

Transport av komprimert, rå biogass

30.11.2021



Et av de største, uavhengige forskningsinstituttene i Europa



OMSETNING



3,4

mrd NOK

ANSATTE



2000

PROSJEKTER



6800

KUNDER



3400

INTERNASJONALT

470 mill NOK

PUBLIKASJONER (inkl
formidling)

5100

NASJONALITETER

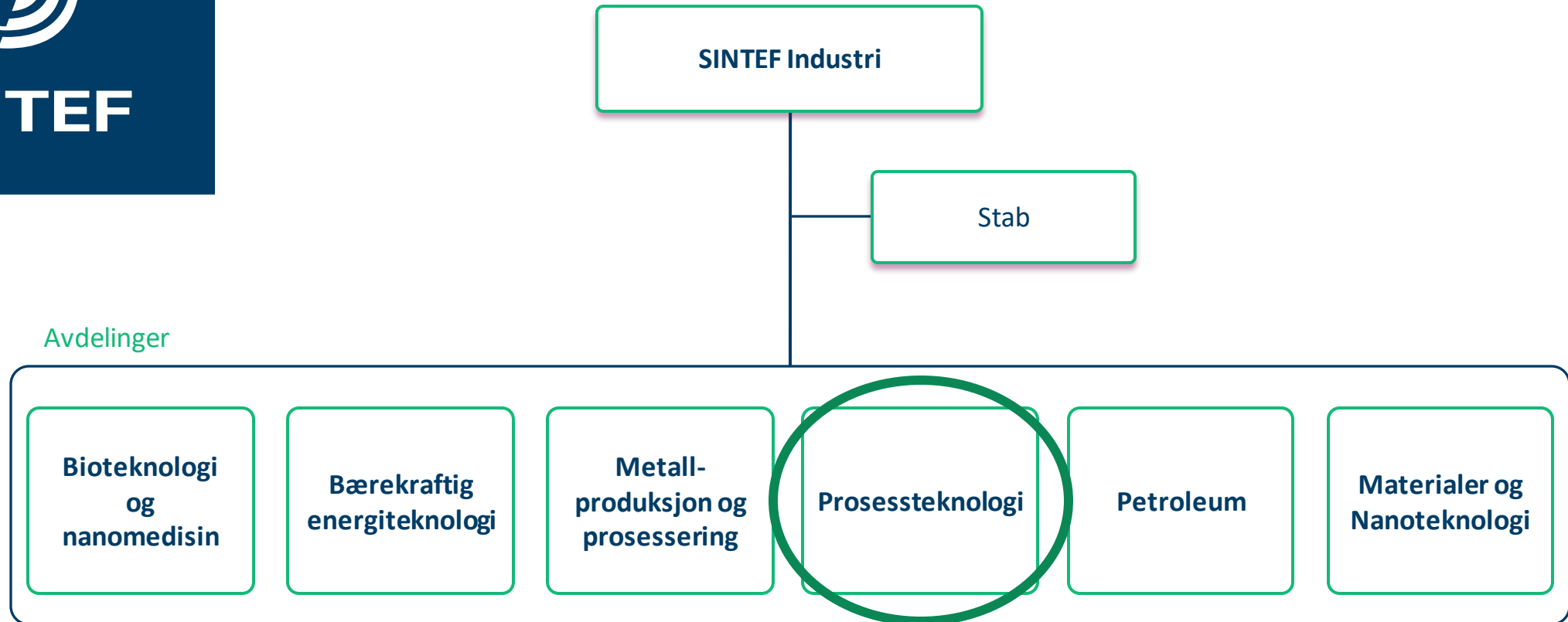
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KUNDETILFREDSHET

4,6 av 5

Teknologi for et bedre samfunn

SINTEF Industri - organisasjon





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SINTEF Industri – organisasjon

**Bioteknologi
og
Nanomedisin**

**Bærekraftig
energiteknologi**

**Metall-
produksjon og
prosessering**

Prosessteknologi

Petroleum

**Materialer og
Nanoteknologi**

Ledelse og stab

Forsknings-
grupper

Medisinsk
Bioteknologi

Massespektrometri

Polymerpartikler og
overflatekjemi

Bærekraftig
bioteknologi og
bioprospektering

Industriell og marin
bioteknologi

Nye
energiløsninger

Solenergi og
materialer

Tynnfilm og
membranteknologi

Industriell økonomi
og optimering

Elektrokjemisk
energikonvertering
og systemløsninger

Materialfysikk Oslo

Verksted

Prosessmetallurgi og
råmaterialer

Støping, forming og
resirkulering

Elektrolyse og
høytemperatur-
materialer

Materialprosessering
og modellering

Strømningsteknikk

Flerfasestrømning

Kjemisk prosess- og
miljøteknologi

Kinetikk og katalyse

Prosesskjemi og
funksjonelle
materialer

SINTEF Tel-Tek

Formasjonsfysikk

Boring og brønn

Anvendt
geovitenskap

Materialfysikk Trh.

Korrosjon og tribologi

Polymerer og
komposittmaterialer

Materialers
integritet og sveising

Material- og
konstruksjonsmekanikk

SINTEF Tel-Tek, Porsgrunn



Eksempel:
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- CO₂ fangst og separasjon (CCS)
- Biogass
- Processdesign og Tekno-økonomi
- Digitalisering og dataanalyse
- Pulverteknologi
- Eksperimentelle fasiliteter





