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Solutions and costs for public facilities

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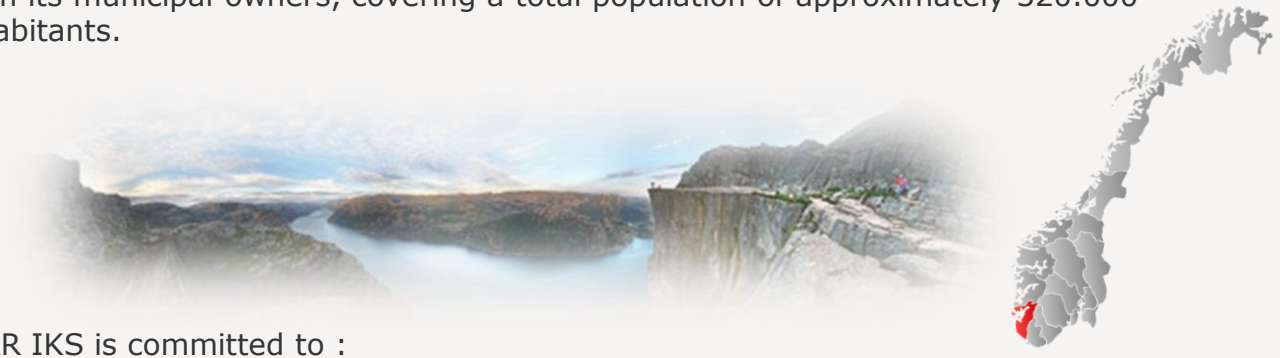
example from an evaluation of technologies for nutrient recovery at Grødaland biogas plant in Rogaland, Norway

IVAR IKS is an inter-municipal water, sewage - and waste collection company owned by 13 municipalities of the Rogaland county in Norway. IVAR receives and treats wastewater from its municipal owners, covering a total population of approximately 320.000 inhabitants.



IVAR IKS is committed to :

- ensure the regional competitive market of water, sewage and sanitation services.
- develop of the regional renewable energy production (today used mostly in gas grid network, plans is to use as vehicle fuel for the region's bus fleet)
- promote and develop resource recovery/recirculation (e.g. Minorga®: pellets of organic fertiliser produced from digested sludge)

Background

IVAR IKS is in the final phase of building Grødaland biogas plant, estimated to be one of the biggest biogas plants in Norway to treat sewage sludge from numerous regional wastewater treatment plants as well as the regional organic fraction of municipal solid waste (OFMSW).

The discharge permit of Grødaland biogas plant required a preliminary study for the implementation of nutrient recovery technologies for the reject streams of the plant.

In addition, it is the target of IVAR IKS to achieve a best possible resource exploitation of nutrients and to optimize market conditions for both biogas and fertilizer products.

Pre-project study:

Evaluation of technologies to recover phosphorous (P), nitrogen (N) and potassium (K) from the reject water streams at Grødaland.

Methodology

- Review on:
  - technologies applied in full (industrial) scale
  - technologies with good operational references
- Compilation of Grødaland data and literature research regarding:
  - substrates amounts and characteristics
  - process parameters
- Mass balance calculations for P, N and K in the different reject water streams and in the biorest (digested mixture of sewage sludge and OFMSW).
- Contact with relevant technology suppliers:
  - Ostara, USA (PEARL®-struvite technology)
  - Royal Haskoning DHV, Netherlands (Crystalactor®-struvite technology)
  - NureSys, Belgium (NureSys®-struvite technology)
  - CNP, Germany (AirPrex®-struvite technology)
  - France Evaporation, France (evaporation technology)
  - Epcon, Norway (evaporation technology)

