Low Temperature Gasification

7th October 2010
Anders Boisen

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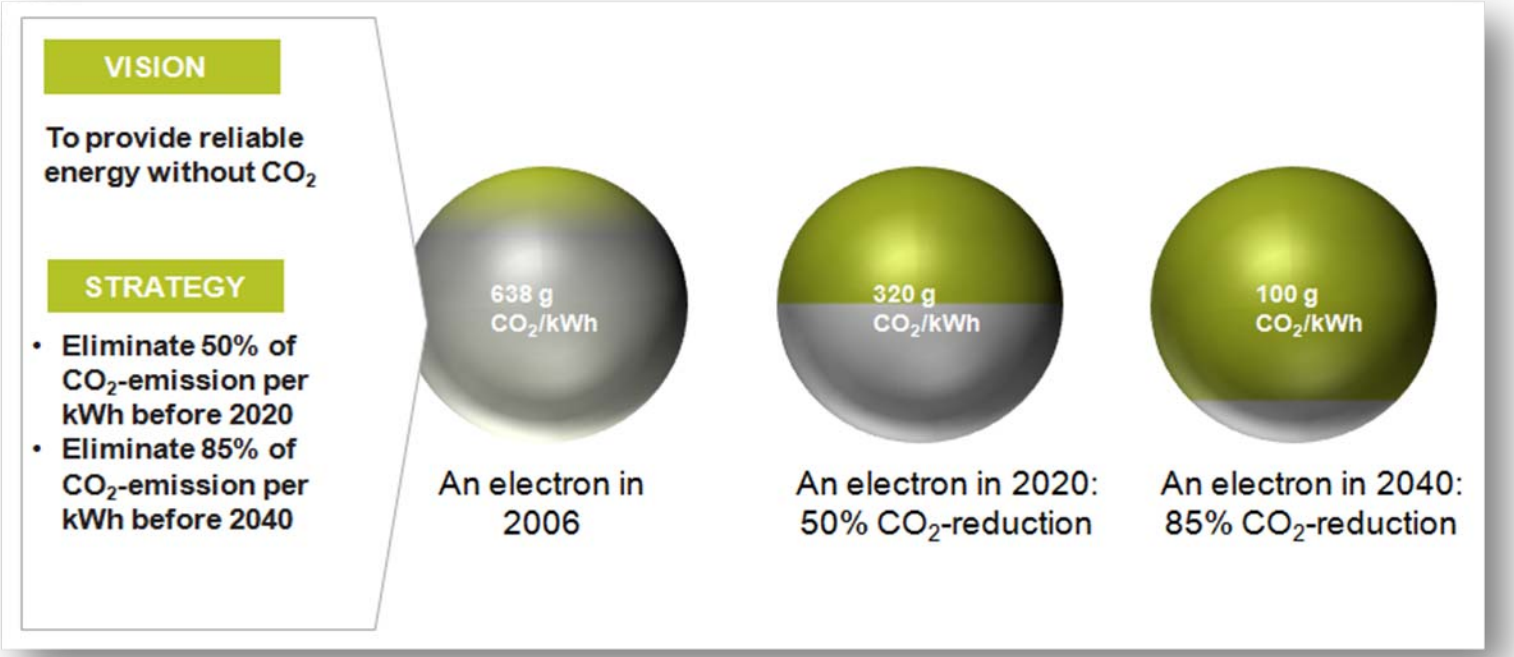
DONG Energy Power in transition 85/15



- DONG Energy has decided to transform into a CO_2 neutral future

- Investments in thermal energy are moved from coal to biomass and natural gas

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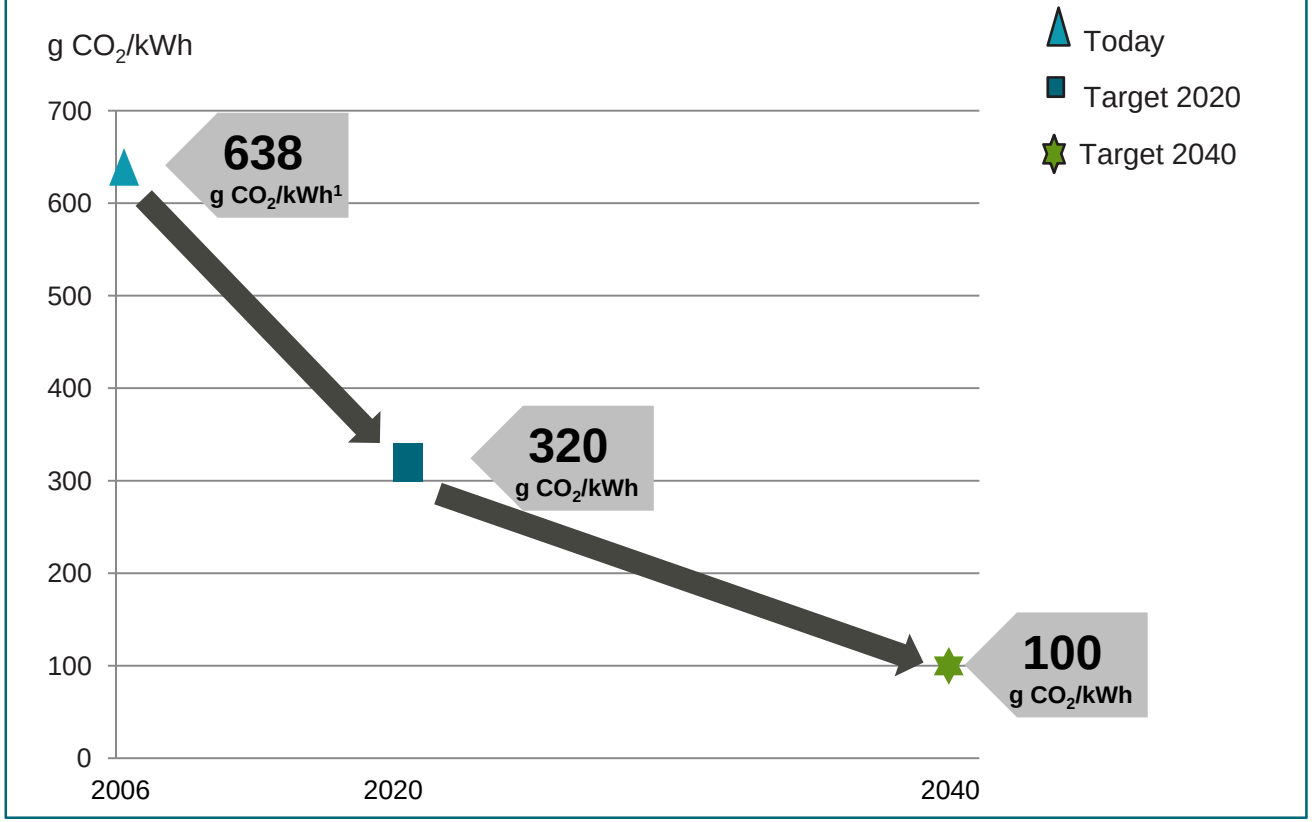
The 85/15 is frontloaded - with ambitious targets for 2020 and 2040

