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Energy research Centre of the Netherlands

Synthetic Natural Gas (SNG) from biomass

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Synthetic Natural Gas (SNG) from biomass

The potential & implementation of SNG by gasification of biomass

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Energy research Centre of the Netherlands (ECN)

ECN Biomass, Coal & Environmental Research

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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 M€
- Activities:
  - Biomass, Coal & Environmental Research
  - Solar
  - Wind
  - Hydrogen & Clean Fossil Fuels
  - Energy Efficiency in the Industry
  - Energy in the Built Environment
  - Policy Studies

ECN in a glance

Mission

- ECN is the largest, independent, market oriented, and innovative Dutch energy research institute.
- ECN focuses on the knowledge and information the government needs to develop and evaluate policy and achieve policy objectives in the field of energy, the environment and technological innovation.
- ECN partners industry in the development and implementation of products, processes and technologies important to the transition to sustainable energy management.
- ECN closely works together with Dutch and foreign universities and research institutes and performs a bridging function with implementation by carrying out technological research.

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

Definition of “Green Natural Gas”

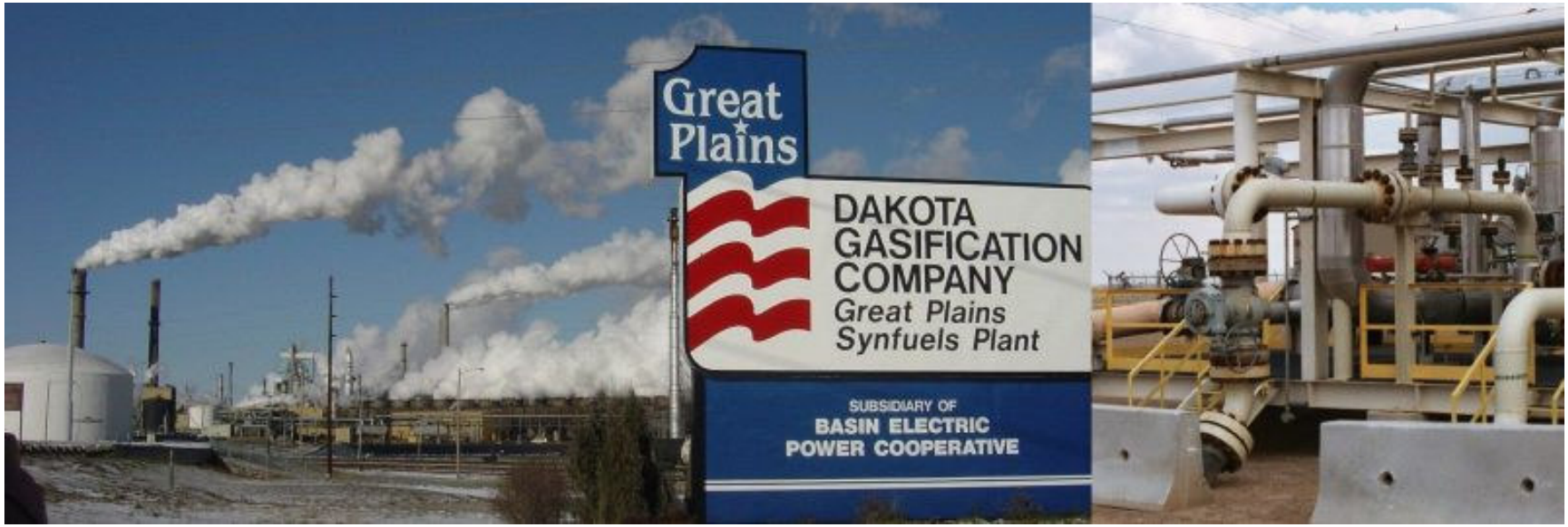
Biogas and SNG

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	- Synthetic Natural Gas from biomass
“***green natural gas***”	- Comprising both bio-SNG and upgraded biogas/landfill gas - Complies with specifications for injection to natural gas grid - Has same properties as natural gas - Can be used in all existing equipment

Synthetic Natural Gas (SNG)