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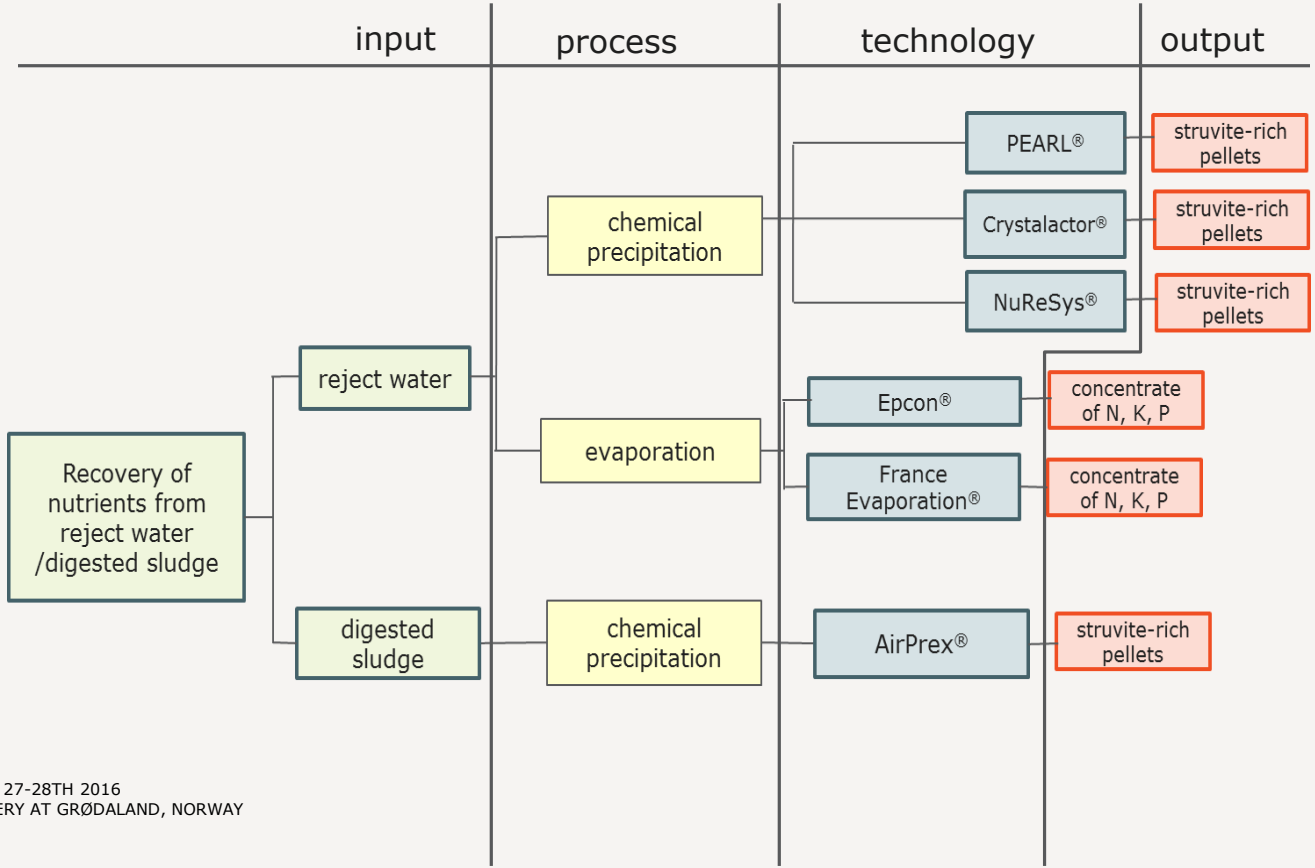
Processes and technologies considered



