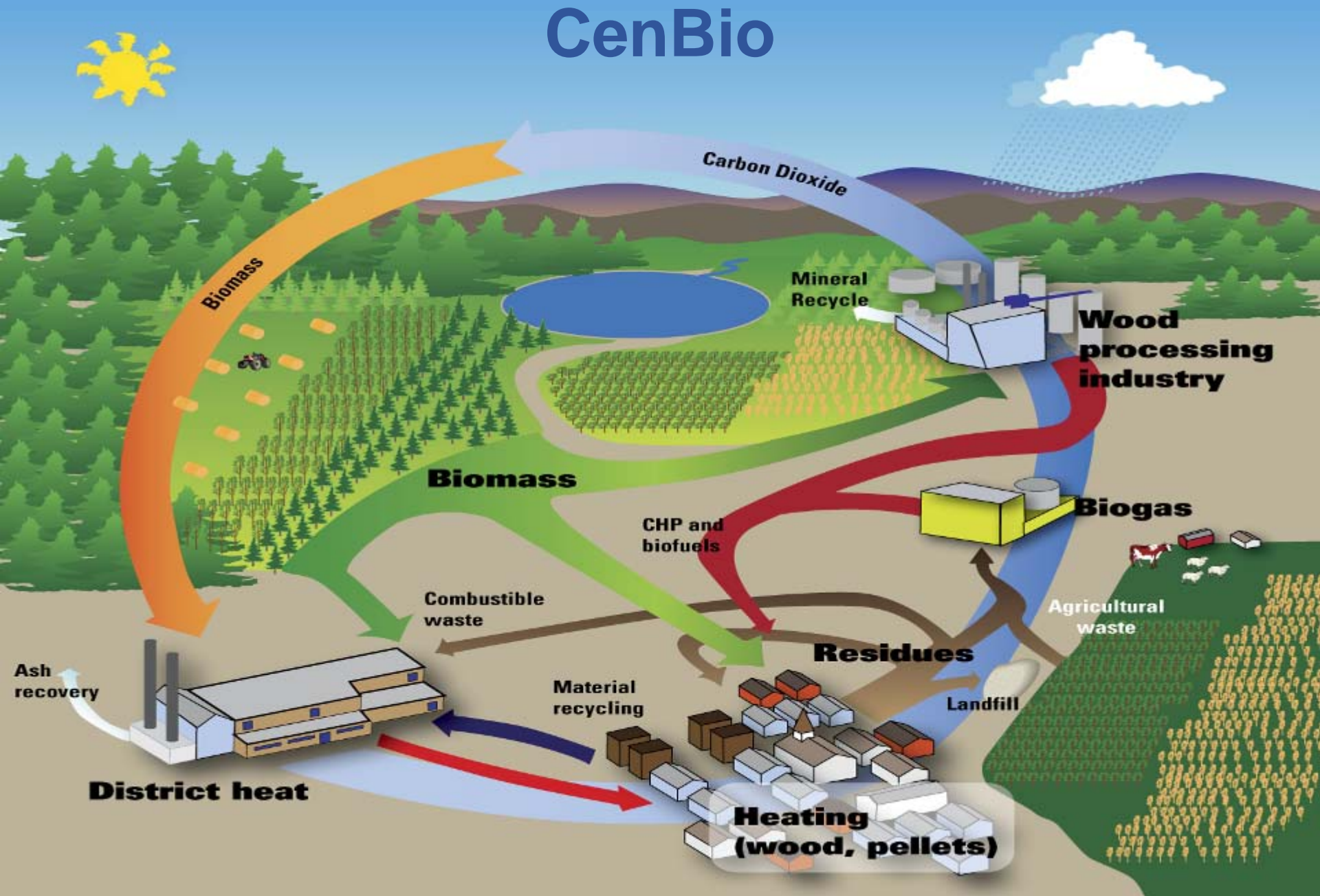
Point heat sources



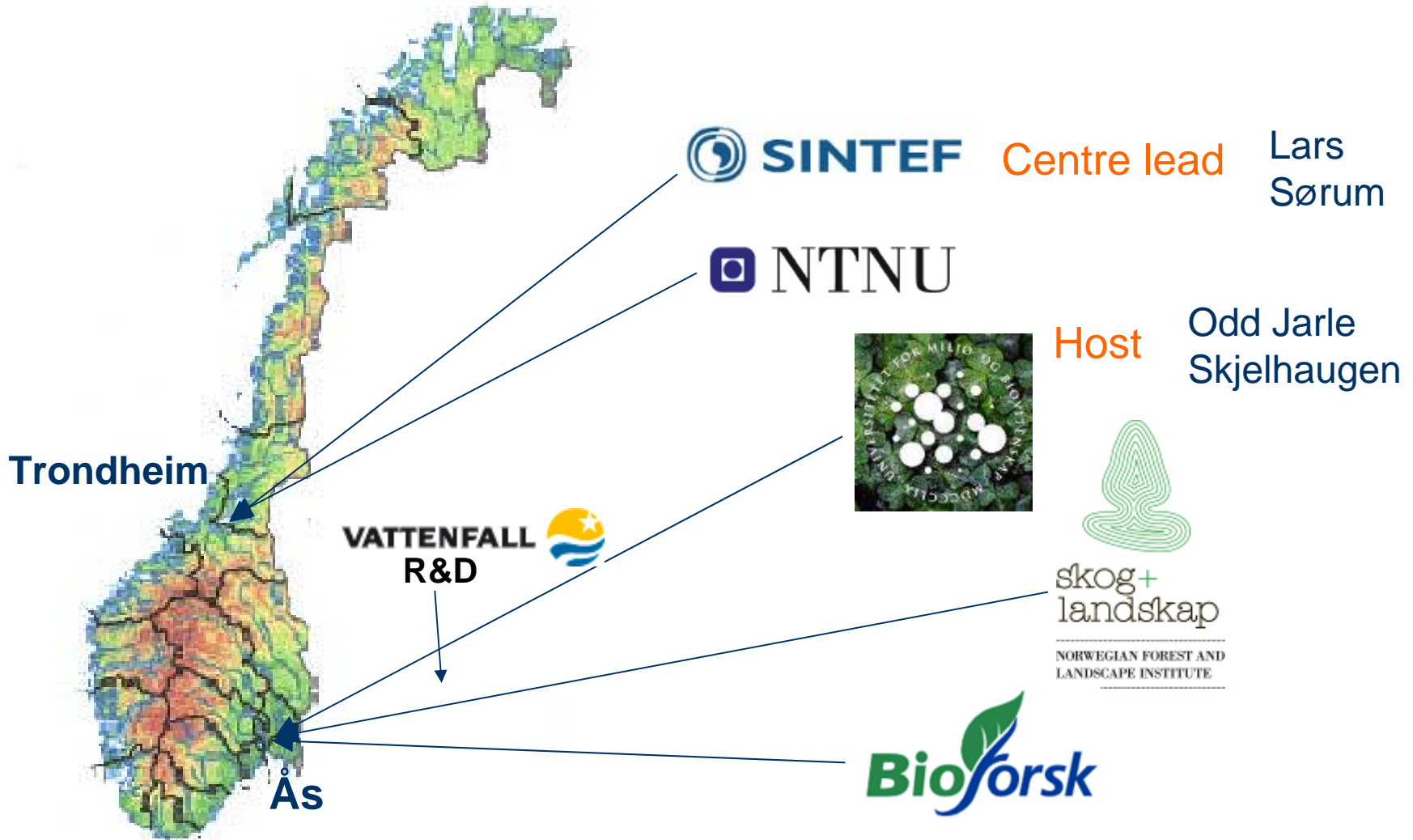
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R&D partners in CenBio



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Industry partners

Bioresources

- Avfall Norge (Waste Management Norway)
- Norges skogeierforbund (Norwegian Forest Owners' Association)
- Norges bondelag (Norwegian Farmers Association)

Technology

- Cambi (biogas reactors)
- Energos (staged combustion technology)
- Jøtul (wood stoves)
- BioNordic (pellet stoves)
- Granit Kleber (heat storing stoves)

Other

- Norsk protein (protein recovery)

Energy producers

- Afval Energie Bedrijf (NL)
- Agder Energi
- Akershus Energi
- EGE Oslo
- Hafslund
- Trondheim Energi / Statkraft
- Nord-Trøndelag Energi
- Norske Skog
- Xynergo
- Vattenfall Nordic Heat (S)