Commercial availability

SNG	- Commercially available - Produced via coal gasification followed by methanation - Main producer: Dakota Gasification Company (USA)
bio-SNG	- Currently still in R&D phase



Green Natural Gas

Characteristics

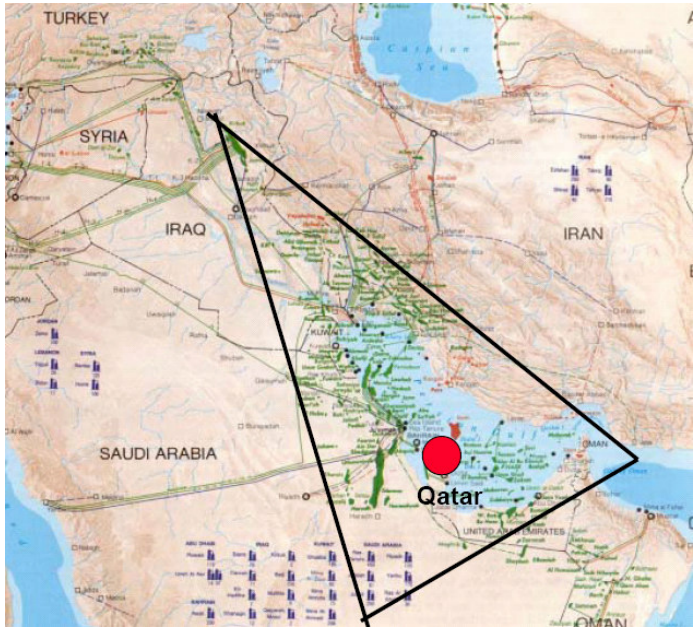
Green Natural Gas = **Upgraded biogas & landfill gas** + **bio-Synthetic Natural Gas (SNG)**

	Upgraded biogas & landfill gas	bio-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 (NL)**:	limited *(< 60 PJ/y)*	unlimited *(> 240 PJ/y)*
• **Feedstock**:	wet biomass *(available in NL)*	dry biomass *(import required)*

Why Synthetic Natural Gas?

International energy developments

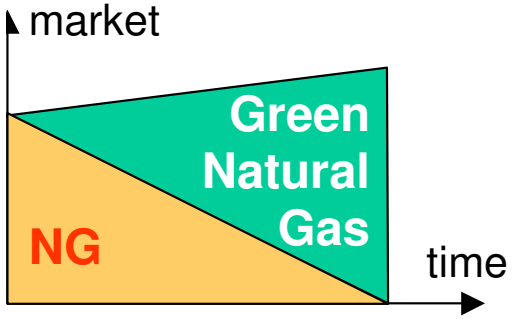
- Security of supply
  - *decrease dependency on one politically unstable region (crude oil)*
  - *energy as political 'pressure tool', i.e. Russia (for natural gas)*
- Increasing prices of fossil fuels
  - *fast growing economies China & India*
- Fuel diversification
  - *decrease dependency on oil*
  - *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)*
- SNG is solution for medium-long term



Why Green Natural 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 Natural Gas is additional to natural gas*
  - *in time Green Natural Gas can compensate for decrease in natural gas*



Why Green Natural Gas?

Dutch considerations

- 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" policy of the government
  - 30% substitution of primary energy by renewables in 2040

- Energy Transition Working Group "Green Natural Gas" (proposal):