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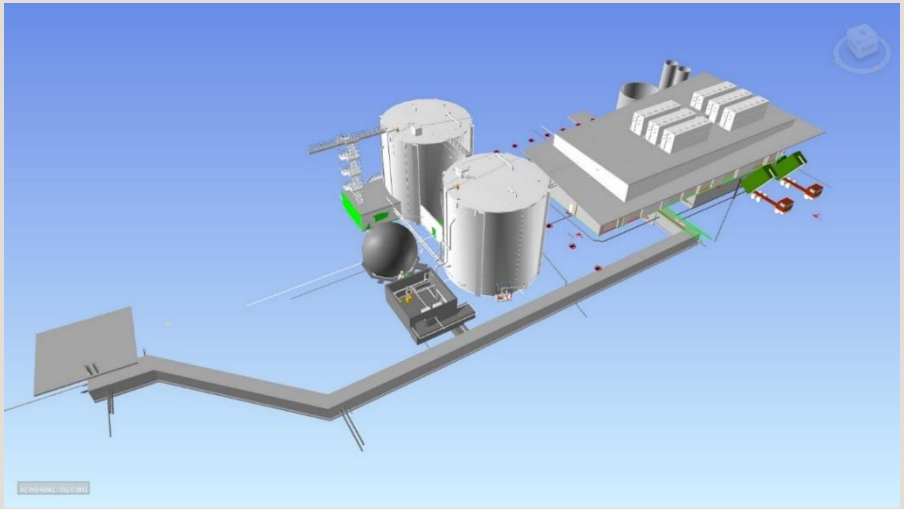
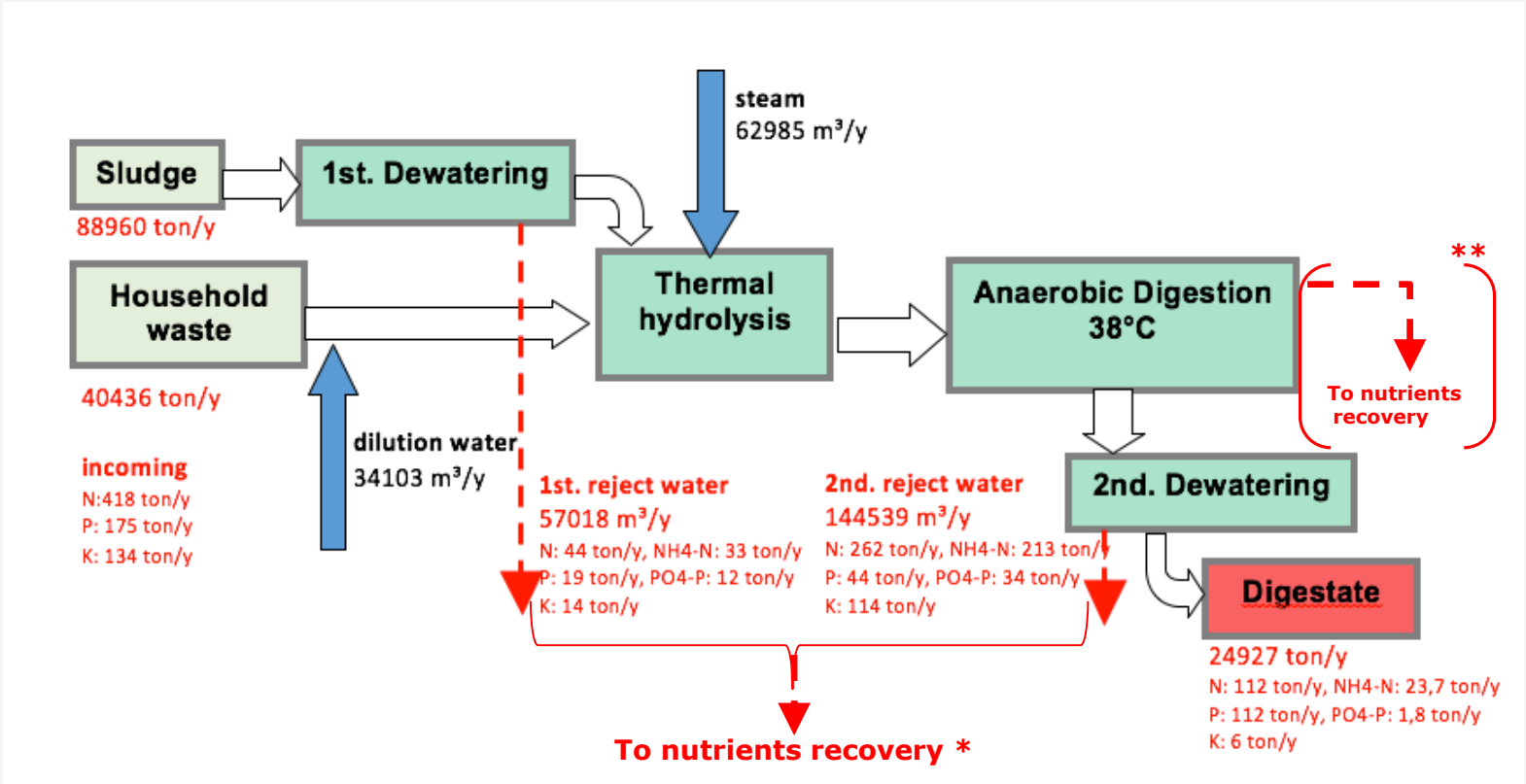
Grødaland biogas plant



> One of Norway's biggest biogas plants for treating sorted organic waste (OFMSW) and sewage sludge
> includes OFMSW pre-treatment facility, biogas upgrading and incineration plant
> Designed for 89000 tons/year sludge and 40500 tons/year OFMSW (total: 22600 tons **TS**/year)
> Biogas production approx. 65 GWh/year

Grødaland biogas plant



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Results

- Concentrations of the combined reject water streams (mg/l) and digested sludge on which recovery processes were applied

	Total volume m^3/year	NH4-N mg/l	PO4-P mg/l	K mg/l
Combined reject water streams *	201557	1220	230-330[1]	630
Digested sludge **	170370	1390	209-300[1]	704