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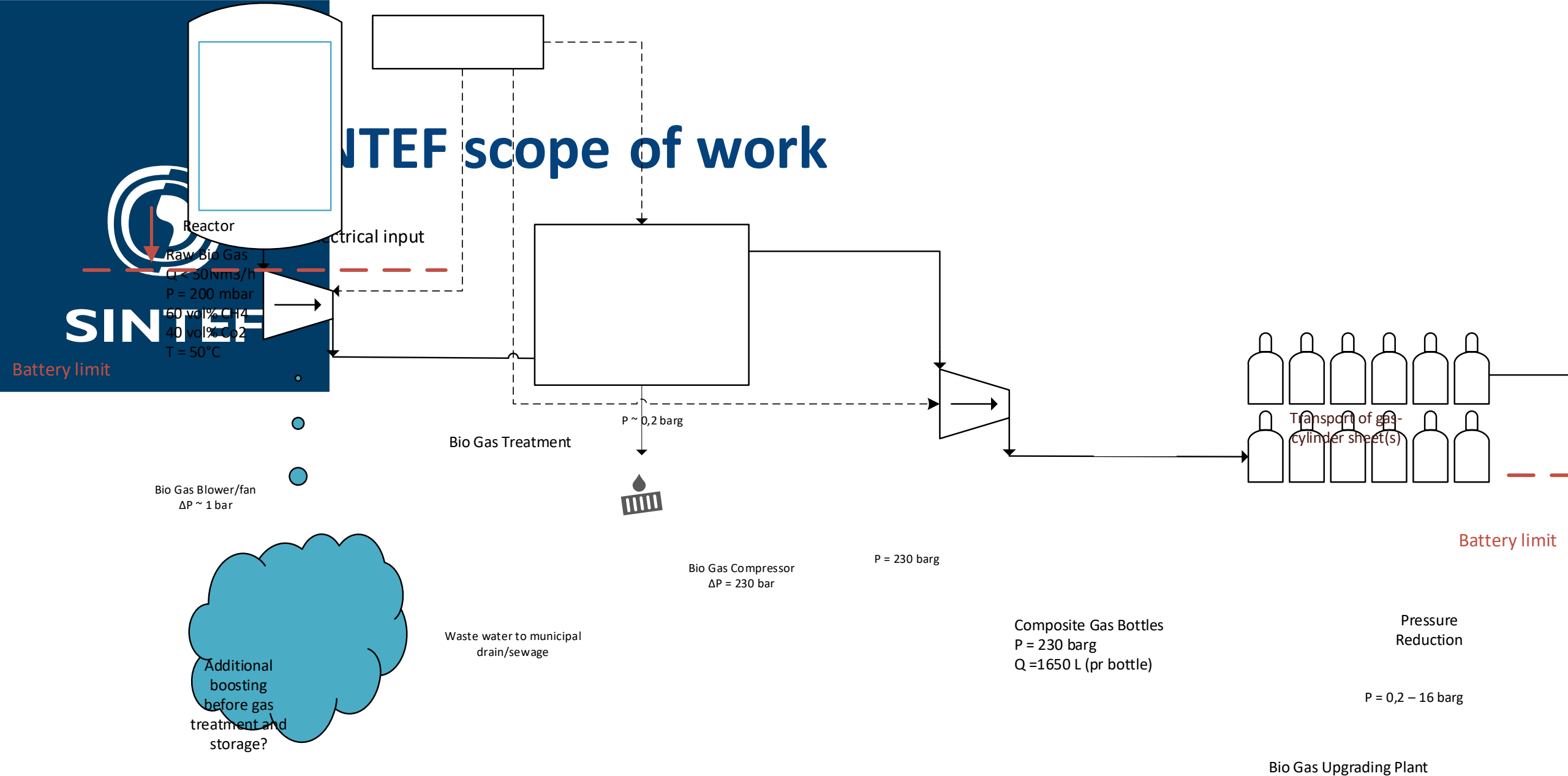


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SINTEF objectives

- 3 cases: definere gass produksjon, gass-sammensetning, logistikk og andre lokale forhold ved Svanem Biogass (Hellandsjøen) og Biogass Møre (Åndalsnes)
- I tillegg skal 1 case knyttes til Innherred og Mære landbruksskole
- Omfangsanalyse der man finner ut hvilke elementer som skal med i et kostnadsestimat
- SINTEF:
 - Tekniske vurdering rundt oppkomprimering av rågass
 - Transport av gass og oppgradering
 - Bedriftsøkonomisk vurdering

NTEF scope of work



Additional boosting before gas treatment and storage?



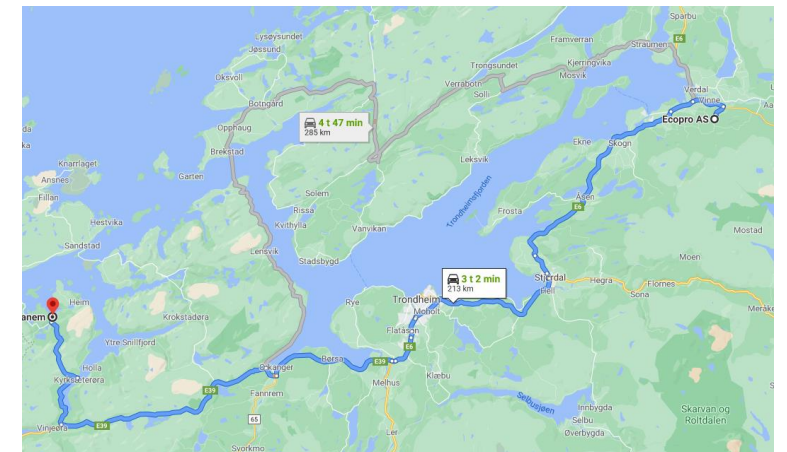
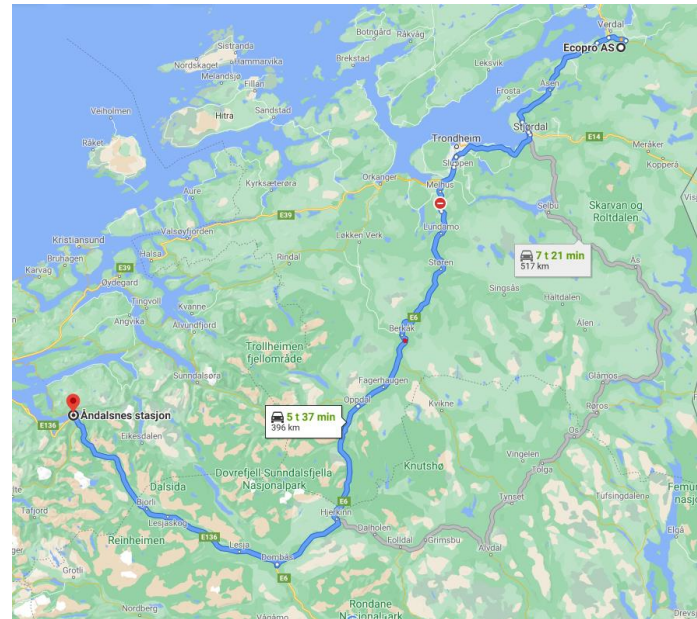
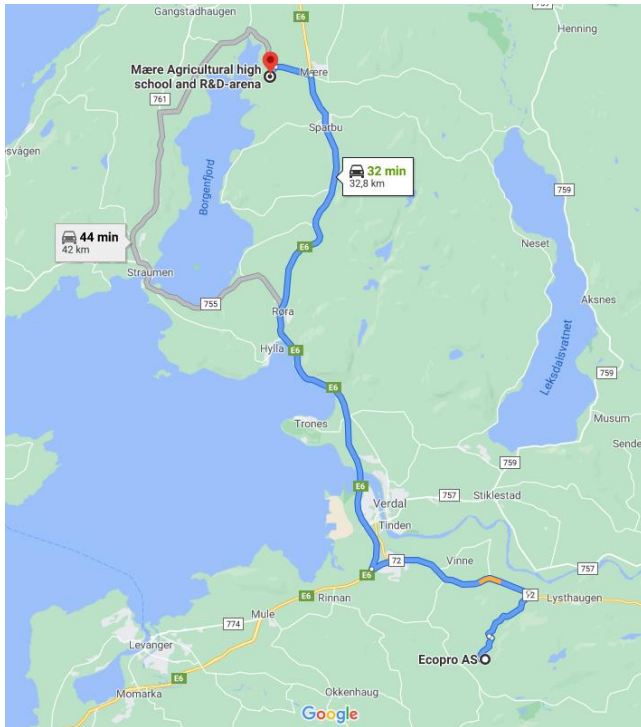
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SINTEF map of locations (ref Google)