  à ***20% substitution of natural gas by Green Natural Gas in 2030***

Potential of Green Natural Gas

Dutch situation

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

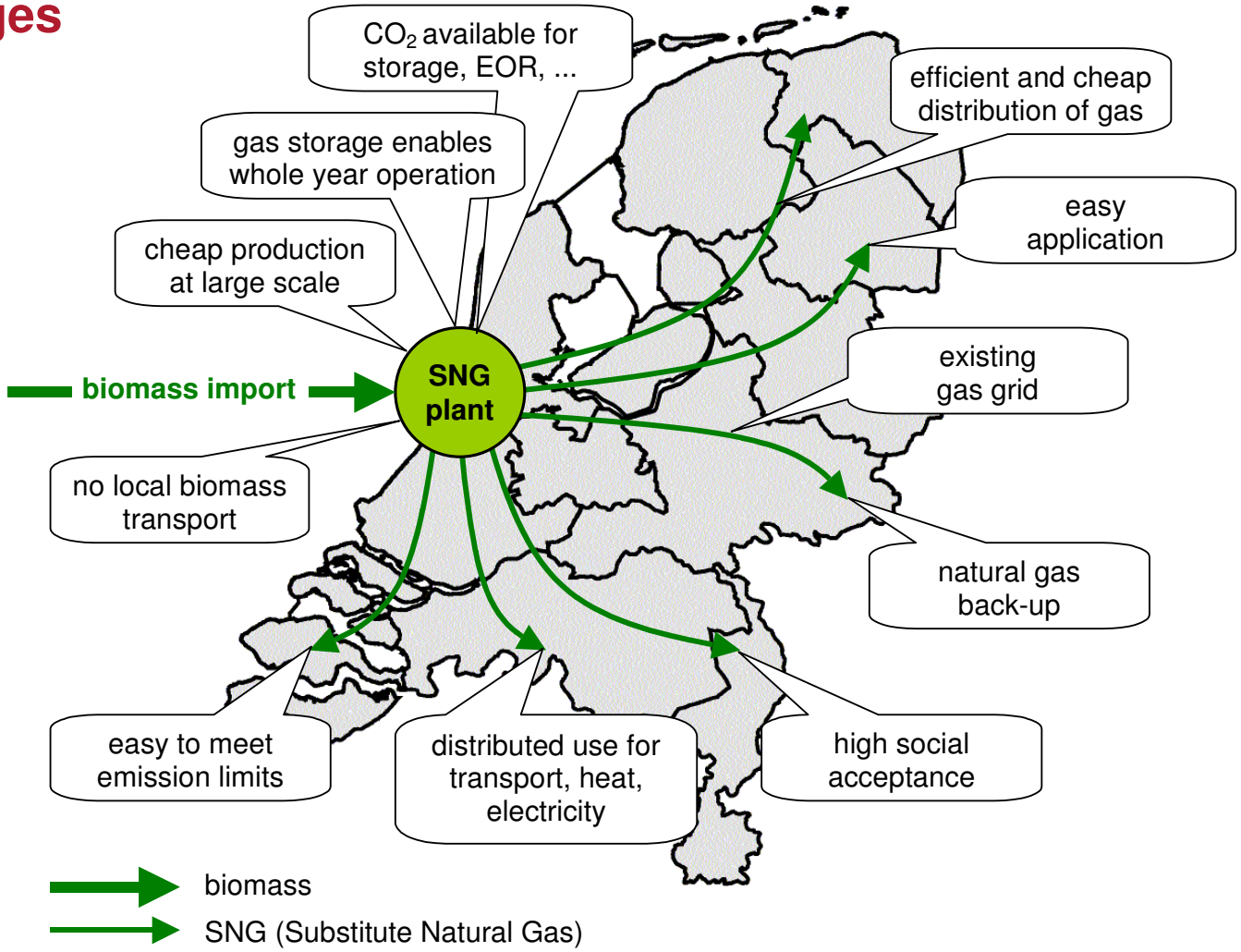
[PJ/y]	Coal	Crude oil	Natural Gas	Other	Total
Electricity	200	10	350	300	860
Transport	.	480	.	10	490
Heat	40	240	1,100	20	1,400
Chemistry	70	370	90	20	550
Total	*310*	*1,100*	*1,540*	*350*	*3,300*

- **20% natural gas substitution = 300 PJ "Green Natural Gas"**

- Large potential for Green Natural Gas = **HEAT**
  - 40% of heat is used by distributed small consumers (mainly households)
  - 96% of this heat is from natural gas combustion

