Scandinavianbiogas

Maximizing biogas production at a South Korean biogas plant

Jörgen Ejlertsson R&D Director, VP, Professor

Björn Magnusson Process Engineer R&D

May 15th 2013

Agenda

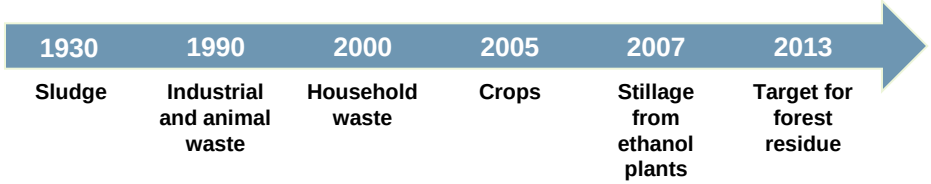
- **Scandinavian Biogas turning waste into energy**
- **The case for biogas in South Korea**
- **Maximizing biogas production at YongYeon WWTP in South Korea**
- **Questions**

Scandinavianbiogas

Sweden: a leading nation in vehicle fuel from biogas

Long experience in the biogas market

- Over 80 years experience from biogas production
- 20 years of municipal/government sponsored investments in anaerobic digestion
- World's highest number of installed gas upgrading units to natural gas standard
- 300 plants in operation with an annual biogas production of 147 million Nm^3, equivalent to 1.3 TWh
- Today, more than 50% of total gas used for the 32,000 natural gas vehicles ("NGVs") on Swedish roads is biogas



Driving forces for biogas in Sweden

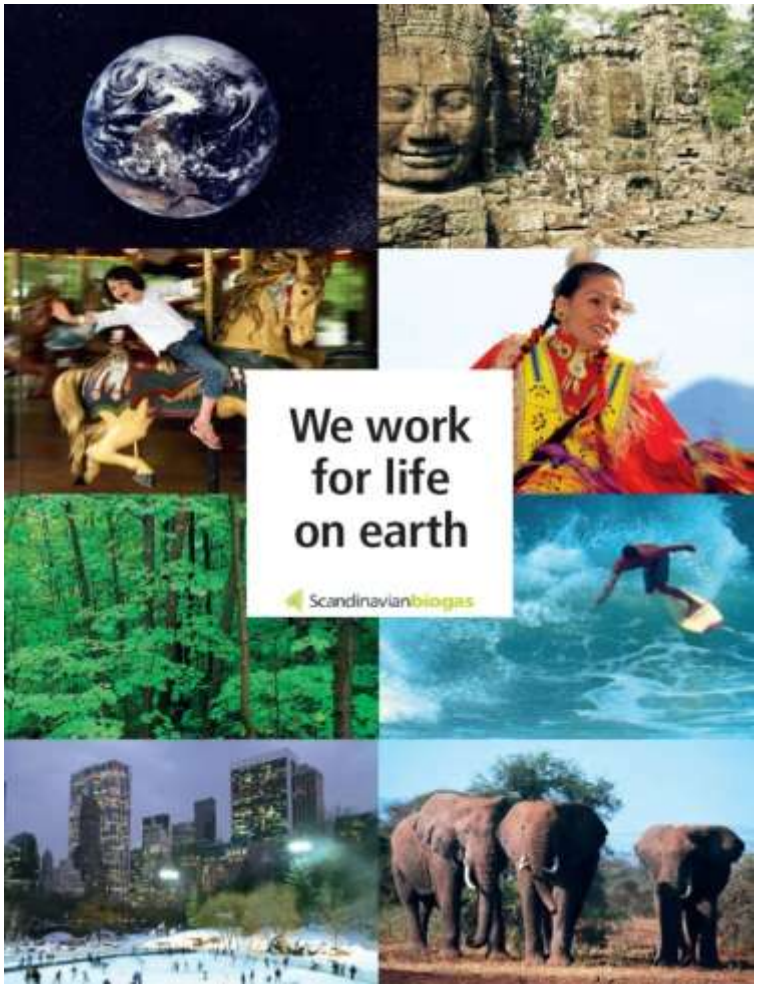
- A number of municipalities have set ambitious biogas goals for public transportation
- Government incentives
  - Decrease the emission that effect the environment
  - Decrease the dependency of oil
  - Ambition – oil-independent transport-sector in 2030
- National grants, usually 30% of investment in biogas production and upgrading facilities 2003-2008
- Compulsory to provide renewable fuels at all major filling stations – resulted in ethanol pumps
- Public awareness
- Ambition to create a national biogas strategy

Scandinavianbiogas

Scandinavian Biogas in brief

- Founded in December 2005
- Former Prime Minister of Sweden Göran Persson as Chairman of the Board
- Ability to prove and optimize concepts in both laboratory, pilot and full scale.