Mære case 308 km / 0,54h
Truck: 60 km/h -> 0,55h

Åndalsnes case 396 km / 5,57h
Truck: 60 km/h -> 6,6h

Svanem case 212 km / 3h
Truck: 60 km/h -> 3,5h



SINTEF – base case assumptions

Electricity cost	0,5	NOK/kWh
Hourly transport rate	1300	NOK/h
Bio gas export pressure	230	barg
Bio gas flow rate - production	50	Nm ³ /h
Bio gas pressure - production	0,2	barg
Inlet temperature - production	20	DegC
Gas bottle size (water volume)	1,65	m ³
Gas volume pr sheet	14850	L
Gas bottle sheet size	9	bottles
Gas bottle filling ratio	0,9	-
No of sheets pr truck load	1	
No of sheets for initial purchase	2	Sheet
Operational hours	8000	h/year
Plant uptime	0,91	%
Operational hours	24	t/day
Maintenance	4 %	of CAPEX
Truck on/off loading time	1	h
Energy density Biogas	6,5	kWh/Nm ³
Energy density diesel	10,7	kWh/L
Diesel cost	14	NOK/L

LP compressor Power	2	kW
HP compressor Power	16,6	kW
Waste Water treatment (pump++)	3,5	kW
Volume flow raw bio gas (theoretical)	1200,0	Nm ³ /day
Gas volume pr sheet	14,9	m ³
Bio gas production rate -Real compr	0,2	m ³ /h
Bio gas production rate -Real compr	5,2	m ³ /day
Transport cost pr year	1 405 358	NOK/year
Required transport frequency	130,1	trips/year
Required transport frequency	10,7	trips/month
Required transport frequency	2,5	trips/week
Number of gas cylinders pr day	3,5	
Number of gas cylinders pr week	24,6	
Required sheet change	2,6	day

Krav til avkastning	
Rente	7,5 %
Antall år	25
Byggetid	1
Driftstid	24
CAPEX number	10,98

- Ecopro can receive large batches of biogas
- Cost of operational personel NOT included
- Waiting time for truck between each trip is not considered – assume full truck utilization
- Only additional equipment for raw bio gas compression and transport considered

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Transport

Case 1 – 1300 NOK/h
Purchase of 2 sheets



Case 2 – 1500 NOK/h
Purchase of 3 sheets



Case 3 – 1800 NOK/h
Purchase of 4 sheets



(Courtesy of Umoe Advanced Composites)