VISION	STRATEGY
To provide reliable energy without CO_2	Eliminate 50% of CO_2 emission per kWh before 2020 Eliminate 85% of CO_2 emission per kWh before 2040

Target for reduction in specific CO_2 emissions



1) 2006 total heat and power production 28,5 TWh eleq/ CO_2 emissions 18,2 mt = 638 g CO_2/kWh

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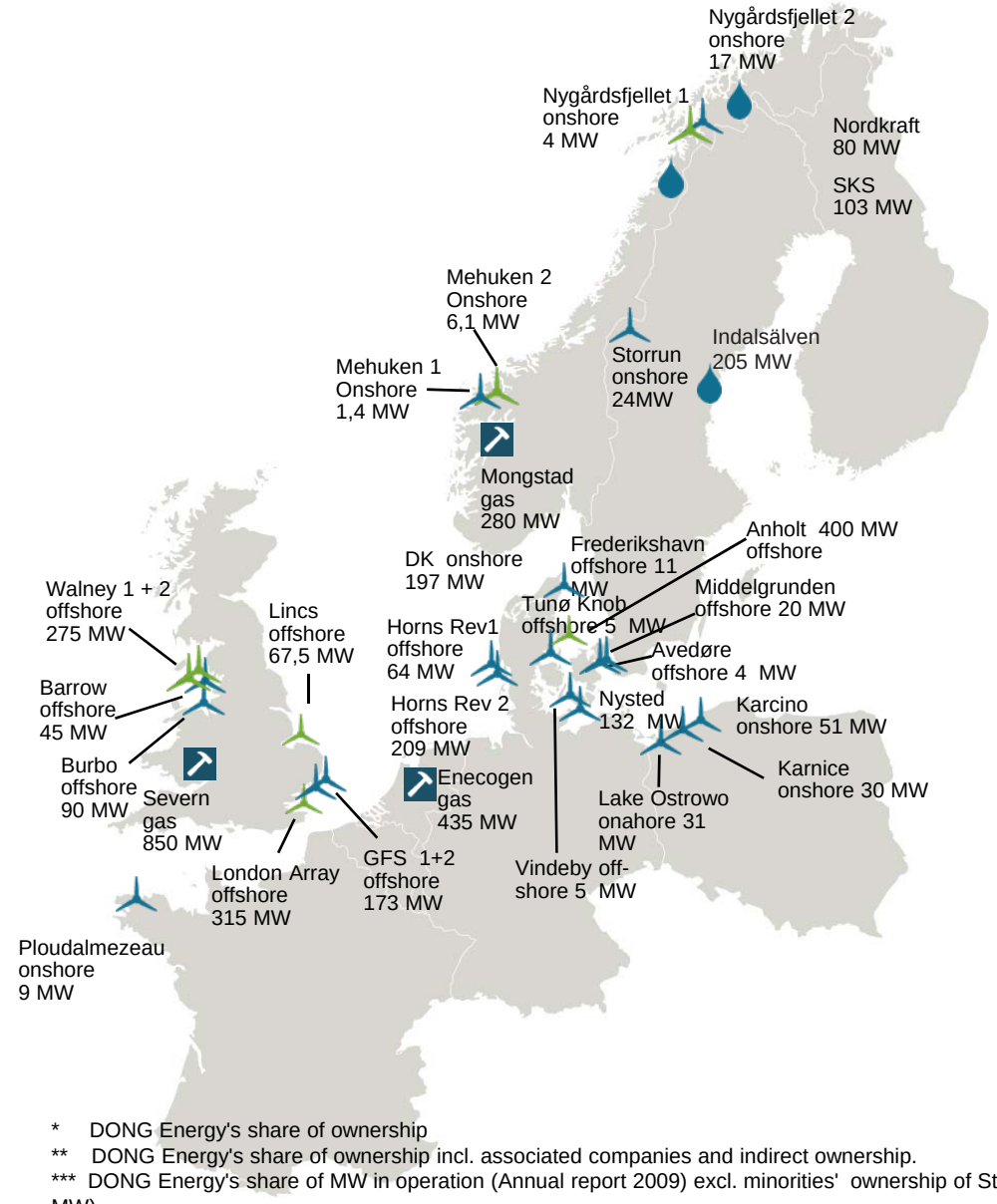
DONG Energy Power: Activities and development plan