International cooperation

- ▶ University of Minnesota (USA)
- ▶ Stanford University (USA)
- ▶ US Forest Service (USA)
- ▶ Finnish Forest Research Institute (FIN)
- ▶ Chalmers University of Technology (S)
- ▶ Åbo Akademi University (FIN)
- ▶ Technical University of Denmark (DK)
- ▶ University of Copenhagen (DK)
- ▶ Vienna University of Technology (A)
- ▶ Technical University Bergakademie Freiberg (D)

CenBio's success criteria

- ▶ 150 international publications, of which 75 in high ranked journals
- ▶ 20 PhD and PostDoc students
- ▶ 50 Master students
- ▶ 25 innovations

- ▶ CenBio will also encourage the establishment of new companies
- ▶ CenBio partners will initiate new projects

Overall objectives

*To develop the basis for a sustainable, cost-effective bioenergy industry in Norway in order to **double the bioenergy use by 2020***

► CenBio focus on **stationary bioenergy** (Heat and Power)

► Action 1. Production of, and accessibility to, **biomass** for energy purposes will have to be increased substantially.

► Action 2. Great improvements must be made in the **efficiency** of biomass production, energy conversion and applications of bioenergy.

► **Requirement 1. By-products** need to be upgraded in order to be ecologically recycled.

► **Requirement 2. Sustainability** must be documented for complete bioenergy value chains to **enable sustainable and cost-efficient bioenergy**

CenBio Vision

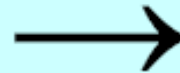
The Norwegian Government Bioenergy Strategy

Target 2020: Doubling from 14 to **28** TWh!

CenBio Vision 2020

TWh - Today:

	Input	Efficiency	Output
Wood / pellet stoves	7	0,6	4,2
District heat	2,7	0,85	2,3
Wood industry	4,4	0,85	3,7
CHP - heat	~ 0	0,6	~ 0
CHP - power	~ 0	0,2	~ 0
Power	~ 0	0,4	~ 0
Biogas	~ 0	0,5	~ 0
SUM	14,1		10,2



Documented overall sustainability

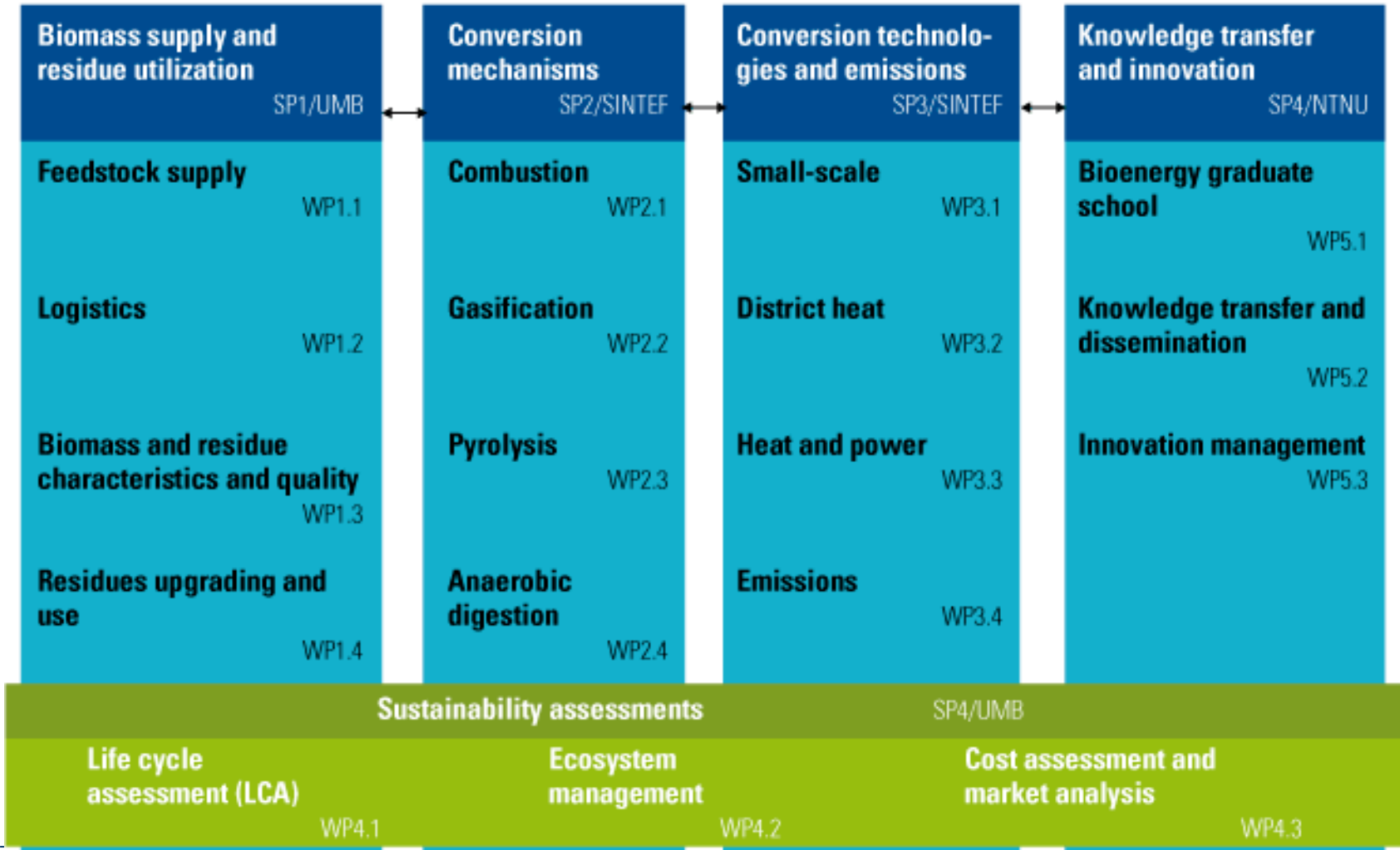
TWh - 2020:

	Input	Efficiency	Output
Wood / pellet stoves	12	0,85	10,2
District heat	6	0,9	5,4
Wood industry	5	0,9	4,5
CHP - heat	4	0,65	2,6
CHP - power	~ 0	0,3	~ 0
Power	1	0,5	0,5
Biogas	2	0,7	1,4
SUM	30		25,8

Wood / pellet stoves
District heat
Wood industry
CHP - heat
CHP - power
Power
Biogas
SUM

Work breakdown structure in CenBio

CenBio management and co-ordination - Lead: SINTEF



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SP3 objectives

Objective: To demonstrate that all the energy conversion efficiencies listed in the CenBio Vision 2020 are practically and economically feasible, as well as environmentally benign.

- In the Small-scale (stove) segment (WP 3.1) energy efficiencies of 0.85 will be demonstrated for selected fuel fractions, not as peak efficiencies, but as average efficiencies including cold-starts.
- In the District Heat segment (WP 3.2), efficiencies of 0.9 will be demonstrated (here the losses in heat distribution are excluded, since heat distribution falls outside the CenBio scope of work).
- In the Heat and Power segment (WP 3.3) the feasibility of efficiencies of 0.95 will be demonstrated for the combined production of heat and power.
- In the final Emissions work package (WP 3.4) it will be demonstrated how emissions from plants converting biomass to energy may be reduced to below the half of present regulations.

SP3 innovations

Innovations from this subproject are initially expected in the following areas:

- New efficient clean-burning stoves and fireplaces
- Concepts for ultra-efficient district heating plants, possibly utilizing biogas and solid waste in synergetic combination
- Concepts for heat and power plants with close to 100 % combined energy efficiency
- New recipes for low-emission plants

