ECN-RX--06-072

Green gas (SNG) in the Dutch energy infrastructure

H. Boerrigter

Presented at the Wetsus Meeting, Workshop Energy
30 March 2006 Leeuwarden, the Netherlands

Revisions		
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Made by: H. Boerrigter	Approved/Issued by: J.W. Erisman	ECN Biomass, Coal & Environmental Research
Checked by: J. Beesteheerde		

APRIL 2006

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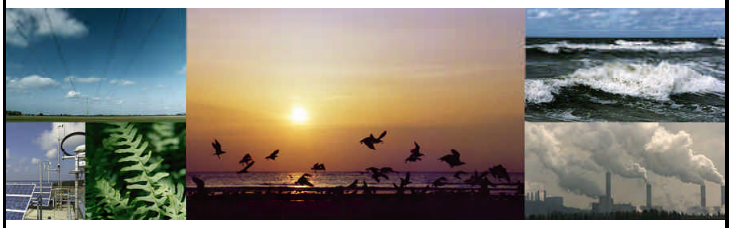

Green Gas (SNG)
in the Dutch Energy Infrastructure

Potential & Implementation

Dr. ir. Harold Boerrigter
Energy research Centre of the Netherlands (ECN)
ECN Biomass, Coal & Environmental research

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- Definitions
- Motivation for Green Gas
- Potential & application
- Green Gas & SNG implementation
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Energy research Centre of the Netherlands

in the dunes of North Holland

- Independent energy research institute
- Founded in 1955
- 650 staff
- Annual turnover: 80 million EURO
- Activities:
  - Biomass & Coal
  - Solar
  - Wind
  - Fuel Cells
  - CO_2 Capture & Storage
  - Energy Efficiency
  - Policy Studies

ECN in a glance

Mission

- ECN is the largest, independent, market oriented, and innovative Dutch energy research institute.
- A sustainable development is the guiding principle for all ECN activities.
- ECN investigates and develops technologies and products for a safe, efficient, and environment-friendly energy supply.
- ECN bridges the gap between research and market application.

ECN develops high-quality knowledge and technology for the transition to a sustainable energy supply

Definition of "Green Gas"

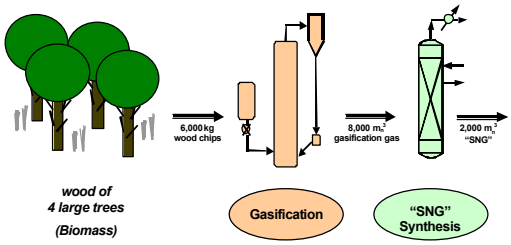
Biogas and SNG

Biogas	- produced by digestion, contains mainly CH_4 and CO_2
Landfill gas	- product of landfills, composition similar to biogas
SNG	- "Synthetic Natural Gas", contains mainly CH_4 - produced via gasification followed by methanation - main sources: coal and biomass
bio-SNG	- SNG from biomass
"***green natural gas***"	- comprising both bio-SNG and upgraded biogas/landfill gas
or "***green gas***"	- complies with specifications for injection to natural gas grid - has same properties as natural gas - can be used in all existing equipment
Syngas	- synthesis gas: H_2 and CO (and CO_2 and H_2O); of fossil origin - produced via gasification or reforming of coal, oil residues, or natural gas
Biosyngas	- biomass origin; chemical identical to syngas - produced via high-temperature (>1200°C) or catalytic gasification
Product gas	- produced via low-temperature (<1000°C) gasification - contains H_2, CO, CH_4, CxHy incl. tar (and CO_2 and H_2O)

Synthetic Natural Gas (bio-SNG)

Production & applications

spatial heating



"Gr
one
for

warm tap water

cooking

"*Green Gas*" for one household for one year

Biogas and SNG

Characteristics

Green Gas = **Upgraded Biogas** + **Synthetic Natural Gas (SNG)**

	Upgraded Biogas	Synthetic Natural Gas (SNG)
• **Technology**:	digestion / landfill	gasification & methanation
• **Status**:	commercially available	in development
• **Implementation**:	today	after 2010
• **Production scale**:	small *(~300 kW)*	large *(~1,000 MW)*
• **Potential**:	limited *(< 60 PJ)*	unlimited *(> 240 PJ)*
• **Feedstock**:	wet biomass *(available)*	dry biomass *(import required)*

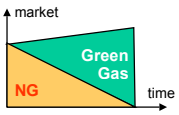
Why (Green) Gas?