- Head office in Stockholm
- R&D and Process Department in Linköping
- Pilot plant in Norrköping
- 30 employees in Sweden
  - Production in South Korea 18 employees



Scandinavianbiogas

Business idea of Scandinavian Biogas

- **The overall business idea** of Scandinavian Biogas is to operate and optimize industrial scale biogas plants to profitably produce and sell biogas.

- **This is achieved** through a *build-own-operate* business model where Scandinavian Biogas fully controls plant design, operation and plant process optimization.

- **Revenues** from the *sale of biogas* and other output from the biogas production as well as from *gate-fees* for accepting waste products.

- **To reduce financing needs**, alternatives to full plant ownership can be considered.

Strong R&D focus

- R&D center in Linköping, continuous evaluation of selected substrates aiming at:
  - Quantifying/confirming biogas yield
  - Analysing process performance of substrate mixtures in laboratory scale
  - Developing new substrate mixtures and feeding strategies
  - Optimize use of additives and trace minerals to boost biogas yield
  - Co-digestion of more than 300 substrates has been verified

Current projects

- Ulsan City (South Korea)
- Fordonsgas Stockholm (Sweden).
  - An exclusive raw gas contract with Stockholm Vatten including a fixed gas price agreement (tied to index) running for 23.5 years for production levels up to 8.6 M Nm^3 vehicle quality biogas at Henriksdal, Bromma and Loudden
  - Scandinavian biogas will assist in doubling the gas production within 5 years
- Biogas Uppland (Sweden)
  - JV between Scandinavian biogas and UL (the public transportation authority; PTA) in the Swedish region Uppland
  - The JV will invest and produce 10 M Nm^3 CBG for long distance busses
- Biogas Varberg (Sweden)
  - A build-operate project with the community of Varberg. Co-digestion of sludge, orange peelings, paper and pulp residues and glycerol.

Agenda

- Scandinavian Biogas turning waste into energy
- **The case for biogas in South Korea**
- Maximizing biogas production at YongYeon WWTP in South Korea
- Questions

Scandinavianbiogas

The case for biogas in South Korea

- Sludge and food waste dumping in the ocean is banned from 2013
- High amounts of organic waste are produced in a small area
- Existing NGV infrastructure and natural gas net
- Tax reduction for high-technology companies within the environmental protection area
- High interest from government for renewable energy which will very likely lead to more incentives in the near future
- Over 600 existing digesters in Korea that can be significantly improved

Ulsan: 40 000 USD/yr per capita (x 2,2 national average)