THERMAL CAPACITY

Central	5,350 MW
Decentral	216 MW
Waste	96 MW
Thermal – under construction*	1,565 MW

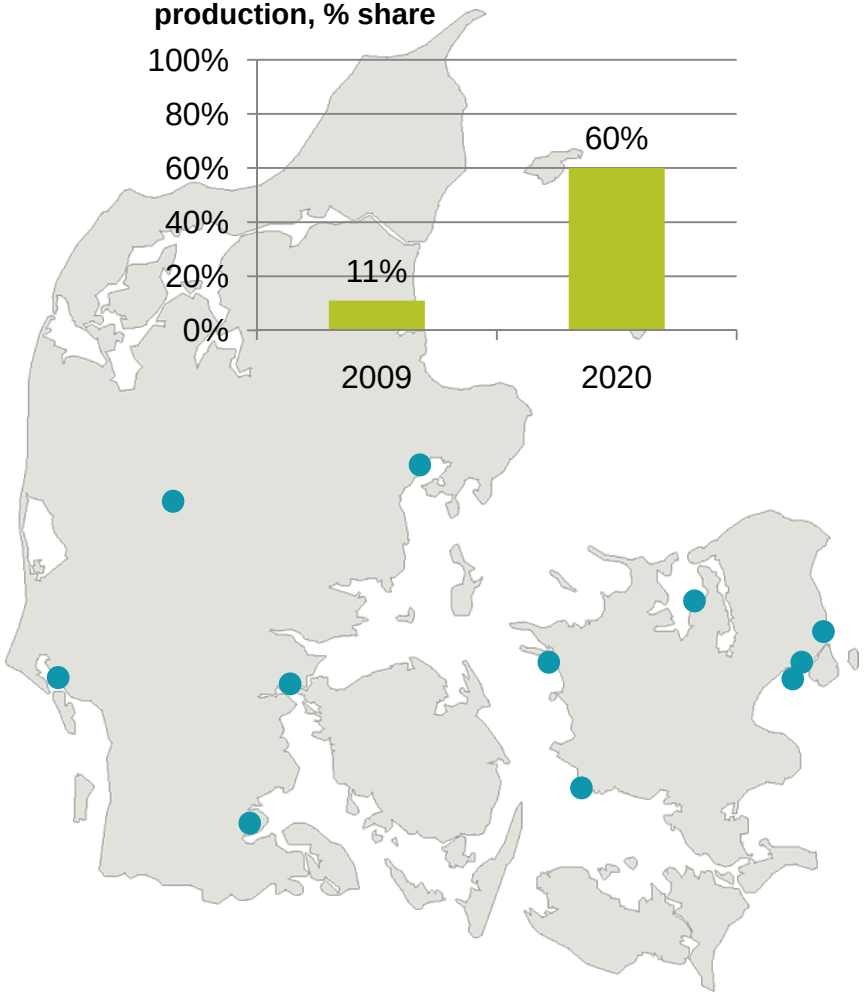
RENEWABLES CAPACITY

Hydropower	388 MW**
Wind in operation	1,098 MW***
Wind under construction	1074 MW****
Geothermal	

* DONG Energy's share of ownership
** DONG Energy's share of ownership incl. associated companies and indirect ownership.
*** DONG Energy's share of MW in operation (Annual report 2009) excl. minorities' ownership of Storrun (6 MW)
**** DONG Energy's share of MW under construction incl. Anholt

A large-scale green conversion of DONG Energy's CHP production in Denmark

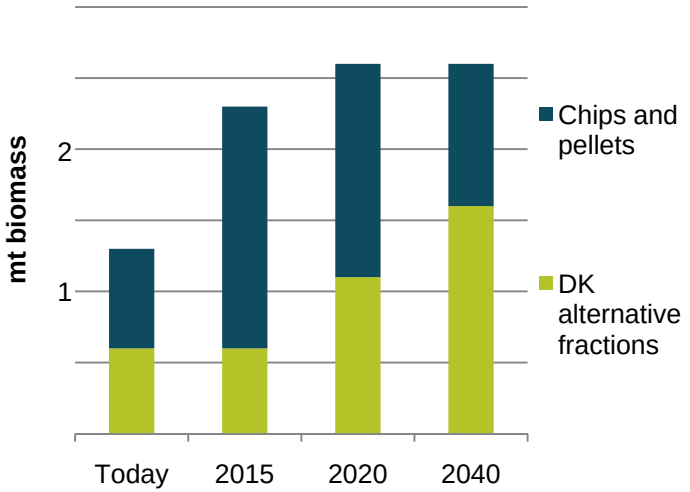
Biomass for combined heat and power production, % share



BUILDING ON EXISTING COMPETENCIES IN BIOMASS

HUGE POTENTIAL
Today less than 0.5% of annual wood harvest residues are converted to wood pellets. Global demand expected to grow steeply