Green Natural Gas for renewable heat

Advantages



Green Natural Gas for renewable heat

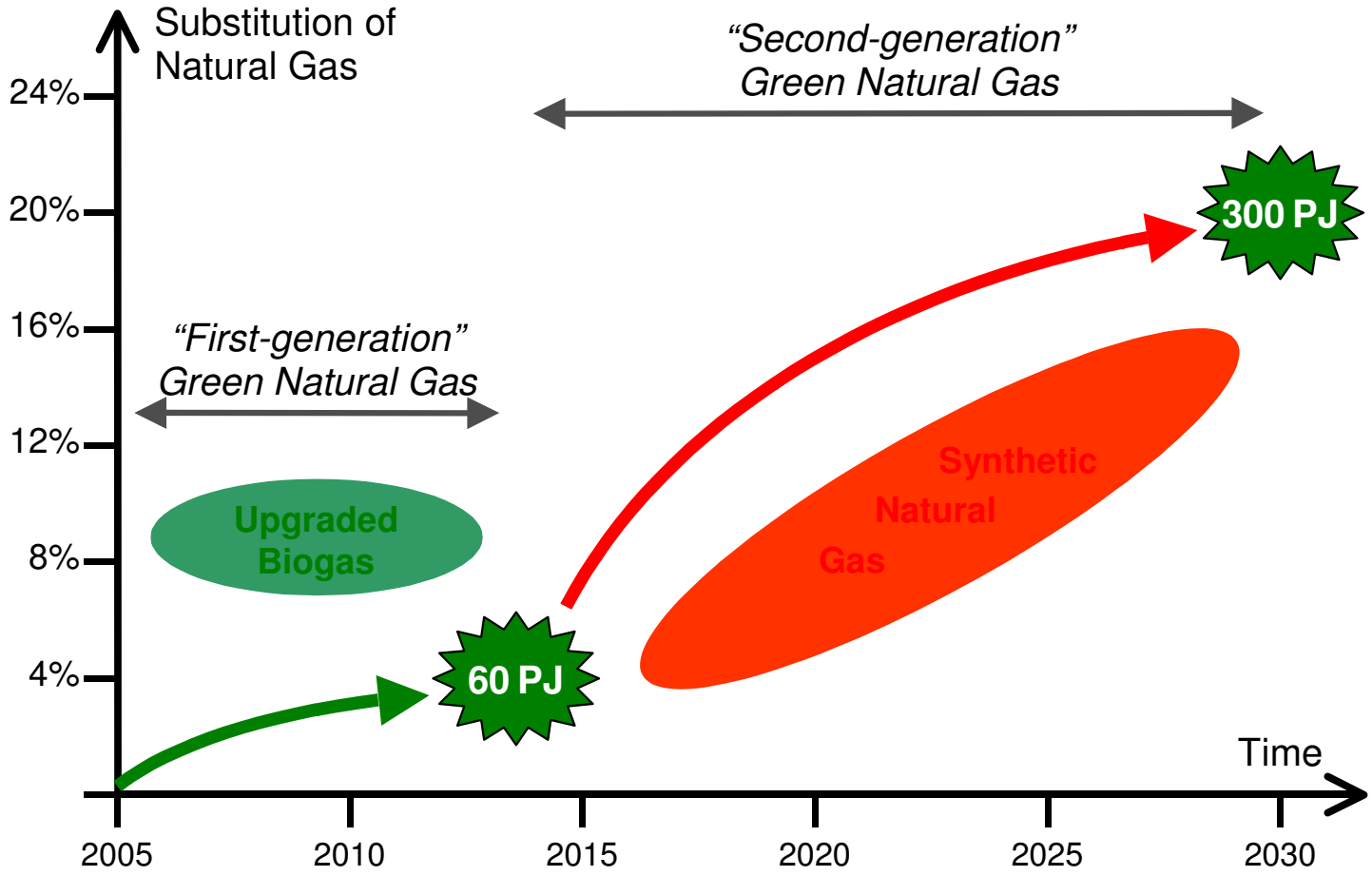
Alternatives

- Local biomass combustion
  Disadvantages: large number of small-scale plants in populated areas, relatively expensive due to small scale, emission problems
- Combined Heat & Power (CHP) plants
  Disadvantages: large number of small-scale plants, relatively 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