Svanem base case cost calculation



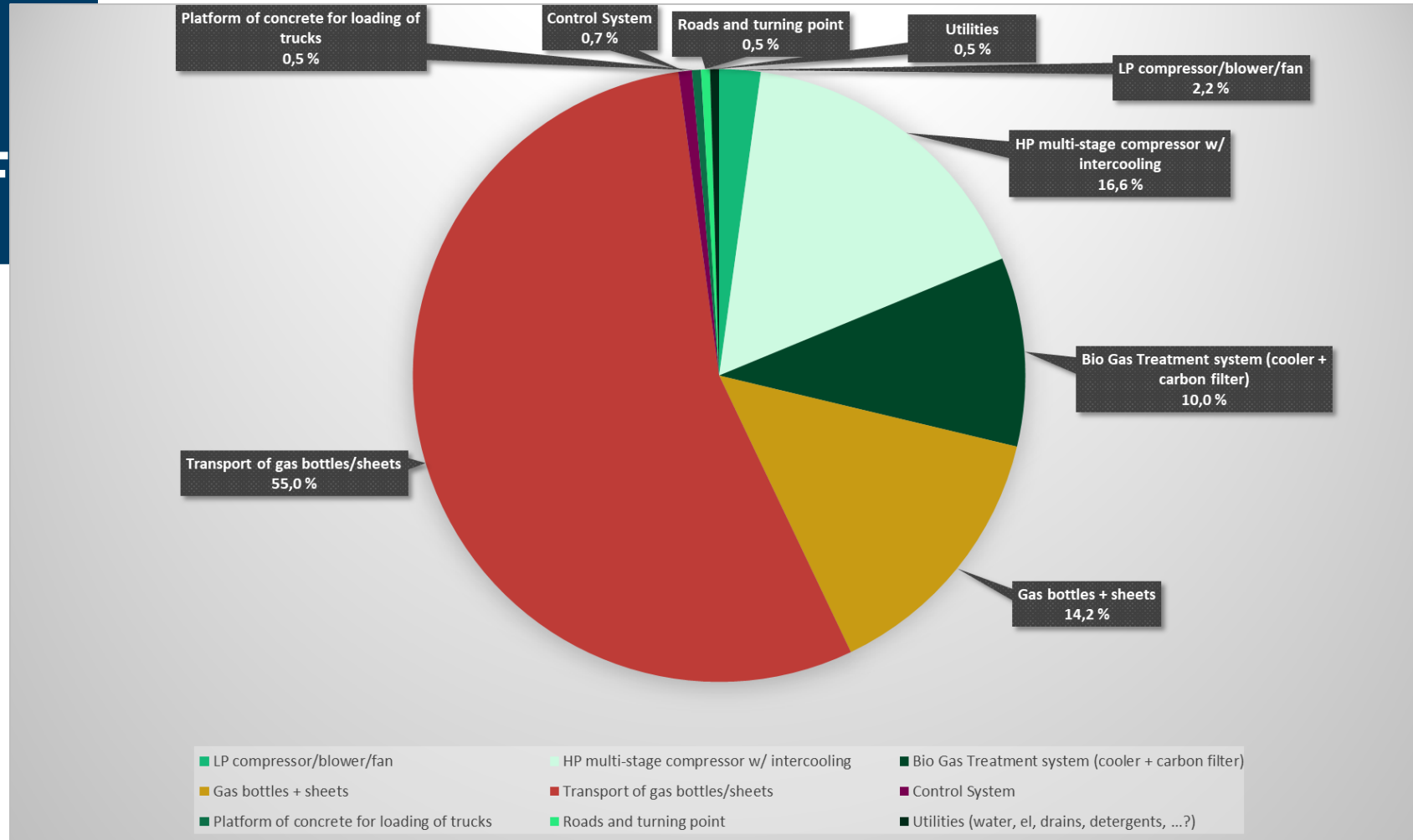
Case 1 - Svanem small scale bio gas production	CAPEX	CAPEX Pr Year	Energy cost	Truck transport	Maintenance	OPEX
Components within scope	[NOK]	[NOK/year]	[NOK/year]	[NOK/year]	[NOK/year]	[NOK/year]
LP compressor/blower/fan	400 000	36 420	8 000		16 000	24 000
HP multi-stage compressor w/ intercooling	3 000 000	273 150	66 400		120 000	186 400
Bio Gas Treatment system (cooler + carbon filter)	2 000 000	182 100	13 926		80 000	93 926
Gas bottles + sheets	3 000 000	273 150			120 000	120 000
Transport of gas bottles/sheets	-	-		1 522 471	-	1 522 471
Control System	150 000	13 658			6 000	6 000
Platform of concrete for loading of trucks	100 000	9 105			4 000	4 000
Roads and turning point	100 000	9 105			4 000	4 000
Utilities (water, el, drains, detergents, ...?)	100 000	9 105			4 000	4 000
SUM	8 850 000	805 793	88 326	1 522 471	354 000	1 964 797

Calculated cost (or sales price CBG)	6,93	NOK/Nm3
Calculated cost	1,07	NOK/kWh



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Svanem –distribution of yearly cost