NEED FOR A DIVERSE SUPPLY



LT-CFB – the simple process

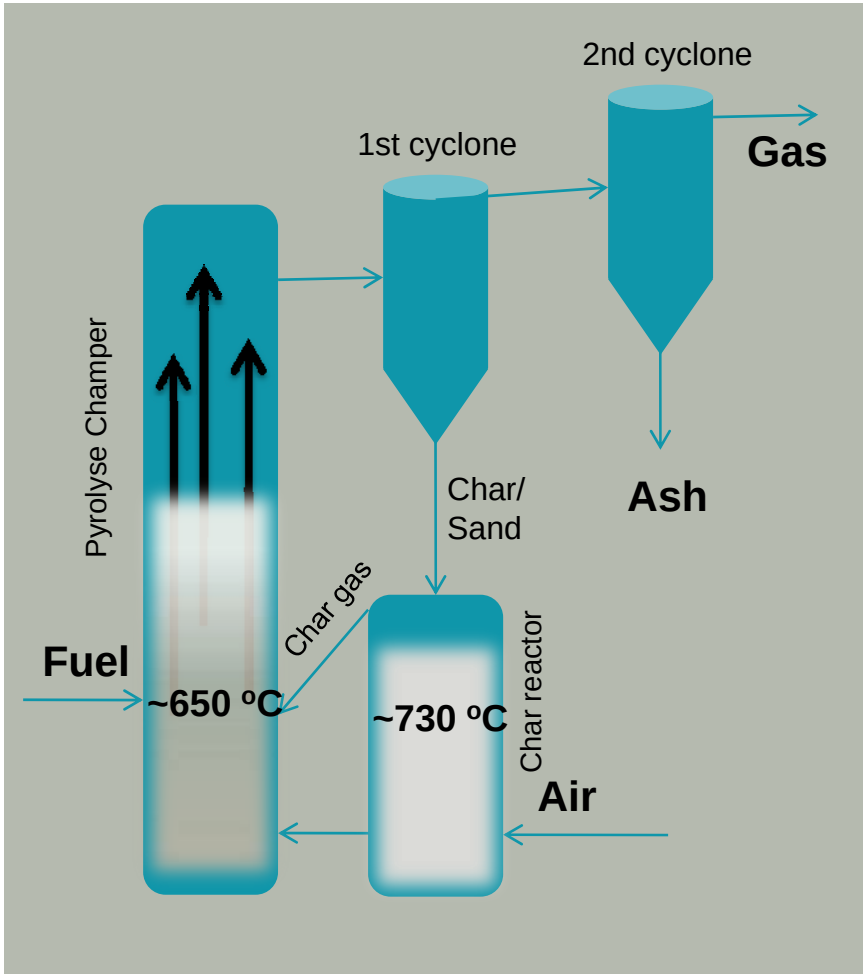
Dry fuel is pyrolysed into a tar containing gas

Char residues and sand is separated in the 1st cyclone

Char is oxidised with air in the char reactor, heating the sand

Sand is transported to the Pyrolysis CFB, and pyrolysis the fuel

The final char gas is cleaned in the 2nd cylone



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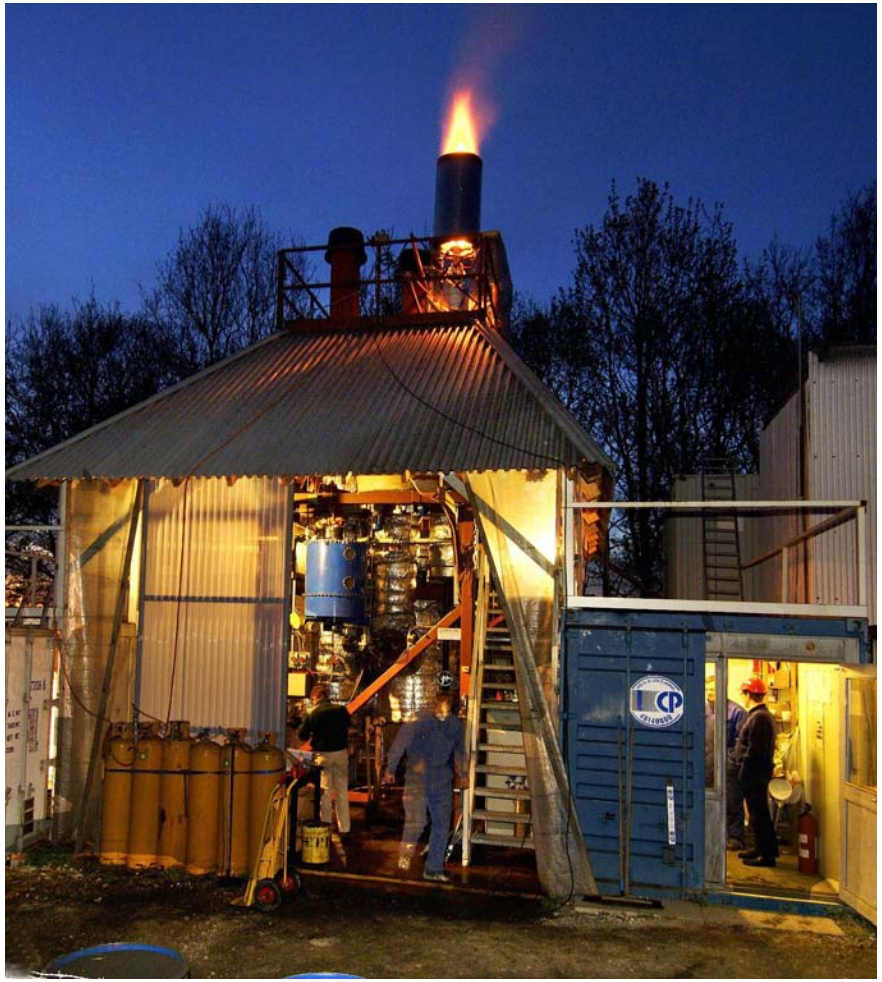
LT-CFB Landmarks I



- 1999 - 50 kW DTU
- 2003 – 500 kW DTU – up-scaling
- 2007 – 100 kW DTU – several fuels
- June 09 – R&D Committee approval
- December 09 – Stoholm agreement

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LT-CFB tests at DTU
- 35 tonnes in approx 500 hours

Test plants	Fuels tested	Hours >700°C	Gas cleaning
50 KW 1999-2004	Wood	2	SC (Sec. cyclone)
	Straw	92	SC
	Pig manure	12	SC
	Hen manure	16	SC
500 kW 2004-2006	Straw	35	SC
	Swine manure	42	SC
	Swine biogas residue	59	SC
	Common biogas residue	39	SC & TC (Tert.cyclone)
100 kW 2009-2010	Straw	124	SC
	Citrus &Sea weed residue	37	SC, Cooler, filter