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

Implementation of Green Natural Gas

Dutch target: 20% substitution (300 PJ) in 2030



Implementation of Green Natural Gas

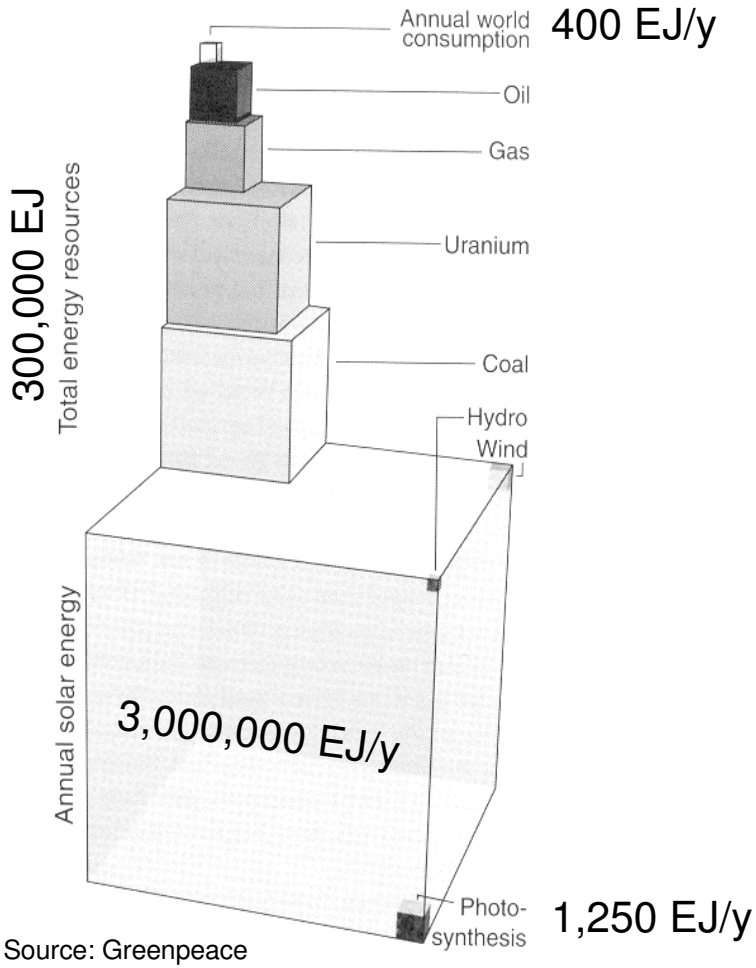
Required SNG production capacity

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

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

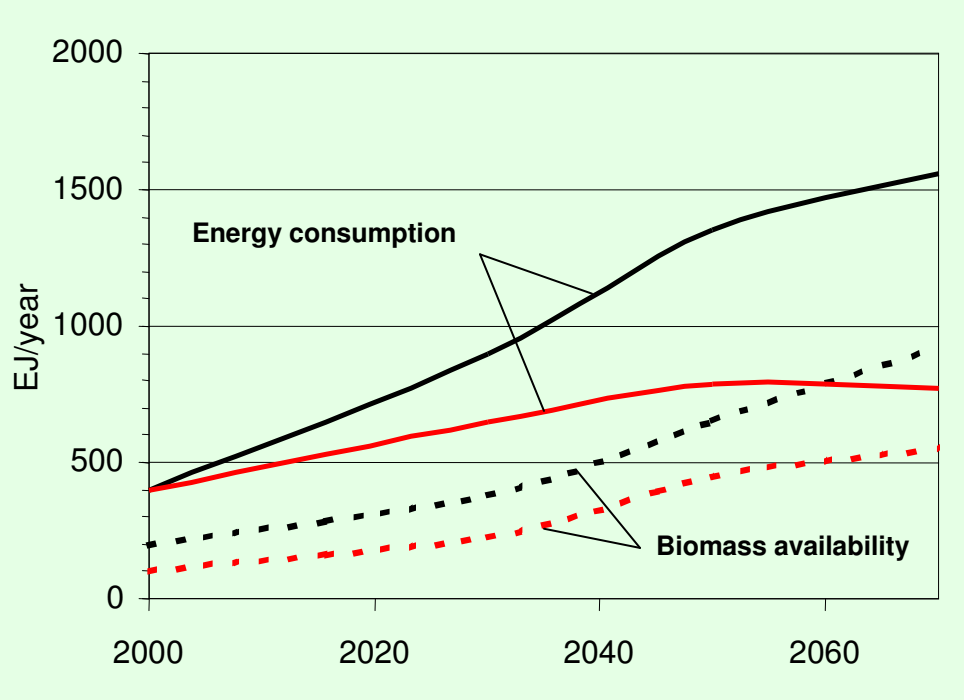
Is there enough biomass??