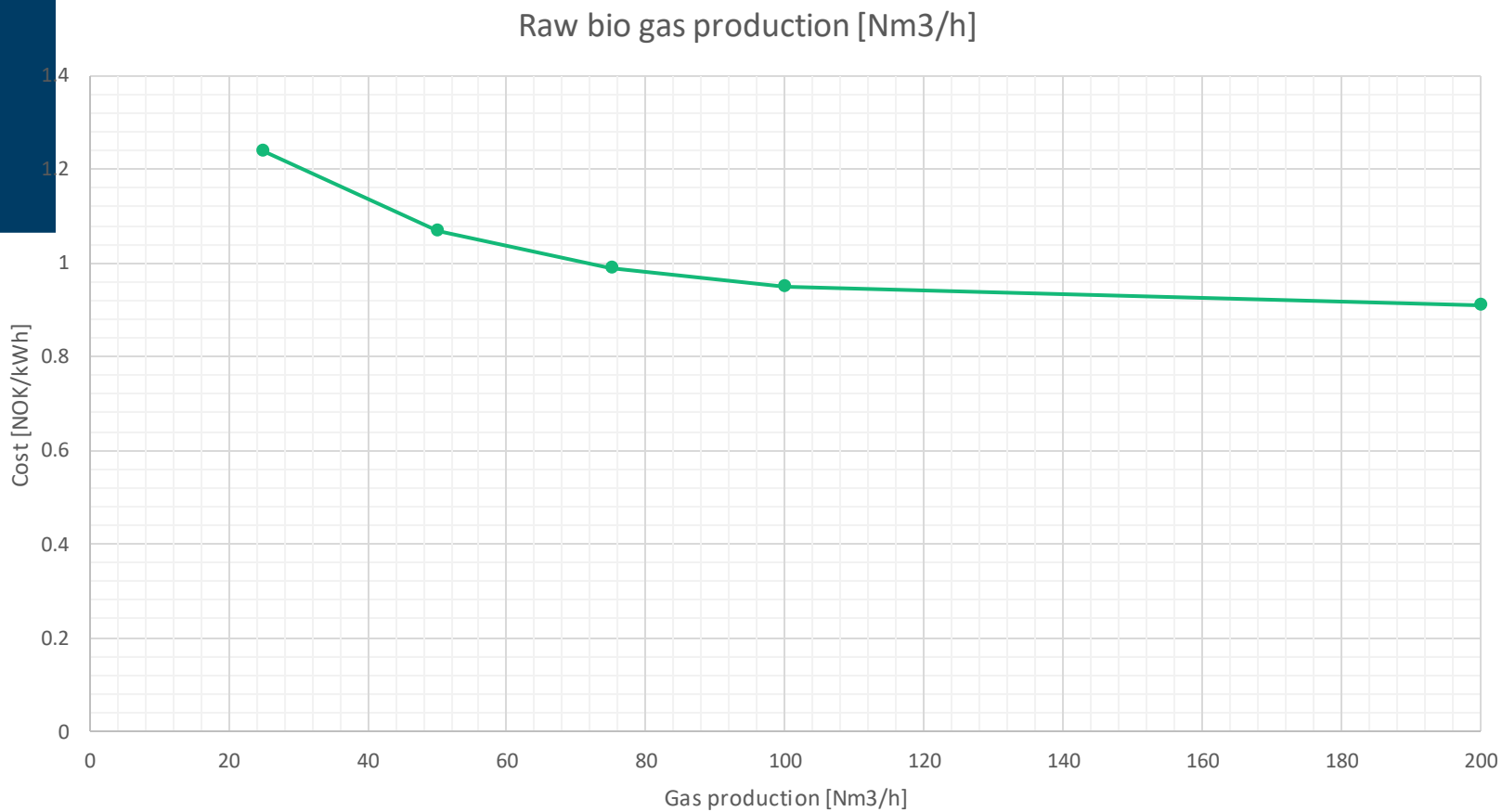


Svanem – Bio gas production rate

(Economies of Scale)



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Åndalsnes base case cost calculation

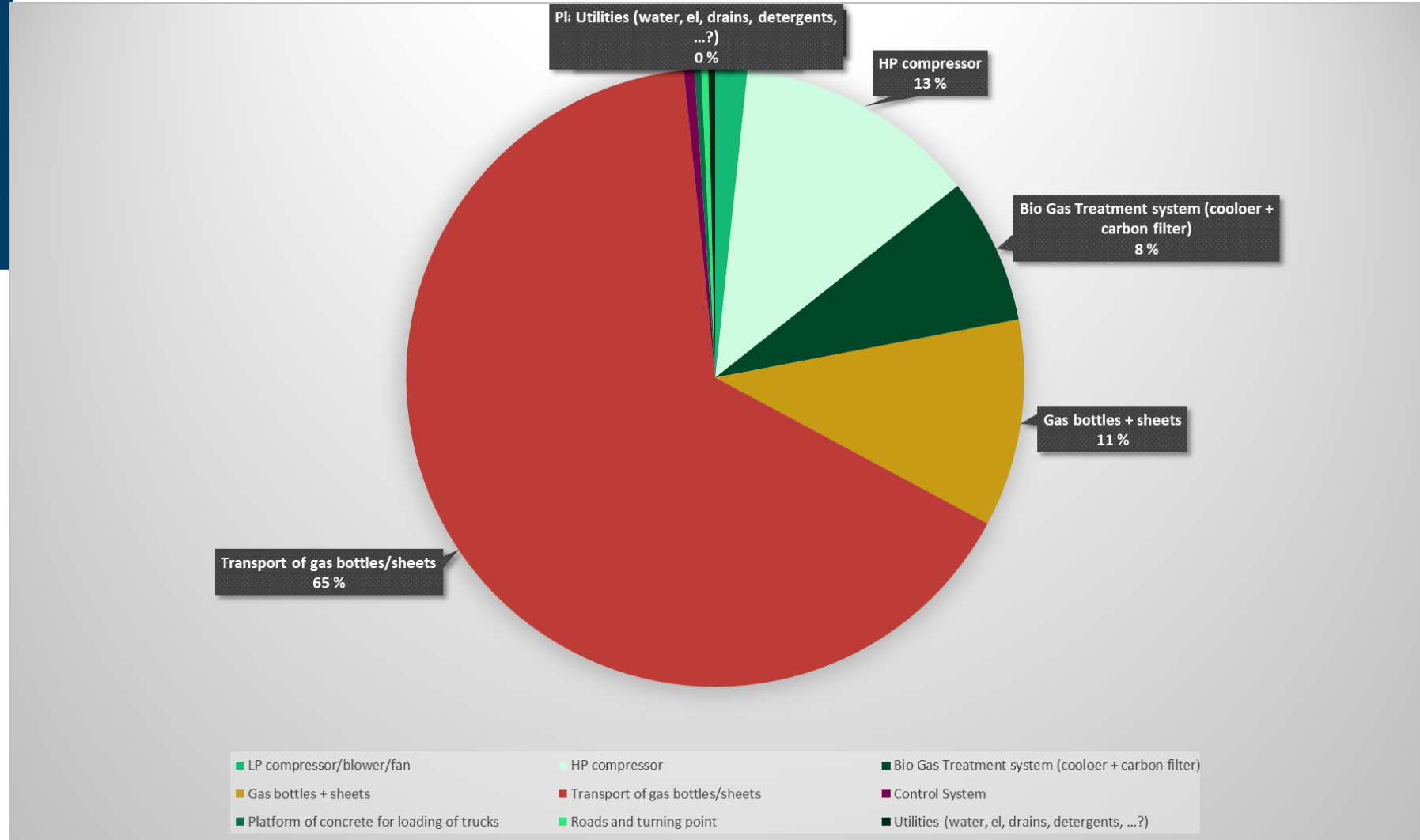
Case 1 - Åndalsnes small scale bio gas production	CAPEX	CAPEX Pr Year	Energy cost	Truck transport	Maintenance	OPEX
Components within scope	[NOK]	[NOK/year]	[NOK/year]	[NOK/year]	[NOK/year]	[NOK/year]
LP compressor/blower/fan	400 000	36 420	8 000		16 000	24 000
HP multi-stage compressor w/ intercooling	3 000 000	273 150	66 400		120 000	186 400
Bio Gas Treatment system (cooler + carbon filter)	2 000 000	182 100	13 926		80 000	93 926
Gas bottles + sheets	3 000 000	273 150			120 000	120 000
Transport of gas bottles/sheets	-	-		2 571 285	-	2 571 285
Control System	150 000	13 658			6 000	6 000
Platform of concrete for loading of trucks	100 000	9 105			4 000	4 000
Roads and turning point	100 000	9 105			4 000	4 000
Utilities (water, el, drains, detergents, ...?)	100 000	9 105			4 000	4 000
SUM	8 850 000	805 793	88 326	2 571 285	354 000	3 013 610