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From biomass to gas by a low temperature gasifier in industry:

5-25 MW

LT - CFB

Gas

Ash + Salts

- and in power sector:

50-150 MW

LT - CFB

Gas

Ash + Salts

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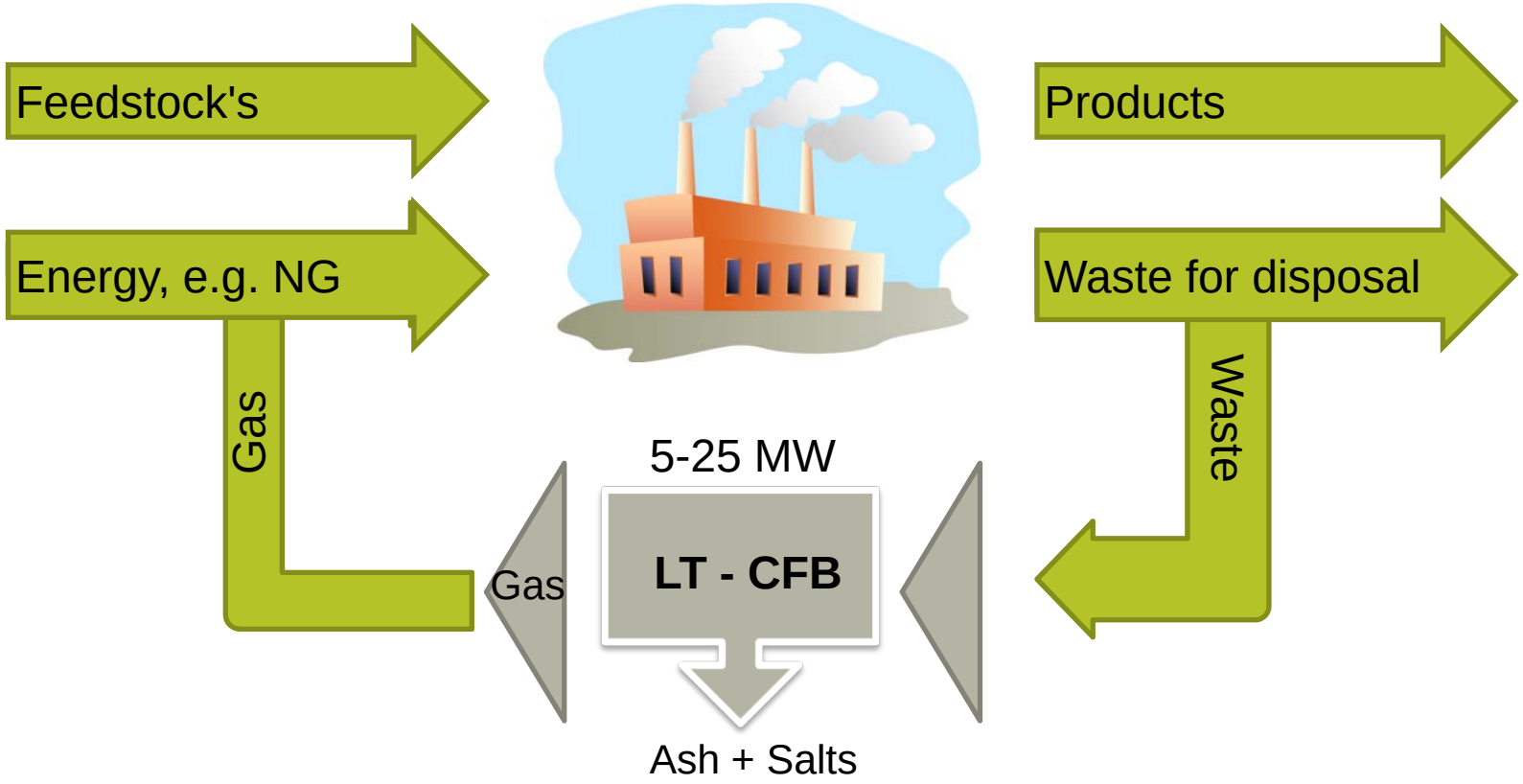
LT-CFB in industry:
NG is being replaced by local waste fractions



The LT-CFB gasifier can use cheap local waste fractions to replace expensive natural gas

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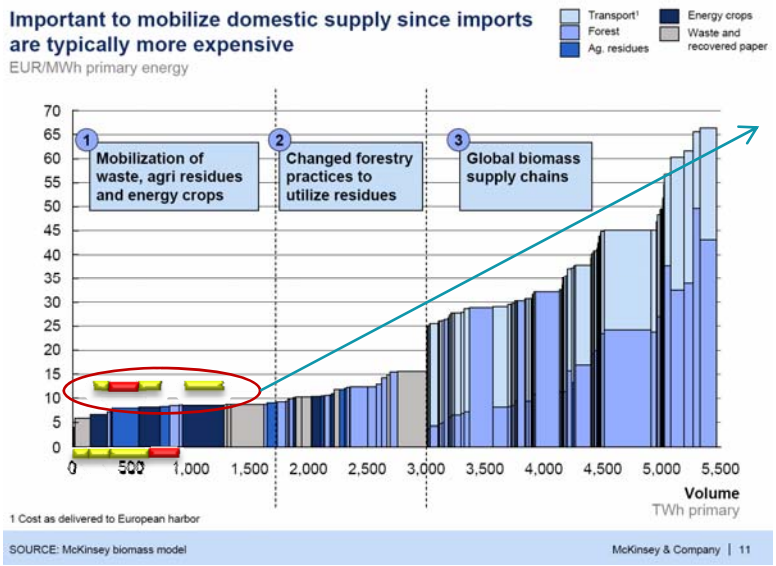
The LT-CFB gasifier is able to utilise high alkali containing biomass fractions for power generation

Potential for Energy Crops in EU-27



650 TWh of local grown Energy Crops as Miscanthus

250 TWh of agricultural residues

Agricultural residues and energy crops have high content of alkaline, and therefore they are difficult to utilise in existing boilers!