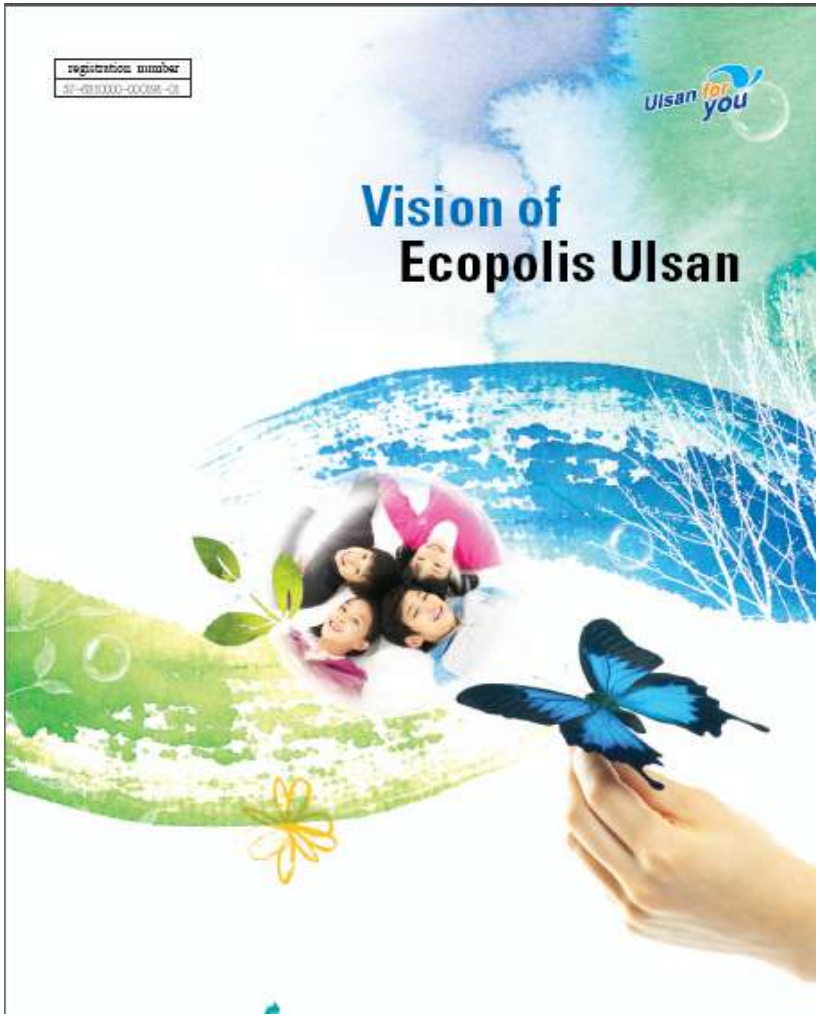
Main Industries	Main Companies	Share of Korean market
Automobile:	Hyundai Motor corporation (world's largest factory as a single unit: 5600 cars/day!)	**25%**
Shipbuilding:	Hyundai Heavy Industries, world largest shipbuilder	**40%**
Petrochemical:	SK petrochemical, LG chemical, Samsung fine chemical, BASF and DuPont, (and170 other chemical companies)	**30%**

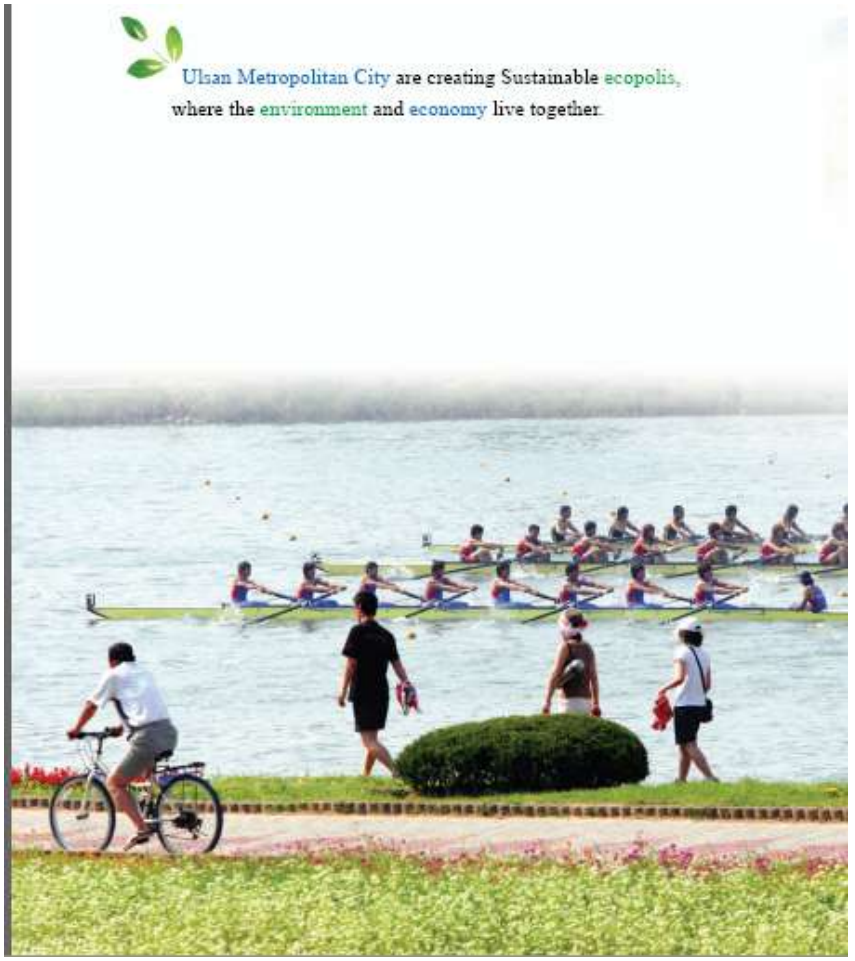
Scandinavianbiogas

Impact on the Environment – Ulsan case

- From 80 000 inhabitants in the early 1960s to a large industrial city of 1,1 million.
- ”Economy-first” development
- Environmental pollution and unbalanced growth.