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 transshipment in Rotterdam
  - 5% increase for total Netherlands transshipment (from 2004 to 2030)
- Biomass for one plant
  - would double transshipment 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

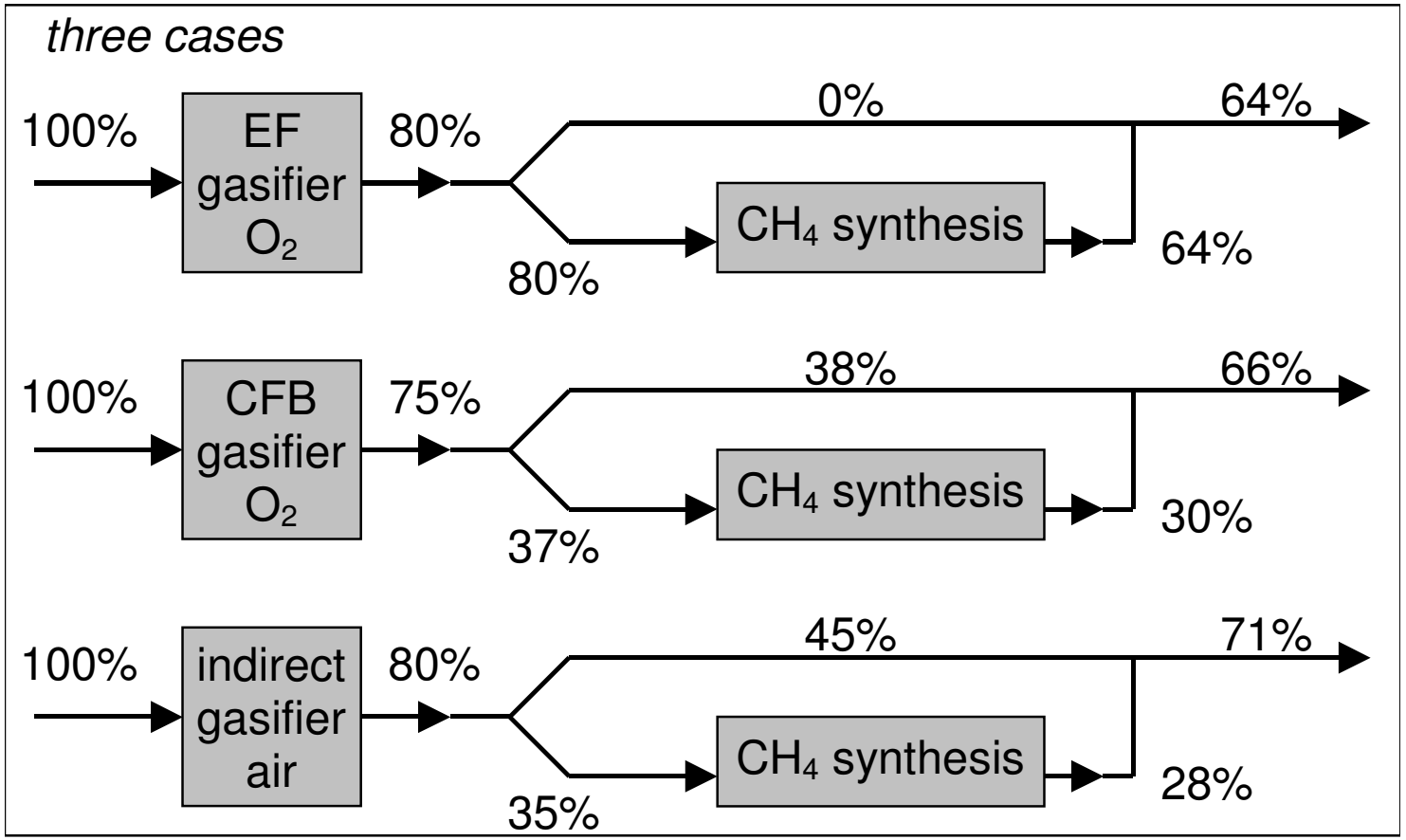
- Total biomass requirement for SNG
  - double of today's wood & pulp transshipment
- Biomass for one plant
  - same order as today's import of sugar & cacao
  - today's cereals transshipment equals biomass import for three SNG plants