- Increase in European biomass demand till 2020 is estimated to 850 TWh (20-20-20)
- Demand can be covered through utilization of low value biomass in competition with imports
- Cost for utilization of local low value biomass instead of imported biomass depends on transport costs, infrastructure and technology for conversion

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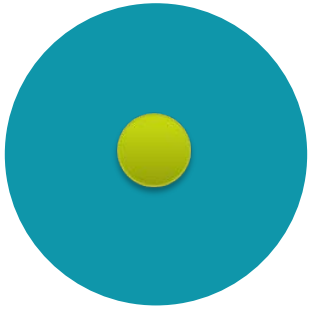
Economy of scale

- Specific CAPEX for large scale makes up for additional transport

• Low density biomass is expensive to transport

• Increasing the transport distance of straw from 50 to 200 km, increases cost with approx. 10 DKK/GJ

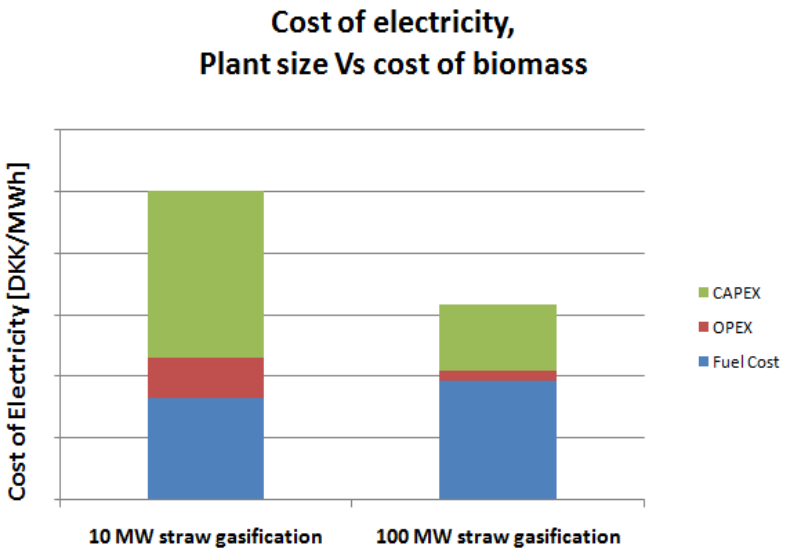


r = 50 km, Area is 7850 km2
r = 200 km, Area is 125600 km2

Plant size is 16 times bigger

2 cases to consider:

	100 MW	6,25 MW
Fuel cost	X + 10 DKK/GJ	X
CAPEX (Total)	100 Y	14 Y
OPEX / per year	100 Z	25 Z
Electrical eff.	46%	42%



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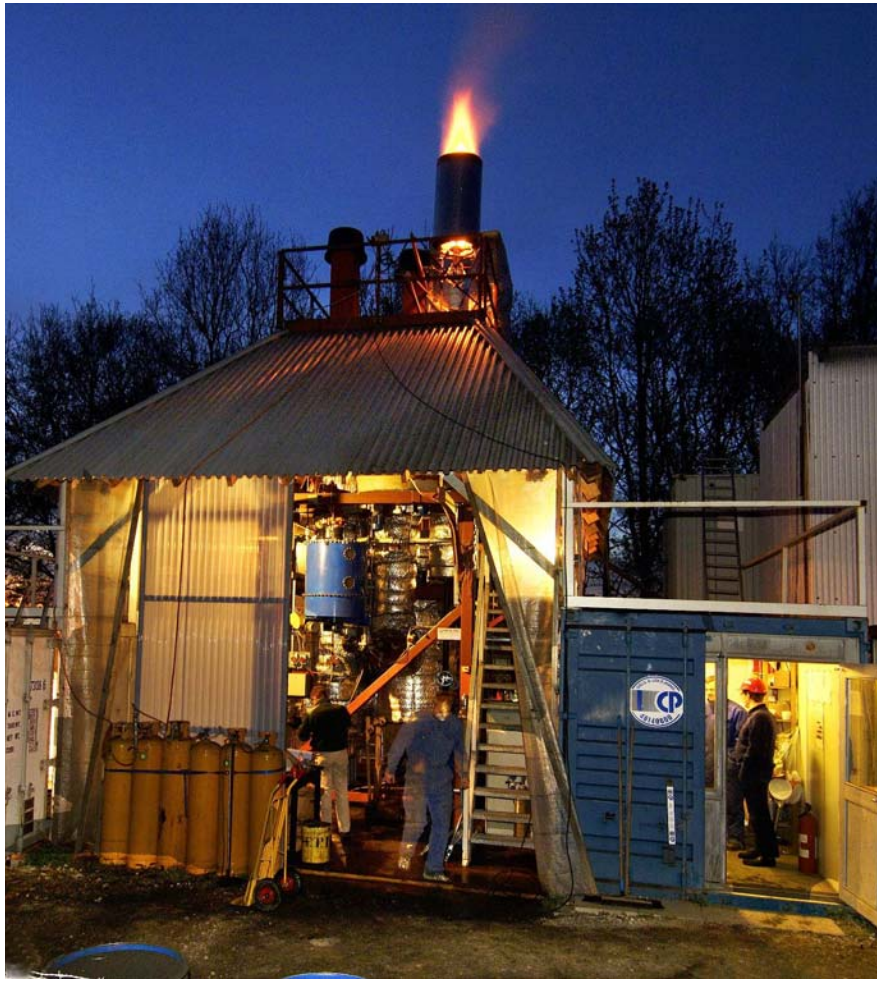
LT-CFB Landmarks II