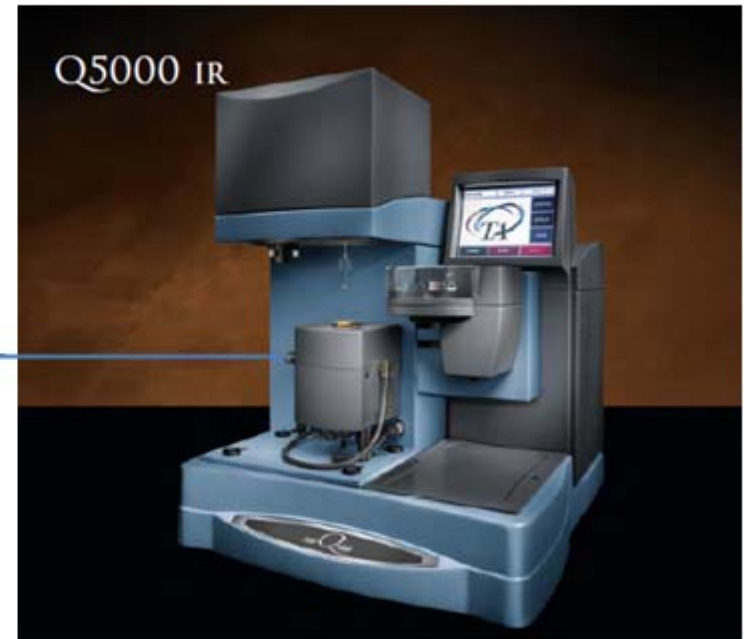
SP4 objectives

- A systematic effort by Norwegian industry to approach bioenergy production has to rely on documented sustainability.
- Very few analyses exist on this for Norway.
- The recent debate about biofuels has also shown the necessity to analyse the sustainability of biomass and biofuels which are imported to Norway.
- Any new investments in bioenergy production will depend heavily on expectations about the development of future energy prices, public incentives and the price of raw materials.
- In particular raw material from forests will appear in strong competition nationally and internationally with the existing forest industries, and some of these industries may also improve their profitability by including bioenergy as a secondary product.
- Finally, it is important to clarify and integrate the concept of sustainability with particular reference to bioenergy, based on the three pillars for sustainability: **environmental, social and economic factors.**

Tools: Bench-scale reactors for biomass reactivity and yield measurements



1-10 mg samples: small transport effects, high time resolution (seconds)



Variables: heating rate, temperature, reaction gas, fuels and fuel mixtures

Tools: Laboratory reactors for thermochemical conversion studies

Key data:

up to 1100 °C

ID: 195 mm, H: 2 m

$35 + 8 + 2 \cdot 4.5 = 52 \text{ kW}$

up to 1.2 kg fuel/h

up to 260 NI air/min

System overview

Key data:

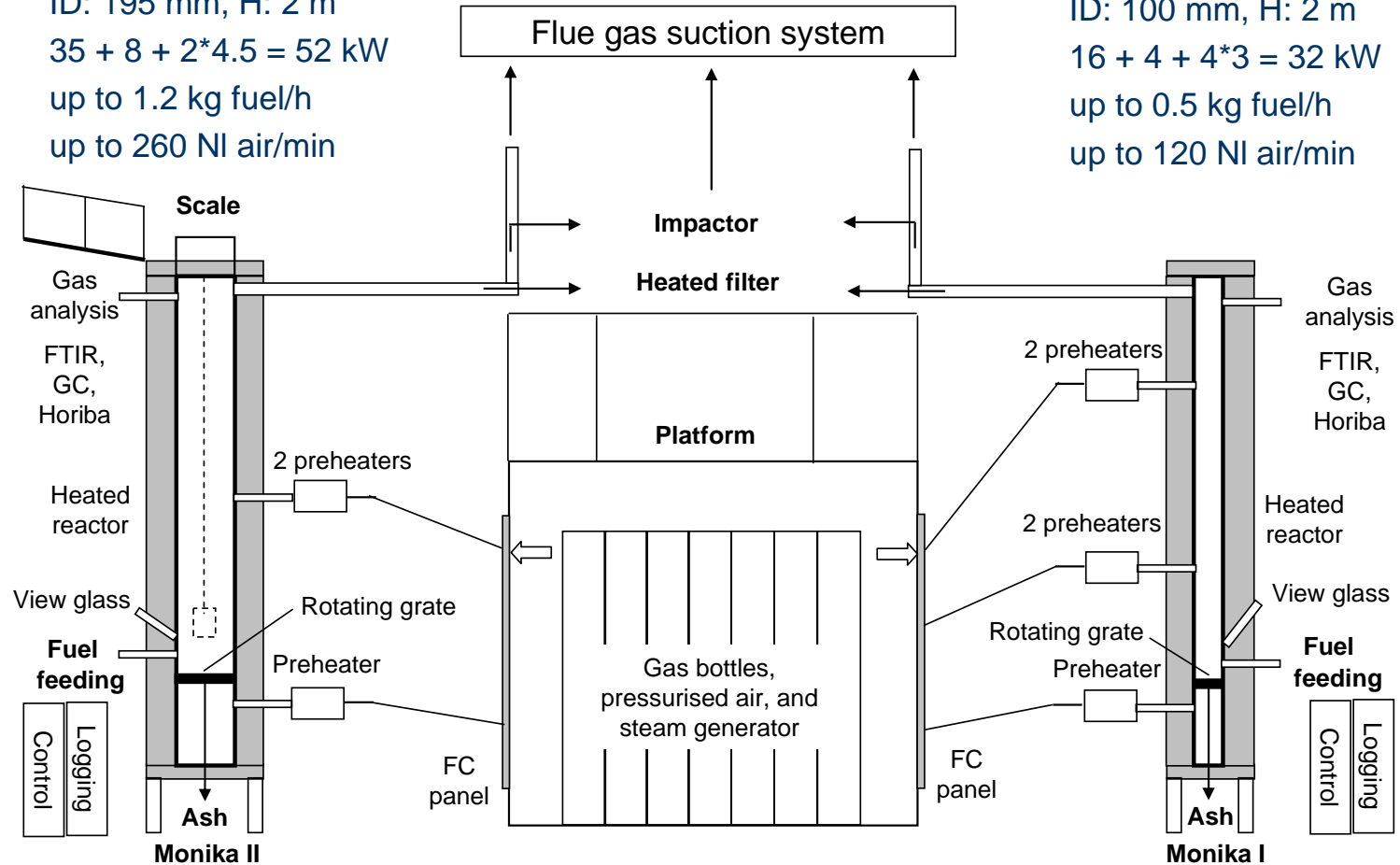
up to 1300 °C

ID: 100 mm, H: 2 m

$16 + 4 + 4 \cdot 3 = 32 \text{ kW}$

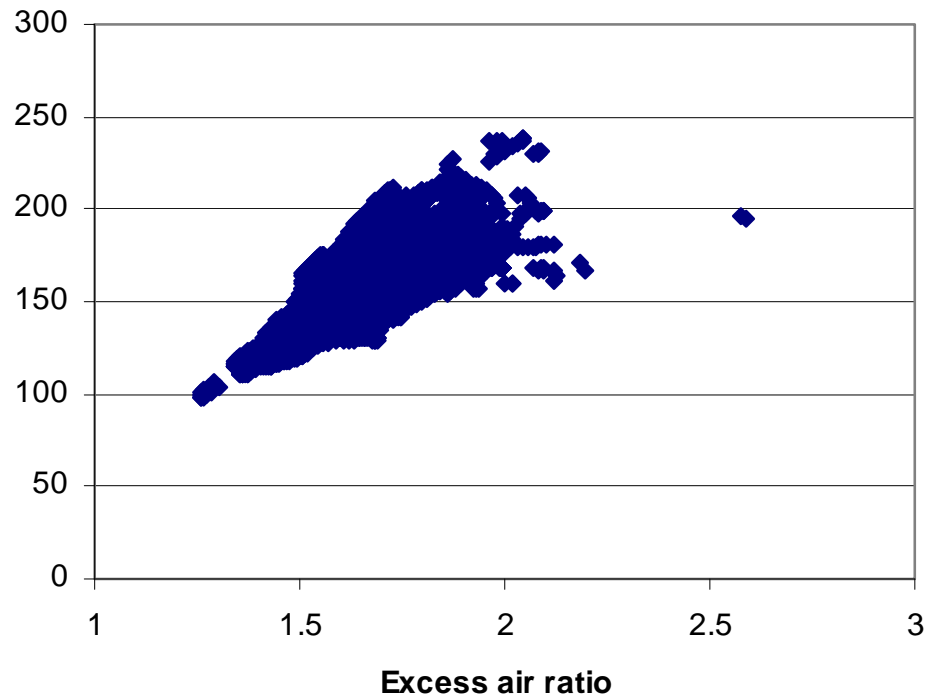
up to 0.5 kg fuel/h

up to 120 NI air/min