Calculated cost (or sales price CBG)	9,55	NOK/Nm3
Calculated cost	1,47	NOK/kWh



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Åndalsnes –distribution of yearly cost





Mære base case cost calculation

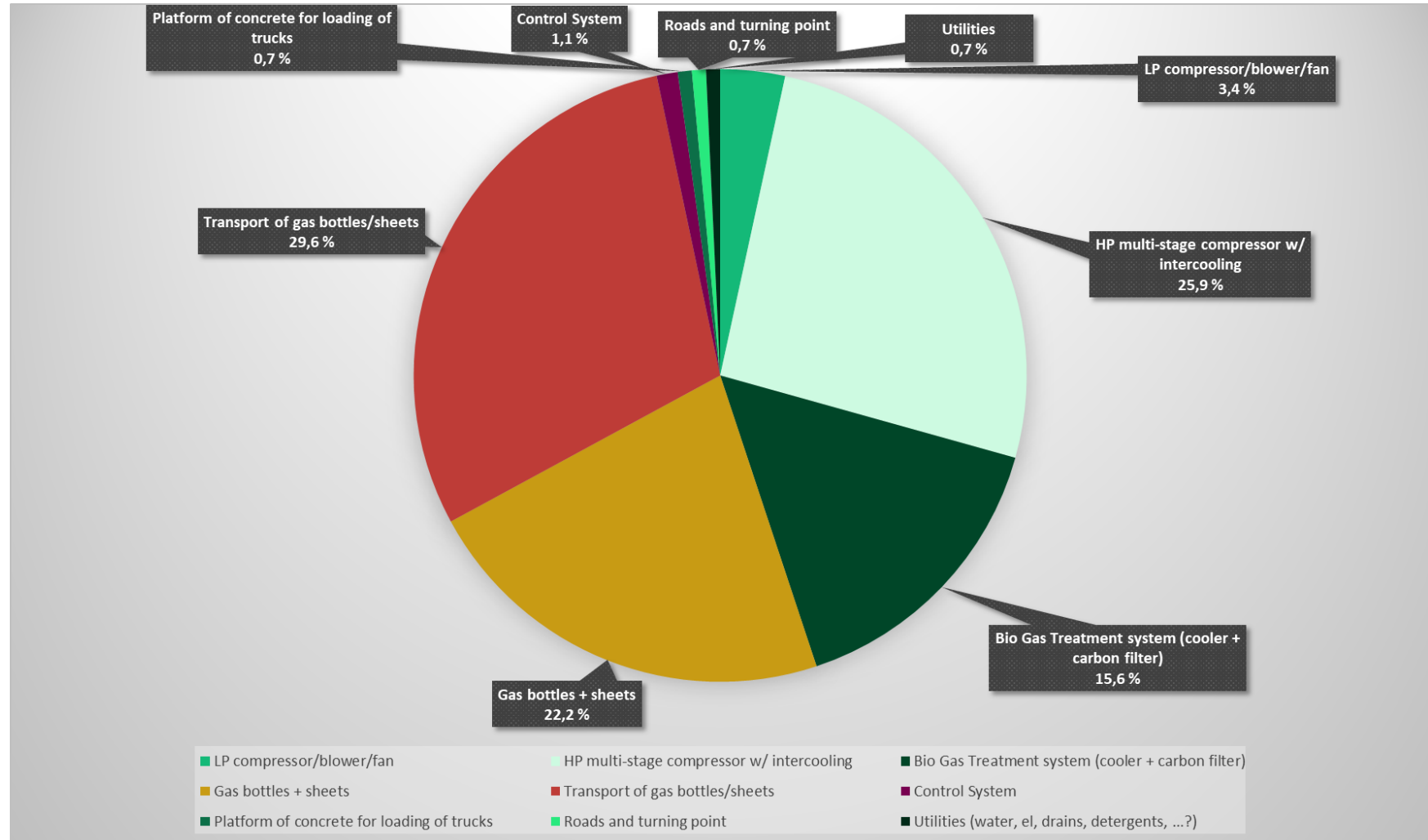
Case 1 - Mære small scale bio gas production	CAPEX	CAPEX Pr Year	Energy cost	Truck transport	Maintenance	OPEX
Components within scope	[NOK]	[NOK/year]	[NOK/year]	[NOK/year]	[NOK/year]	[NOK/year]
LP compressor/blower/fan	400 000	36 420	8 000		16 000	24 000
HP multi-stage compressor w/ intercooling	3 000 000	273 150	66 400		120 000	186 400
Bio Gas Treatment system (cooler + carbon filter)	2 000 000	182 100	13 926		80 000	93 926
Gas bottles + sheets	3 000 000	273 150			120 000	120 000
Transport of gas bottles/sheets	-	-		524 407	-	524 407
Control System	150 000	13 658			6 000	6 000
Platform of concrete for loading of trucks	100 000	9 105			4 000	4 000
Roads and turning point	100 000	9 105			4 000	4 000
Utilities (water, el, drains, detergents, ...?)	100 000	9 105			4 000	4 000
SUM	8 850 000	805 793	88 326	524 407	354 000	966 733