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- 2007 – 100 kW DTU – several fuels
- June 09 – R&D Committee approval
- December 09 – Stoholm agreement
- January 10 – Investment Committee
- March 10 – Energinet.dk Board approval
- March 10 – Start of demo project

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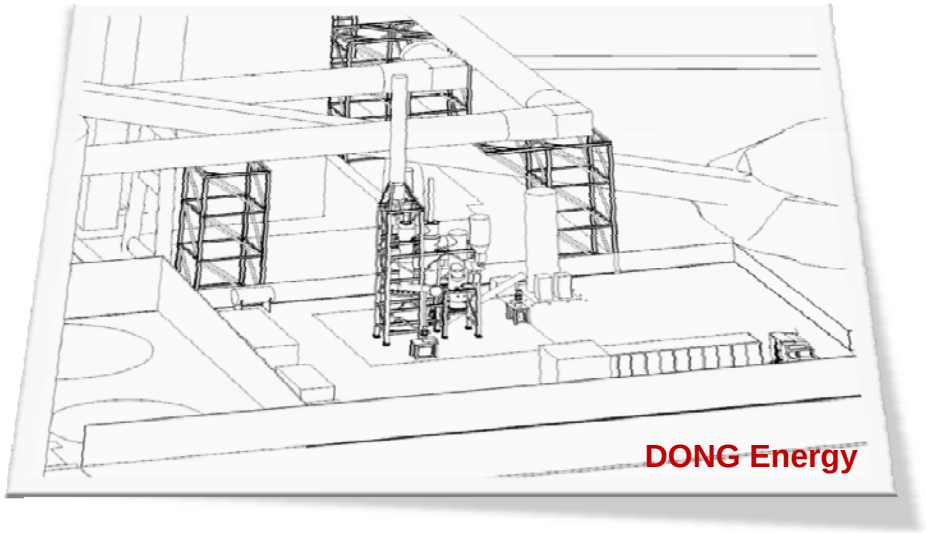
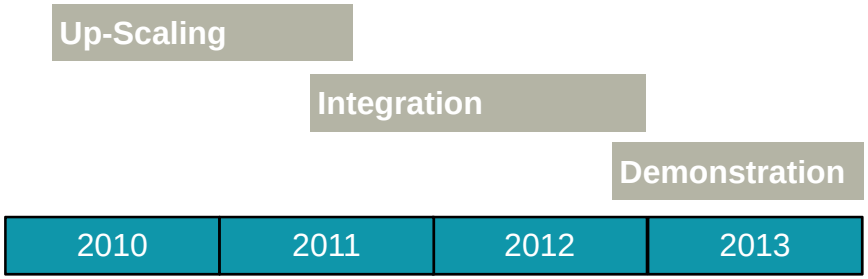
From biomass to gas by a low temperature gasifier
Construction of 6 MW_{th} demo plant started August 2010