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 2.5 €ct/kWh electricity
  - carbon costs: 50-75 € per ton CO_2
- Support options:
  - subsidy (e.g. "Gas MEP") of 4 €/GJ
  - establishment of CO_2 trading market
  - additional costs of ~2.5 €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

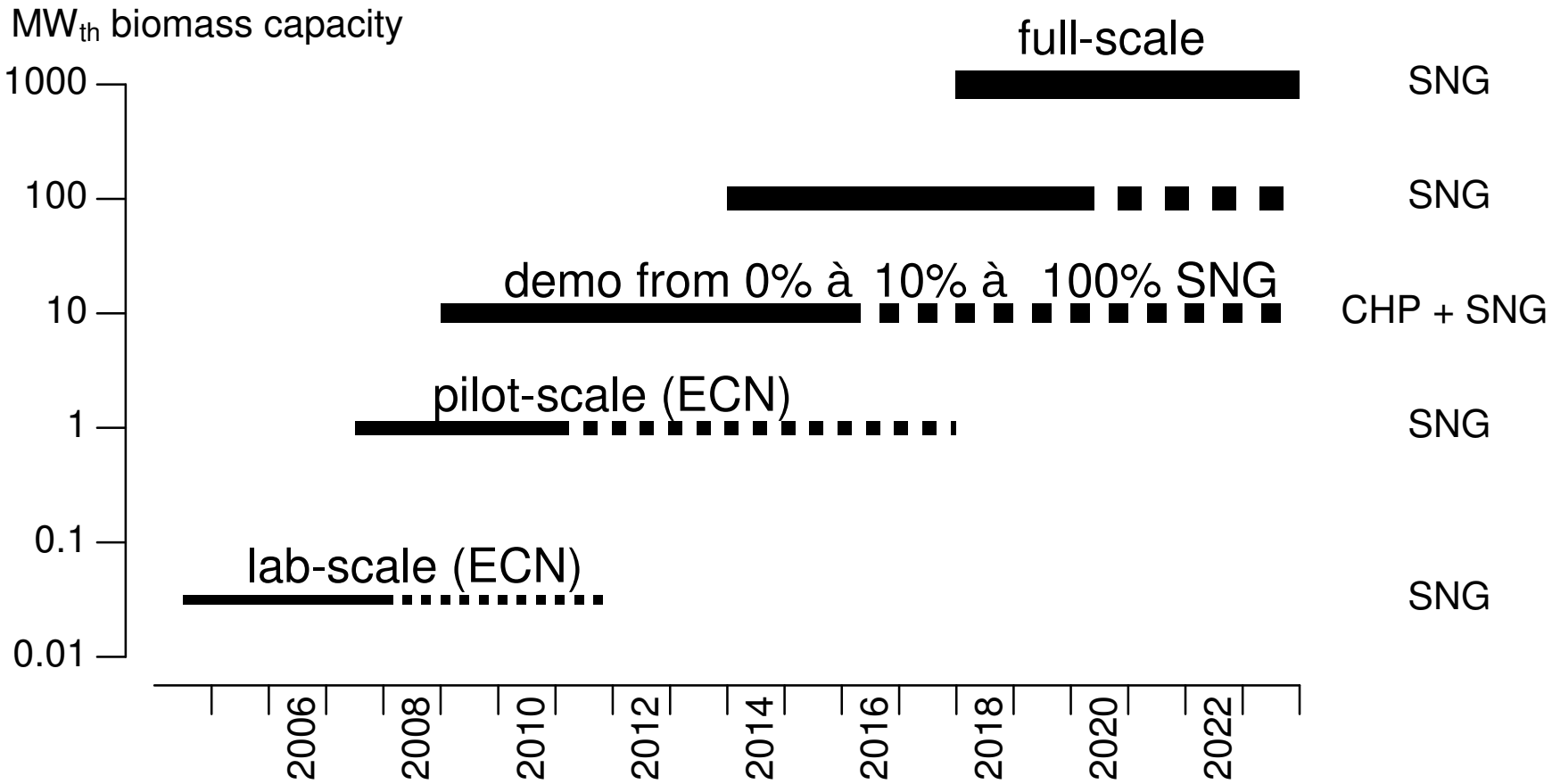
SNG production: efficiency



EF: entrained flow, CFB: circulating fluidised bed

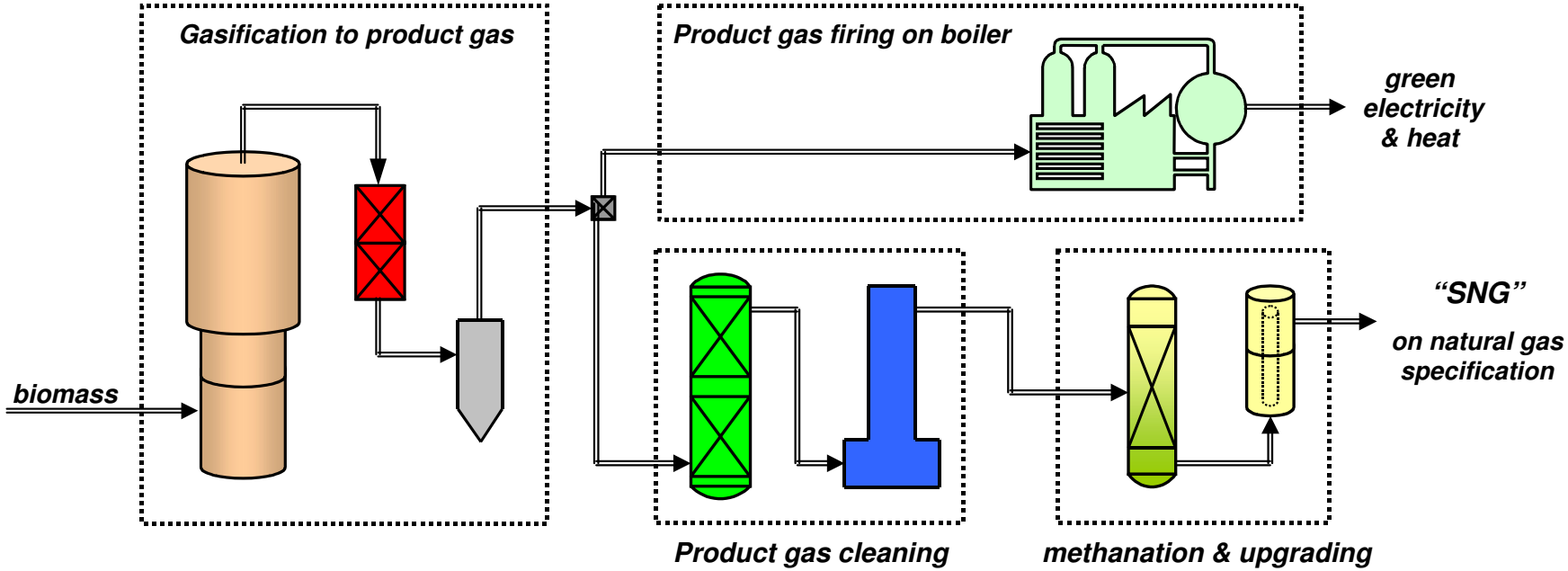
Implementation trajectory

Phased approach



SNG demonstration project

Slipstream SNG production



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 Natural Gas important as renewable fuel
- Green Natural Gas comprises biogas and SNG à 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 than 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

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

Including the latest report ECN-E--06-018 on the development and implementation of an integrated bio SNG system (coming soon)

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

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