[1] range considered a 20% increase on P availability due to THP and AD

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Results

› Recovery rates obtained

Technology	Evaporation (France Evaporation/Epcon)	Struvite from reject water (PEARL/NureSys)	Struvite from digested sludge (AirPrex)
P recovery (% input P)	21-30,4[1]	23,5-34[1]	17-25[1]
N recovery (% input N)	47	1,7-2,7	1,5-2
K recovery (% input K)	76	0	0

[1] range considered a 20 % increase on P availability due to THP and AD

Results

Supplier	France Evaporation	Epcon	Ostara	CNP-Technology	NuReSys
Technology	Evaporation	Evaporation	Struvite-from reject water (PEARL®)	Struvite-from digested sludge (AirPrex®)	Struvite-from reject water (NuReSys®)
Investment costs (k€)	**5495**	**5613**	**6690**	**4548**	**4892**
Operational Costs (k€)					
Electricity	364,7	323,8	11,8	11,6	16,3
Thermal energy	48,5	-	2,9	2,9	2,9
H_2SO_4	125,9	139,7	-	-	-
$MgCl_2$	-	-	64,5	57,6	64,2
HNO_3	6,4	6,4	12,8	12,8	12,8
NaOH	5,2	5,2	13,0	13,0	13,5
Antifoam	85,4	85,4	-	-	-
Maintenance	21,3	21,3	21,3	21,3	21,3
Personal costs	42,6	42,6	42,6	42,6	42,6
Sum operational	700,0	624,4	168,9	161,8	173,6
Income (k€)	-	-	79,9	33,0	80,9
Net operational costs (k€)	**700,0**	**624,4**	**89,0**	**128,8**	**92,7**
Depreciation of capital costs (k€)	**494,2**	**504,8**	**601,7**	**428,2**	**462,2**
Estimated annual project costs (k€)	**1194,2**	**1129,2**	**690,7**	**557,0**	**554,9**

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Conclusions

> The amount of P possible to recover is in the range of 23-34 % of total-P load coming into Grødaland.
> According to the rate of P recovered and the total yearly costs, specific costs were **16, 13 and 18 €/kg P-recovered** for PEARL®, NuReSys® and Airprex®, respectively. Differences were not pronounced, selection of a technology would need an open bidding process between all technology providers.

> An investment of between 4,6-6,7 mill. € is expected for a recovery facility, with yearly project costs of approx. 550-700 k€.
> The income from selling the products alone could never match the project costs and justify economically the project. At wastewater treatment facilities exclusively treating bio-P sludge, or biogas plants having substrates with high P content where spontaneous struvite precipitation occurs, savings in maintenance costs and higher production rates can make recovery economically favourable.

> Techniques for improving the dissolution of P from organic waste fractions are researched so to increase the efficiency of the recovery processes. Thermal treatment of recovered struvite for re-precipitation and use of seawater as reagent to reduce the costs in the controlled struvite precipitation are some techniques currently explored by IVAR, as well as possibility of struvite recovery upstream the digestion tanks

Thank you for your attention !

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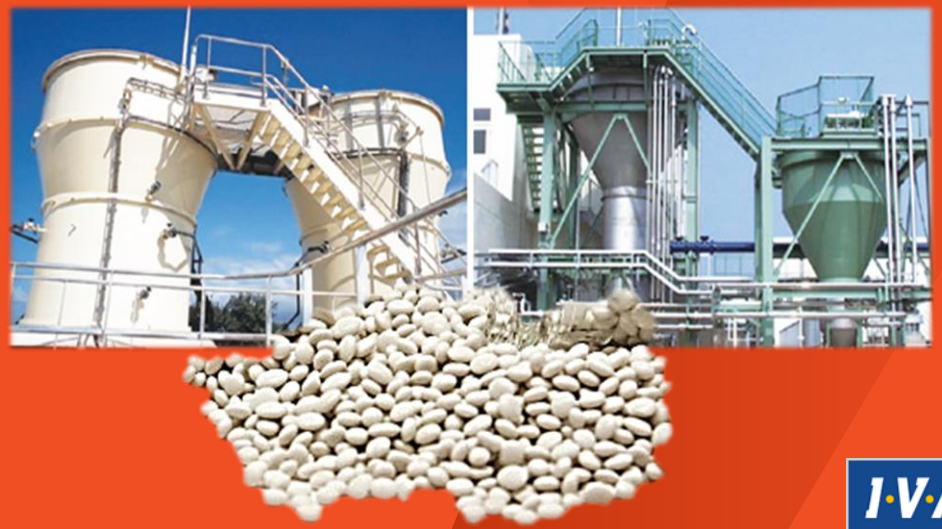

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