International energy developments

- Security of supply
  - *decrease dependency on one politically unstable region (crude oil)*
  - *energy as political 'pressure tool', i.e. Russia (for natural gas)*
- Increasing prices of fossil fuels
  - *fast growing economies China & India*
- Fuel diversification
  - *decrease dependency on oil*
  - *use coal, biomass, and natural gas (LNG)*
- Depleting resources of fossil fuels
  - *crude oil (20-40 years)*
  - *natural gas (40-60 years)*
  - *coal (~200 years)*
- Natural gas is solution for medium-long term

Why Green Gas?
Environmental considerations

- Reduction of Greenhouse Gas (GHG) emissions
  - *Kyoto protocol (CO_2)*
- Agricultural development
  - *production of biomass in EU-25*
  - *job creation & rural development*
- Local emissions
  - *gas is a clean fuel*
  - *reduce local emissions from transport*
  - *EU targets for natural gas as transport fuel*
- Implementation
  - *natural gas market is growing*
  - *Green Gas is additional to natural gas*
  - *in time Green Gas can compensate for decrease in natural gas*



Why Green Gas?
Netherlands situation

- Security of supply is not a big issue (for natural gas)
- Renewable energy targets are main driver (Kyoto)
  - *substitution of 10% primary energy by renewables in 2020*
  - *biofuels: 2% in 2005, 5.75% in 2010, and 15% in 2020*
- "Energy Transition" of government
  - *30% substitution of primary energy by renewables in 2040*
- Energy Transition Working Group "Green Gas" (proposal):

  => 20% substitution of natural gas by Green Gas in 2030

Potential of Green Gas
Netherlands situation

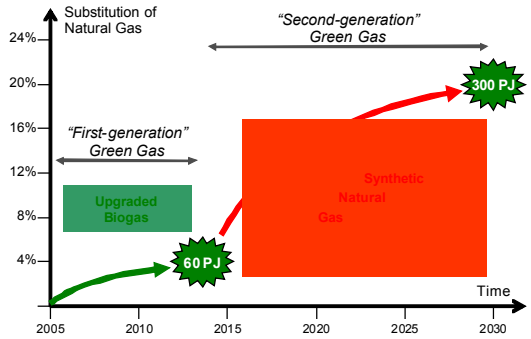
- In the Netherlands (2004), in total 3,300 PJ primary energy is consumed:

[PJ/y]	Coal	Crude oil	Natural Gas	Other	Total
Electricity	200	10	350	300	860
Transport	.	480	.	10	490
Heat	40	240	1,100	20	1,400
Chemistry	70	370	90	20	550
Total	*310*	*1,100*	*1,540*	*350*	*3,300*

- **20% natural gas substitution = 300 PJ "Green Gas"**
- Large potential for Green Gas = **HEAT**
  - *40% of heat is used by distributed small consumers (i.e. households)*
  - *96% of this heat is from natural gas combustion*

Green Gas implementation

Target: 20% substitution (300 PJ) in 2030



Green Gas / SNG for renewable heat

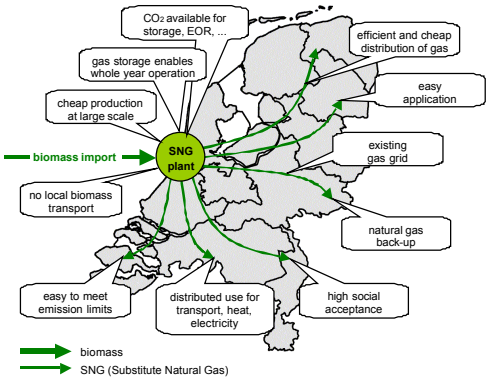
Advantages (1)