Need for a change: Ecopolis Ulsan





2 u.5-years plans to reduce air and water pollution (100projects, 10 sectors, 1 Bil.USD/5 year plan)

Scandinavianbiogas

Agenda

- **The case for biogas**
- **Scandinavian Biogas turning waste into energy**
- **Maximizing biogas production at YongYeon WWTP in South Korea**
- **Questions**

Scandinavianbiogas

Maximising Biogas production at YongYeon WWTP in Ulsan

Scandinavianbiogas

Ulsan Project - Overview

Contract duration	▪ 15 years (starting 2010)
Client	▪ Ulsan City, South Korea
Project description	▪ **Design, Construction, Operation** ▪ 2 digesters (7,000 m^3 x 2) at municipal YongYeon WWTP ▪ Substrates: PS and Food Waste ▪ Increase input of food waste by approx. 350% (65 kt/yr) – New Food Plant ▪ Generates approx. **11 M Nm^3 biogas per year** (from ca 2.5 M Nm^3) ▪ Biogas used internally for heating digesters, the rest sold externally ▪ Gas treatment in 2 steps: I) Drying & H2S removal; II) Biogas upgrading preferably with cryogenic technique ▪ Investment and operation via SPC – Scandinavian Biogas Korea Ulsan
Start of production	▪ Stepwise since 2009: Completed: Food plant, sludge dewatering, digesters refurbishment and gas treatment step 1

Ulsan, Korea – Time line and business case

Time line:

- 2007 MoU
- 2008 Contract and start of refurbishment and start of investment. Biogas from mainly primary sludge
- 2010 Production of biogas from food waste + primary sludge
- 2015 Final investment in Gas-upgrading

Business case:

- Build operate transfer project on 15 years (with possible prolongation)
- Revenues from
  - Food waste gate fee (ca 60%) and
  - Raw gas sale (ca 40%) to SK-Chemicals (exchange of natural gas in boilers)
- Major costs:
  - Environmental fee – dewatering of sludge
  - Grit incineration, personnel costs, chemical costs: $FeCl_3$ and polymers