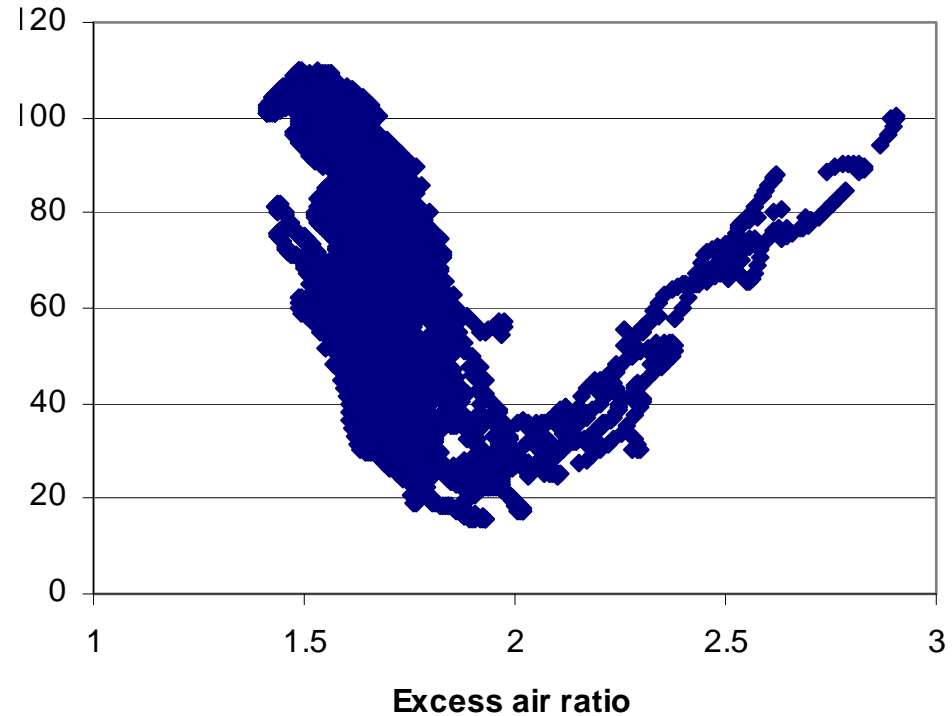


Results - NO_x reduction by primary measures

Non-staged combustion

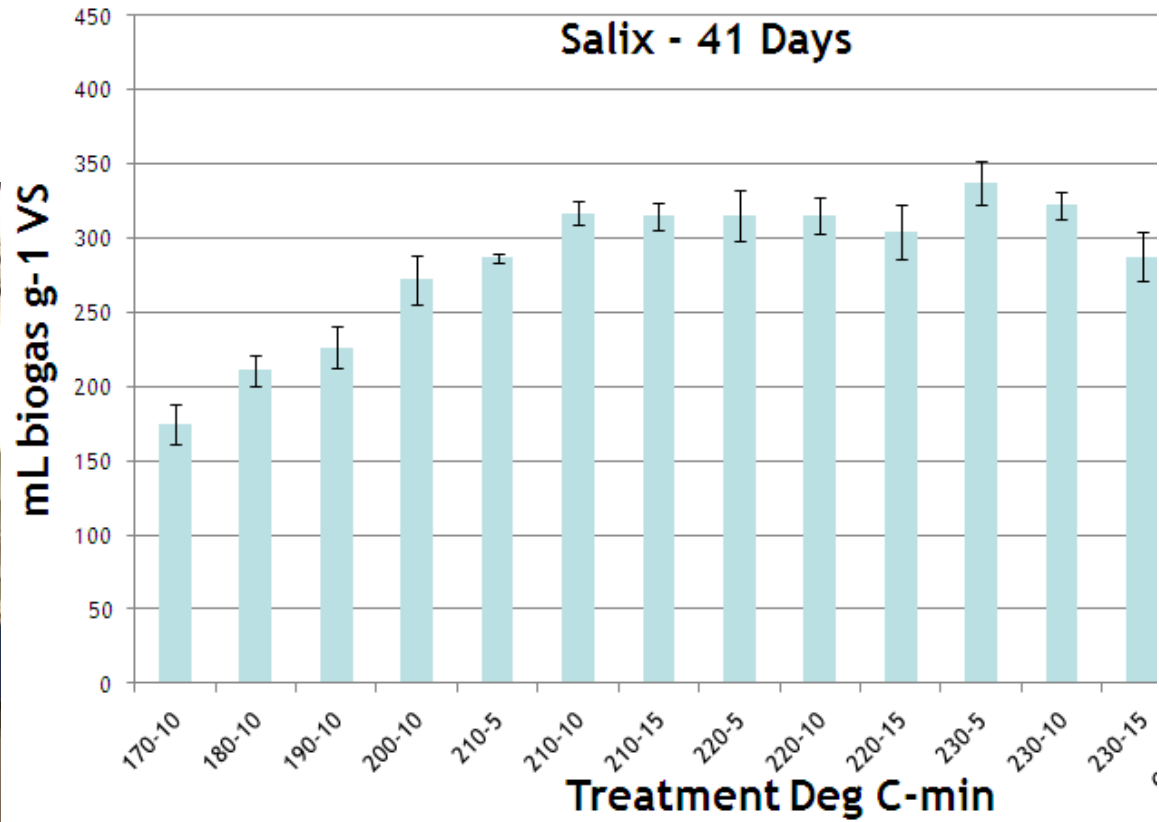


Staged combustion



Results - Anaerobic digestion

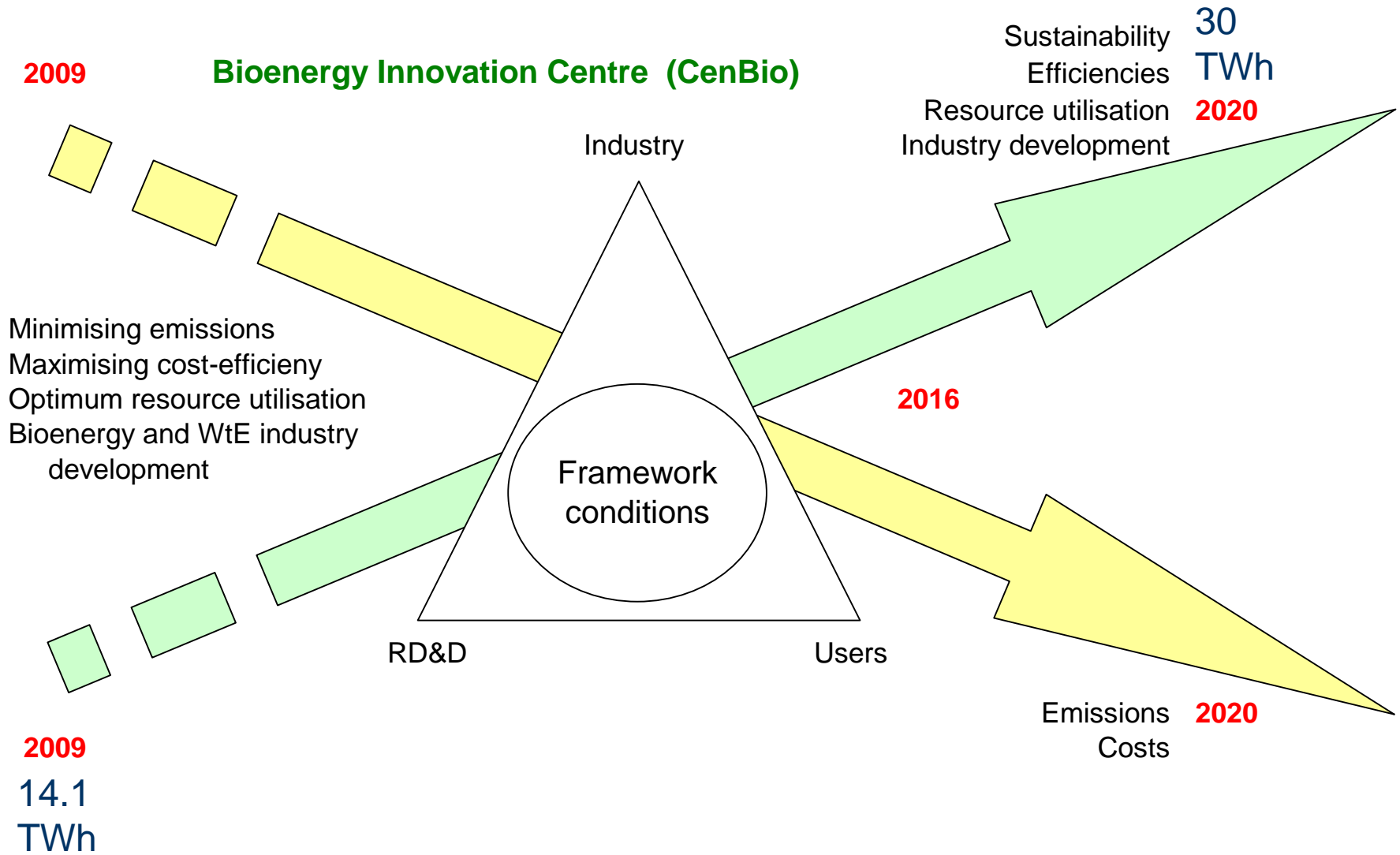
Biomass



Explosion



CenBio summary



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Forskningsrådet

Thank you for your attention!

Acc.V Spot Magn
5.00 kV 3.0 350x

Det WD
SE 9.9

100 μ m