Calculated cost (or sales price CBG)	4,43	NOK/Nm3
Calculated cost	0,68	NOK/kWh



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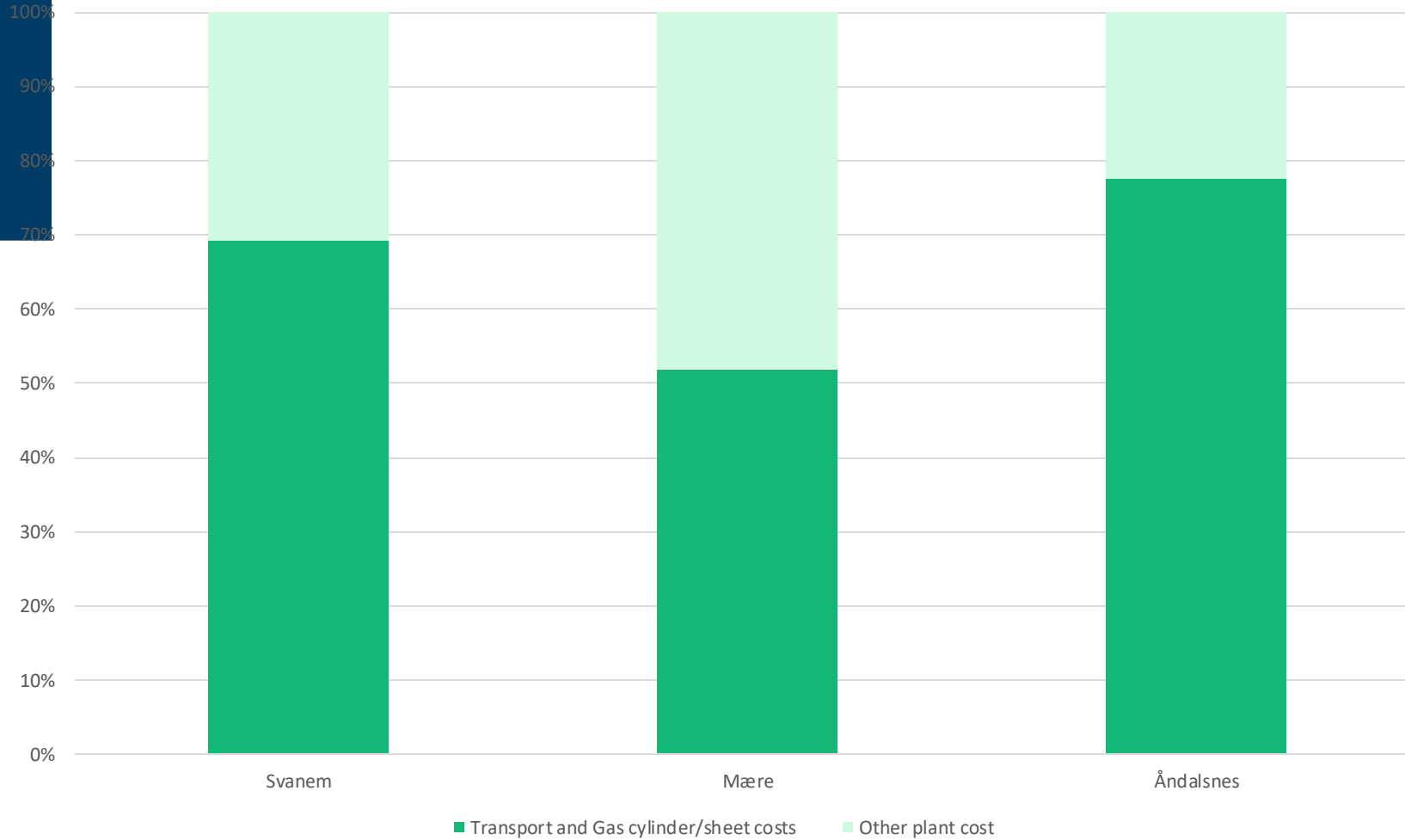
Mære –distribution of yearly cost





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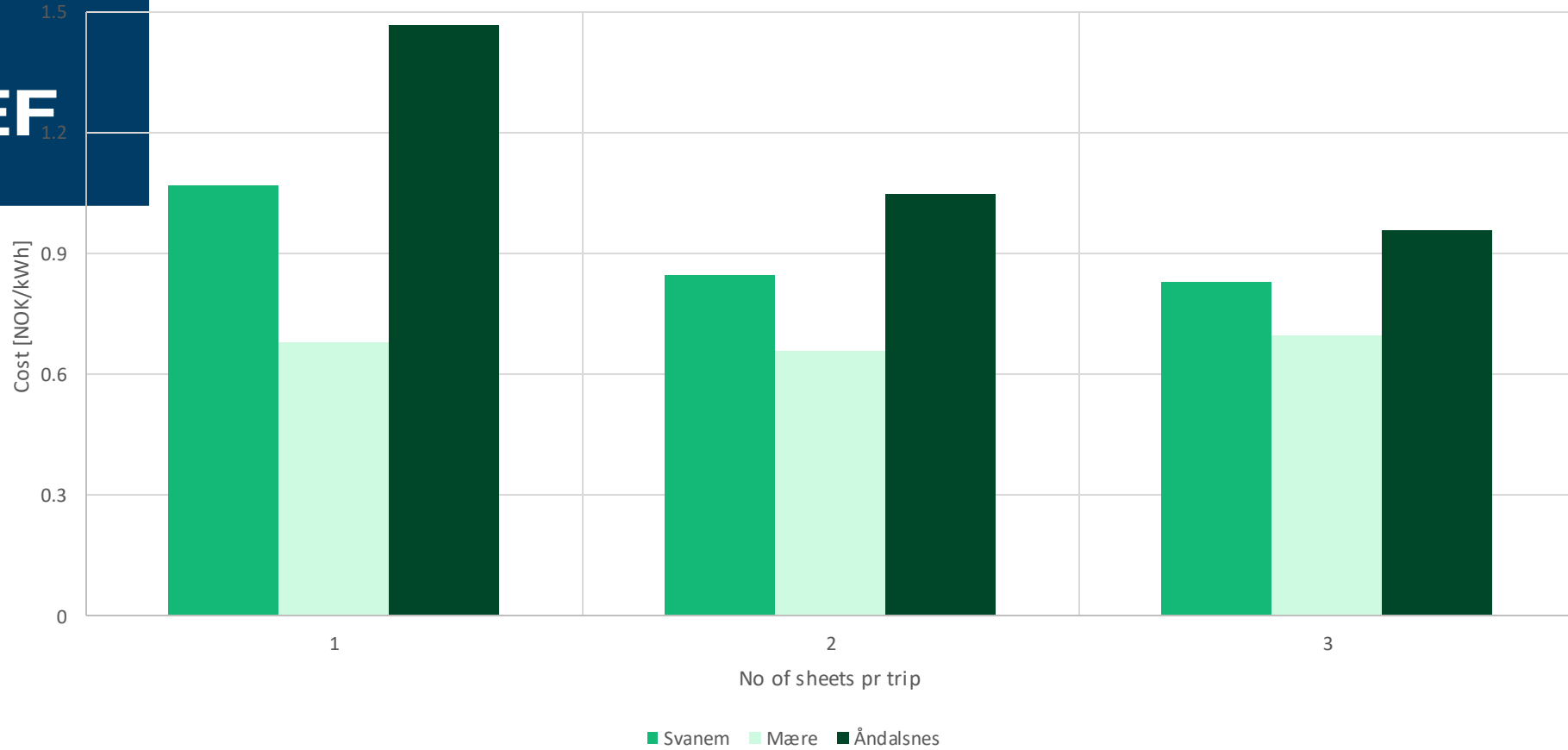
Location specific cost/uncertainty distribution