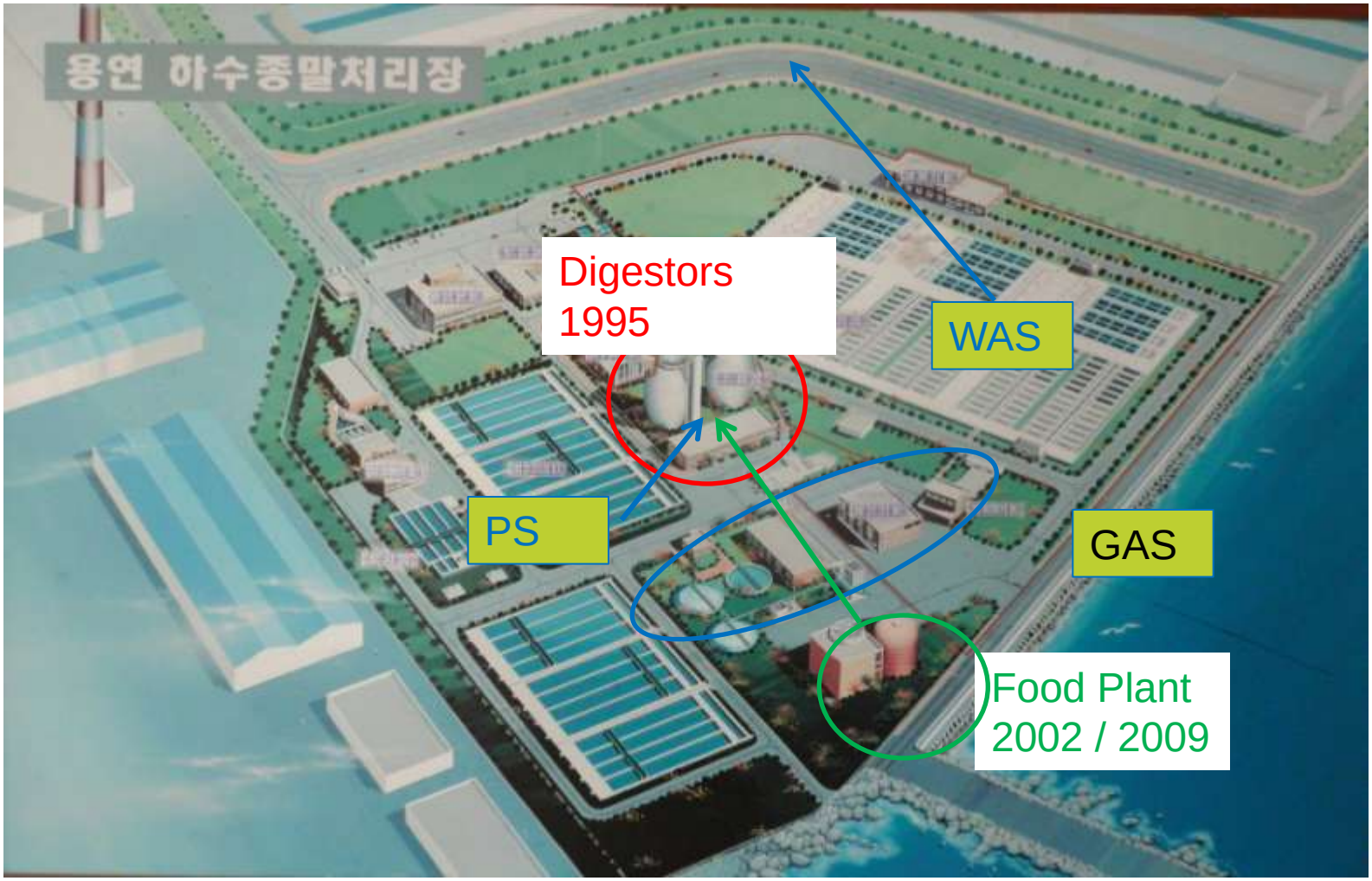
Map of Korea

YongYeon WWTP: German design(80's), 250 000 m³/d

Before

PS
500m³/d

Food
W.
40 t/d



After