The advantages of SNG for distributed heat production are:

- large-scale production / small-scale utilization
- gas storage: production all year
- efficient distribution: 1% (S)NG loss vs. typically 15% energy loss in heat distribution systems
- no new infrastructure needed
- SNG combustion: easy-to-meet local emission limits
- high social acceptance
- natural gas back-up (security of supply!)
- ease of introduction: only few industrial partners, but many end-users
- free market possibility (similar to green electricity)

Green Gas / SNG for renewable heat

Advantages (2)



Green Gas / SNG for renewable heat

Alternatives

- Local biomass combustion
  Disadvantages: large number of small-scale plants in populated areas, relative expensive due to small scale
- Combined Heat & Power (CHP) plants
  Disadvantages: large number of small-scale plants, relative expensively due to small scale, electricity and heat demand not in balance
- All electric heating
  Disadvantages: new equipment, new power capacity and network expansion required, only high efficiency combined with (expensive!) heat pumps

=> SNG is the best route for the large-scale production of renewable heat
large-scale centralized production plants, transport via existing gas grid, local consumption, clean conversion

Green Gas implementation

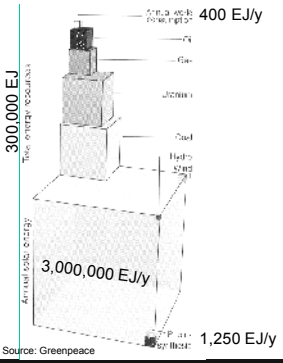
Required SNG production capacity

- Biomass feedstock is imported in the Netherlands
- Biomass available in large amounts in few harbours
- Typical SNG production plant = 1,000 MW_{th}
- Total 12 plants required
- Total annual biomass consumption:
  - *20 million tonnes per year*
  - *1.7 million tonnes per plant*

- Is that a lot? **YES!**
- Is that unrealistic? **NO!**

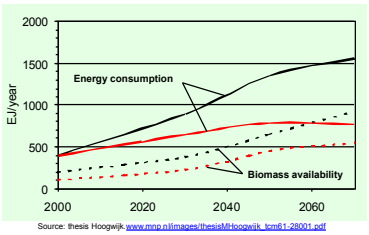
Is there enough biomass??

Two approaches



Source: Greenpeace

Economic & Biomass scenario's



Source: thesis Hoogwijk, www.mnp.nl/images/thesisMHoogwijk_tcm61-28001.pdf

Yes, there is enough biomass…
to be a serious option for renewable energy generation and SNG production

Required biomass import

References (1)

Import & Export by sea shipping (2004)			Transhipment [million tonnes per year]			
Harbour	Position	Share	Total	Coal	Crude oil & Oil products	Ores & Minerals
Netherlands	-	100%	463.8	46.7	160.7	71.0
Rotterdam	1	76%	352.0	25.3	136.0	50.0
Amsterdam	2	11%	50.0	12.7	16.0	6.4
IJmuiden	3	4%	18.0	5.8	0.3	9.0
Delfzijl & Eemshaven	7	0.5%	2.3	0.008	0.013	1.2

- Total biomass requirement for SNG
  - same range as today's coal transhipment in Rotterdam
  - 4.3% increase for total Netherlands transhipment (in 2030)
- Biomass for one plant
  - would double transhipment in Delfzijl

Required biomass import

References (2)

Organic materials (2000) [kton/year]	Import	Export	Transhipment
Wood & Pulp	7,010	3,462	10,472
Oil seeds	7,133	1,845	8,978
Meat, Fish & Dairy	2,995	5,028	8,023
Cereals	6,413	630	7,043
Sugar & Cacao	1,926	1,856	3,782

- Total biomass requirement for SNG
  - double of today's would & pulp transhipment
- Biomass for one plant
  - same order as today's import of sugar & cacao
  - today's cereals transhipment equals biomass import for three SNG plants