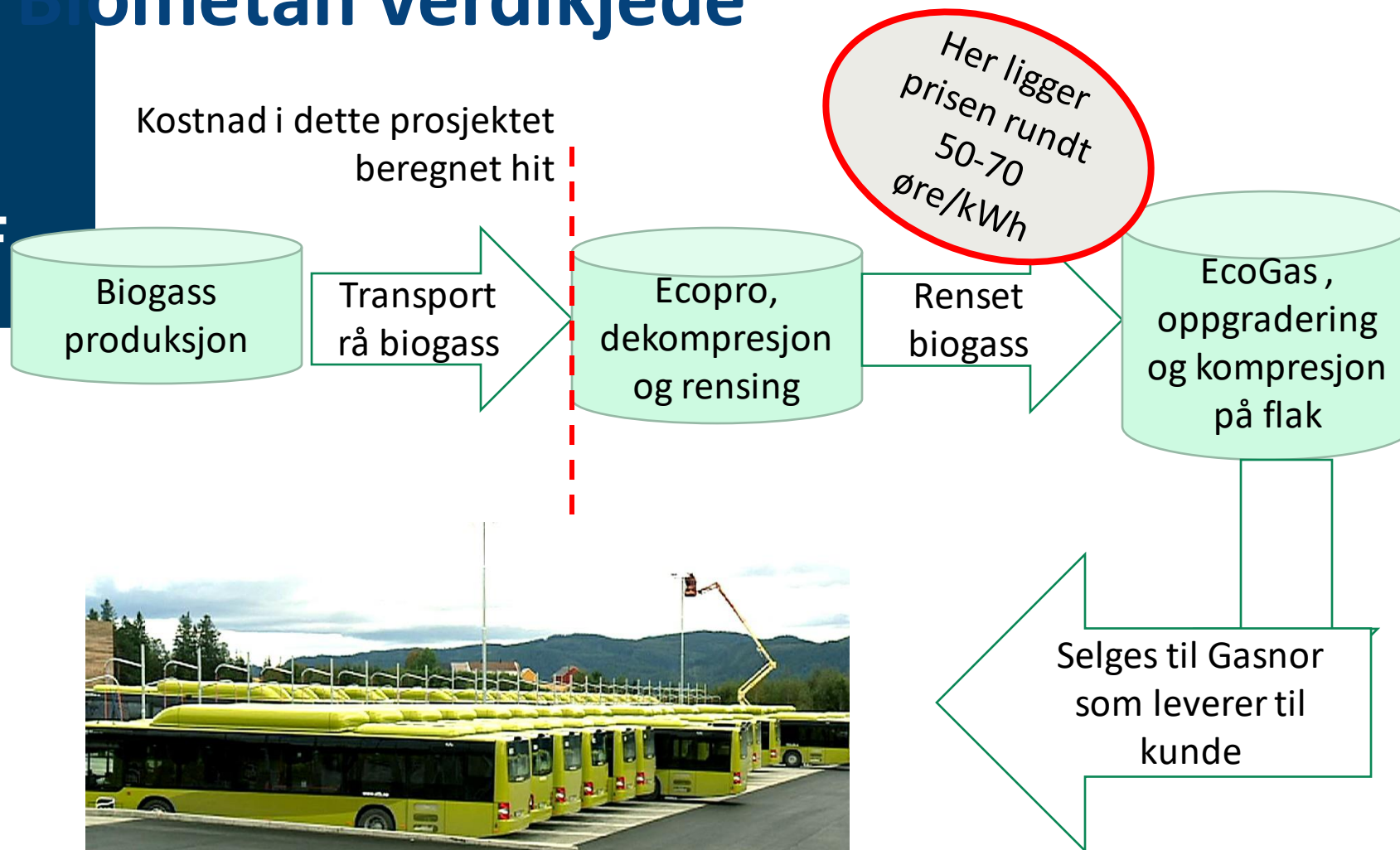
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Transport sensitivity – truck configuration





Biometan verdikjede





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Summary of findings

- Transport cost of gas is the most important variable
- Svanem and Andalsnes cases benefit from using at least two sheets pr transport
- Mære has a short transport distance to Ecopro and would not benefit from purchasing more than 2 sheets/ 1 sheet pr transport.
- The current gas production requires sheet replacement every 2.6 days (theoretical)
- Transport time
 - 0 – 0.5h 1 sheet/truck
 - 0.5h – 2.75h 2 sheets/truck
 - 2.75h – 4h 3 sheets/truck
- The specific cost depends on location (best case):
 - Mære -> 0,66 NOK/kWh
 - Svanem -> 0,83 NOK/kWh
 - Åndalsnes -> 0,96 NOK/kWh
- Doubling of bio gas production reduces specific bio gas cost (base case) of 10% ~ 0,95 NOK/kWh
- The concept seems not viable at the moment based on the project assumptions made



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Concept adjustment / Cost savings

• Governmental funding

• Still operating costs.....maintenance, electricity, logistics

- Local use of upgraded biomethane
- Concept of local upgrading facilities – smaller volumes – feasible at this point?
- Combined Heat and Power
- Large fuel tank on tractors – if similar energy storage as diesel



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