PS
500m³/d

Food
Waste
180 t/d

Scandinavianbiogas

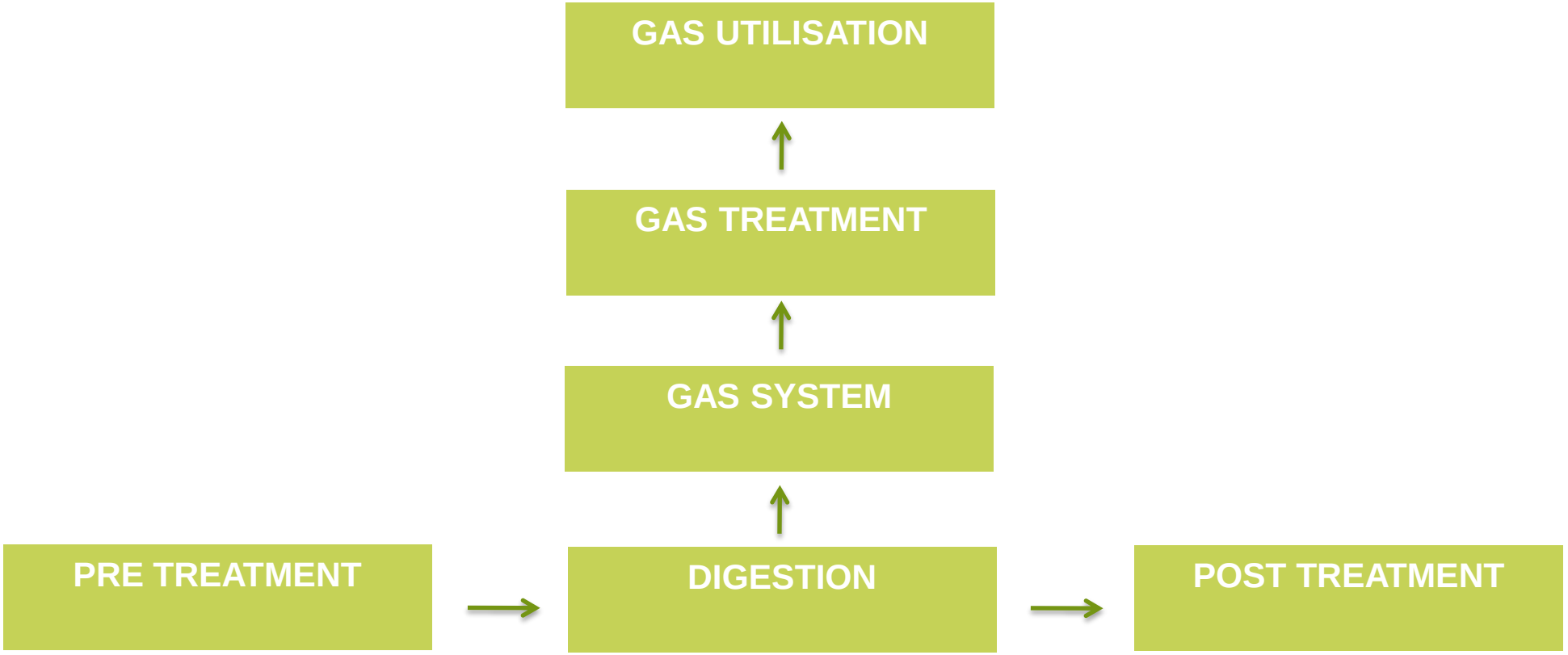
Influent values at YongYeon WWTP 2006 (Base year)