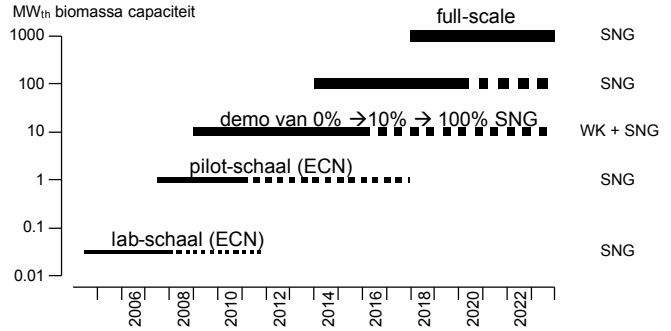
Economy

For large-scale SNG production in 2030

- The projected long-term production costs of **SNG = ~10 €/GJ$_{SNG}$**
- Additional costs:
  - *4 €/GJ, with a **natural gas price = 6 €/GJ***
  - *equivalent to ~1.5 €ct/kWh electricity*
  - *carbon costs: ~75 € per ton CO_2*
- Support options:
  - *subsidy (e.g. "Gas MEP") of 4 €/GJ*
  - *establishment of CO_2 trading market*
  - *additional costs of ~2.0 €ct for each m_n^3 gas consumed*
- But what happens to the natural gas price in 2030?
  - *increase to level of SNG production costs*
- Financial support required for Development and Demonstration
  - *new technology*
  - *first plants are small scale*

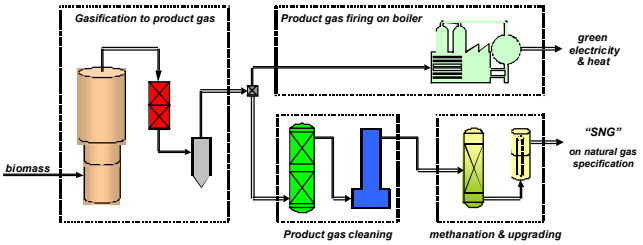
Implementation trajectory

Phased approach



SNG demonstration project

Slipstream SNG



Possible line-up of demonstration project

- 10 MW_{th} biomass gasifier (~15 kton/jr)
- Production of green electricity with boiler-firing
  - *low risk, direct profit*
- slipstream gas for demonstration
- product gas cleaning & "Green Gas"
  - *attractive demo (subsidies)*

Conclusions

- Natural gas increasingly important as fuel for medium-long term
- Green Gas important as renewable fuel
- Green Gas comprises biogas and SNG; SNG will be main source
- SNG mainly for heat in the Netherlands, excellent existing infrastructure
- Biomass import required to meet targets
  - *sufficient biomass available globally*
  - *logistics easily adaptable in existing infrastructure*
- Today, SNG is more expensive than natural gas
  - *but SNG is more attractive option and most green electricity routes*
- Implementation via phased approach with stepwise larger plants
- Development & Demonstration requires financial support
- SNG offers excellent opportunities for Dutch industry.

Thank you for your attention

For more information, please contact:

Dr. ir. Harold Boerrigter
phone +31 224 56 4591
fax +31 224 56 8487
email boerrigter@ecn.nl

Publications can be found on:
www.ecn.nl/en/bkm

Visit also: "Phyllis" - *internet database for biomass, coal, and residues: www.phyllis.nl*

"Thersites" – *internet model for tar dewpoint calculations: www.thersites.nl*

ECN Biomass, Coal & Environmental Research

Programme & Mission

Development of knowledge, concepts and (conversion) technologies for a cleaner environment and a sustainable use of biomass and/or coal for the production of energy, fuels and products.

Biomass research program
- Gasification and Gas Conditioning
- Heat and Power production
- Biofuels and Refinery Processes

- **Environmental research program**
- Air Quality and Climate Change
- Environmental Risk Assessment
- *Emission Reduction Technology*