	2006	
Q average	235 315	m^3/d
Influent	mg/L	kg/d
BOD	105	24 708
SS	112	26 355
N-tot	32	7 530
P-tot	3.2	753

Reduction rate over primary settlers

- BOD ca 30%
- SS ca 50%
- N and P ca 10%

Segmentation of a biogas plant



Scandinavianbiogas

Deliveries - Examples within the project

Deliveries

Pipe: Korea

Heat Exch. Pump: Italy

Mixing system: USA

Instruments: Holland, Germany, Sweden

NFP:s stokker: Sweden

Motors/Pump: Korea, Sweden

Scandinavianbiogas

Pre treatment - Food Plant: Extension

BEFORE

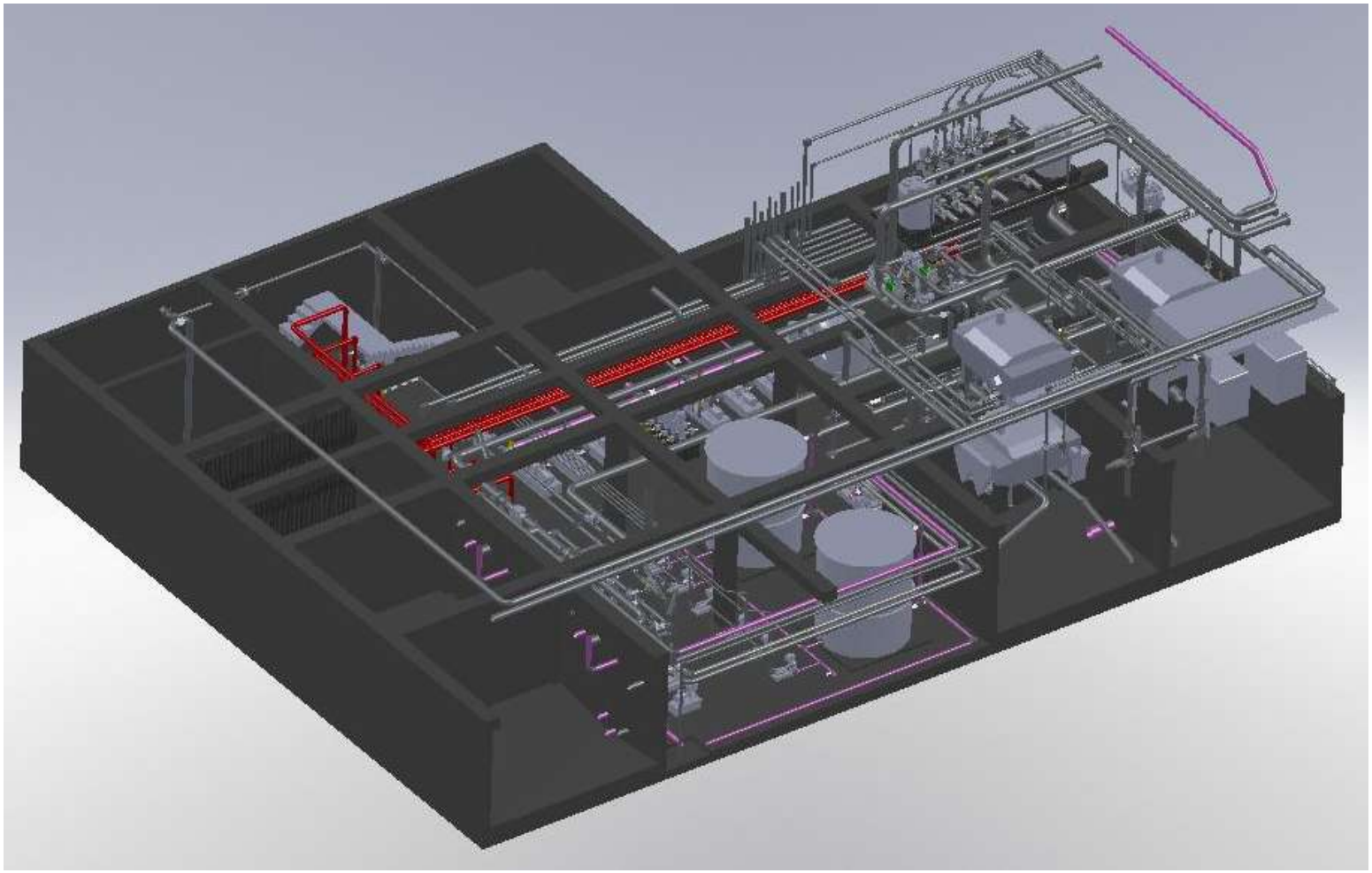
AFTER

Scandinavianbiogas

Pre treatment - Food Plant

Scandinavianbiogas

Pre treatment - Dewatering of PS



Design in 3D – Works completed

Scandinavianbiogas

Pre treatment - Mechanical dewatering of PS

Scandinavianbiogas

Digestion - renovation of digesters

Removal of existing equipment

Gas dome

Heat exchange pump

Safety Outlet

Motor to central mixing device

Scandinavianbiogas

Digestion - renovation of digesters

Scandinavianbiogas

Digestion - renovation of digesters

Installation of pumps

Piping

Instrumentation

Digester refurbishment

Control system

Scandinavianbiogas

Gas System Renovation (1/2)

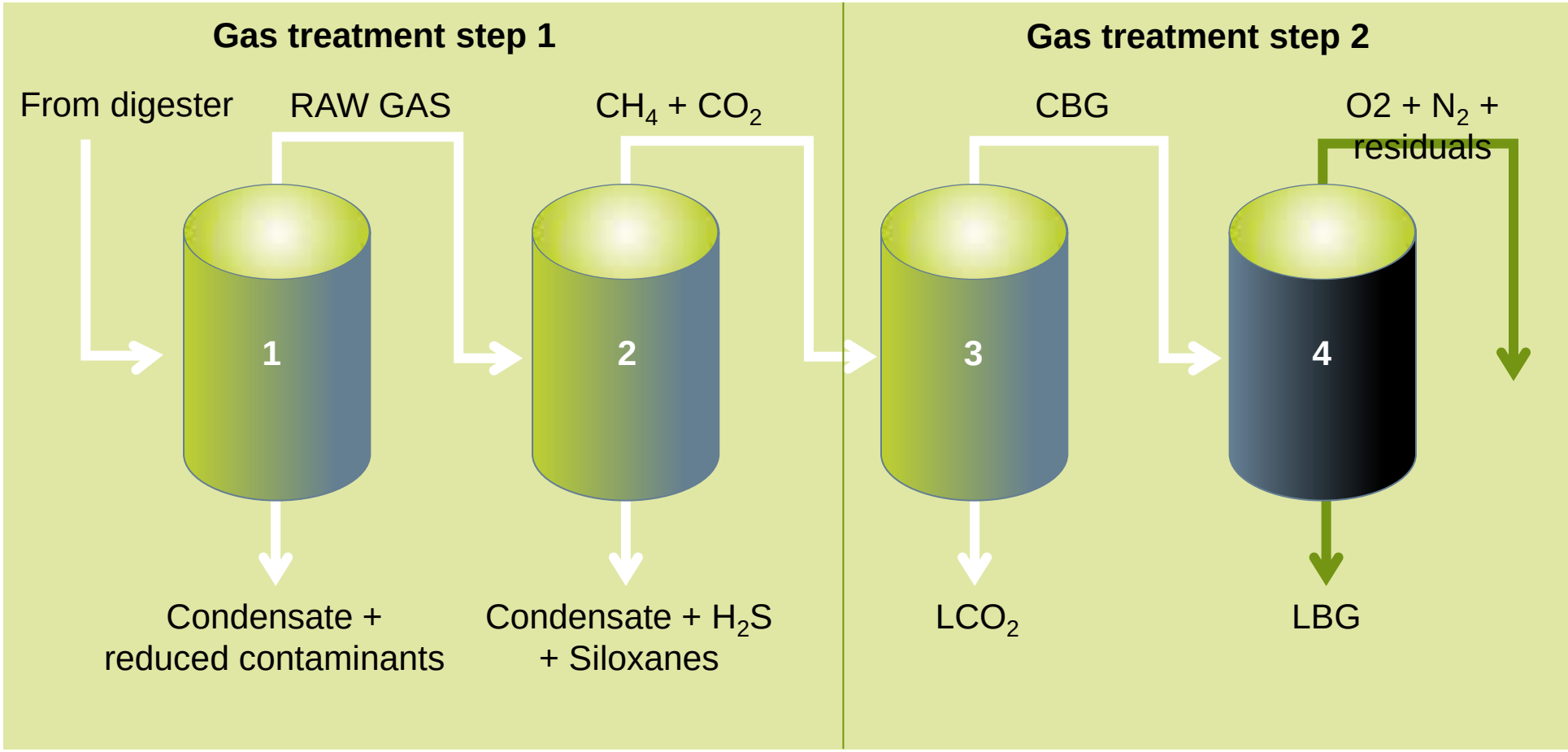
Scandinavianbiogas

Gas System Renovation (2/2)

Scandinavianbiogas

Cryogenic Gas-treatment

CBG & LBG gas treatment modules



Scandinavianbiogas

Gas treatment Step 1

- Gas treatment step 1
  - Green container: Drying and Compressors
  - Soxia filter: H_2S and siloxane removal
- Gas treatment step 2
  - To be implemented 2015

Maximising Biogas production

BEFORE		AFTER	
Volume in:	*600 m3/day*	***Volume in:***	*620 m3/day*
Load:	*18 ton VS/day*	***Load:***	*38 ton VS/day*
	ca. 1.3 kgVS/m³/day		*ca. 2.7 kgVS/m³/day*
VS reduction:	*30-35 %*	***VS reduction:***	*70 %*
Gas Production:	*ca* ***5-8 000 m3/day***	***Gas Production:***	*ca* ***30 000 m3/day***
Methane content:	*61.5%*	***Methane content:***	*61%*

- The Ulsan plant was the first biogas plant in South Korea to be approved according to new Korean biogas law
- The Ulsan plant treats 1.3% of all South Korean food waste (2012)
- The Ulsan biogas plant produces 6% of all biogas in South Korea (2012) ranked n:o 4 in the nation
- The major share of biogas produced (ca 11 M Nm^3/yr) is sold to a nearby industry and distributed via gas pipe. Internal use of biogas is c:a 8%

A good staff on site!!

Scandinavianbiogas

Ulsan, Korea

SBF have invested 15 M EUR in:

- Expansion of food plant to fourfold treatment capacity
- Refurbishment of digester
- Re-construction of primary sludge thickening from gravity to mechanical dewatering
- Odor treatment
- Treatment of raw biogas from H2S and siloxanes
- Compression of biogas for efficient transport in pipes
- Representative building

The work goes on – higher efficiency can be achived

- Follow up on Operation by special working group with focus on safety and economical profitability.
- Examples of future actions
  - More food waste to be treated
  - Reduction of light grit (today ca 12%) by better separation of plastics
    - Reduce costs of grit
    - Increase gas yields
  - Utilization of upgraded gas as fuel for vehicle
  - Sale of CO_2

Thank you for your attention – Questions?

Contact information

Scandinavian Biogas Fuels AB
Holländaregatan 21A -111 60 Stockholm

Switchboard: +46 (0)8 50 38 72

Matti Vikkula
CEO and President
matti.vikkula@scandinavianbiogas.com
+46 (0)70 597 99 38

Jörgen Ejlertsson
Director R&D
jorgen.ejlertsson@scandinavianbiogas.com
+46 (0)73 993 95 73

Michael Olausson
CFO, VP
michael.olausson@scandinavianbiogas.com
+46 (0)70 537 53 73

Björn Magnusson
Process Engineer R&D
bjorn.magnusson@scandinavianbiogas.com
+46 (0)70 396 27 96