Gasification Demonstration Project

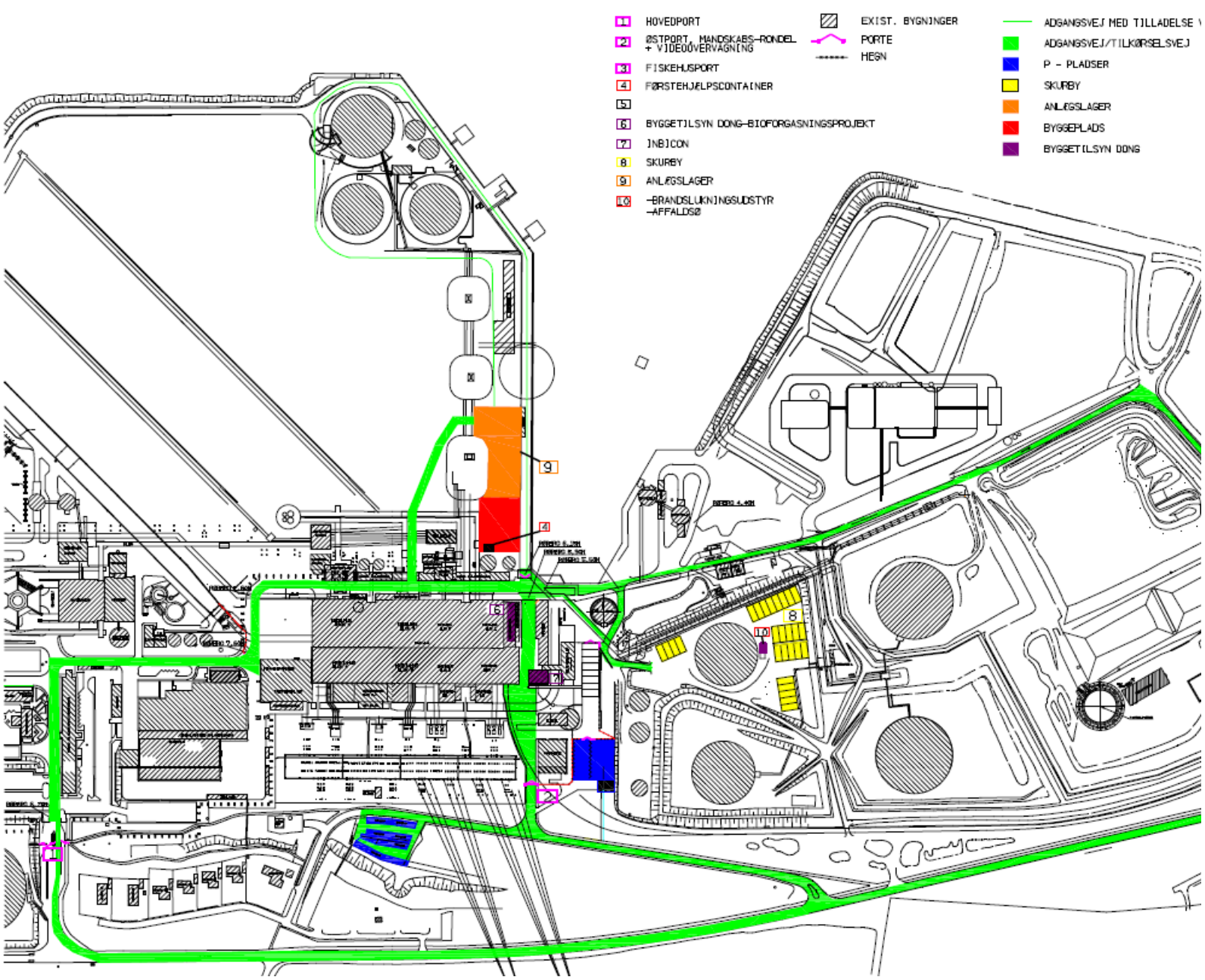


- Total budget 90 MDKK
- Grant from ForskEL and ForskVE 35 MDKK

Features:

- Fuel: straw, manure fibres..... local residues
- Operating temperature is around 650 °C
- Efficiency ~ 95%
- Capacity: 6 MW_{th} / 1,5-2,3 tonnes straw per hour
- Location: ASV 2, Kalundborg
- Construction initiated
- Commissioning during spring 2011

- Conversion of low value biomass and waste fractions into "alkaline free" gas
- Conversion of troublesome alkaline species into useful fertilizer


1 HOVEDPORT
2 ØSTPORT, MANDSKABS-RONDEL + VIDEOOVERVÅGNING
3 FISKEHUSPORT
4 FØRSTEHJÆLPSCONTAINER
5
6 BYGGETILSYN DONG-BIOFORGASNINGSPROJEKT
7 INBICON
8 SKURBY
9 ANLÆGSLAGER
10 -BRANDSLUKNINGSUDSTYR -AFFALDSØ
EXIST. BYGNINGER
PORTE
HEGN
ADGANGSVEJ MED TILLADELSE
ADGANGSVEJ/TILKØRSELSVEJ
P - PLADSER
SKURBY
ANLÆGSLAGER
BYGGEPLADS
BYGGETILSYN DONG

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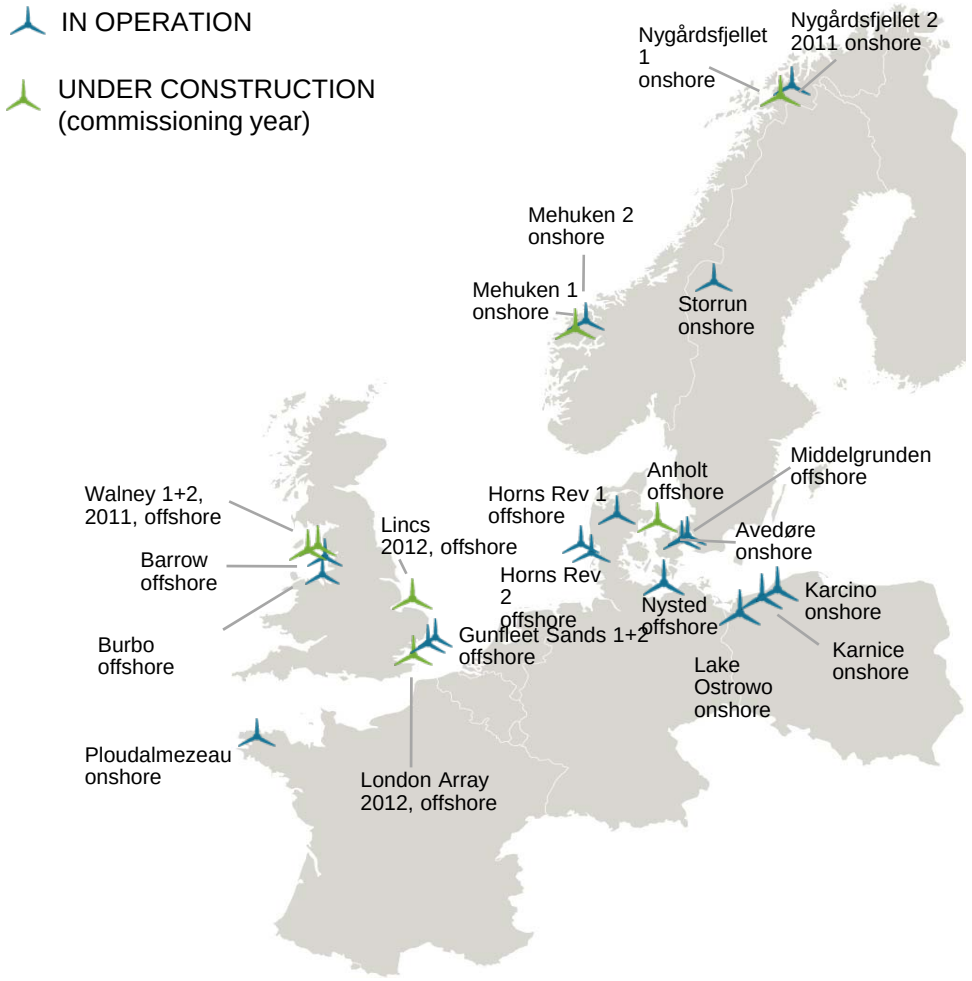
Site status October 1, 2010:

Wind is the key to the low-carbon transition – and DONG Energy will continue to be a world leader



STRONG POSITION THROUGH INDUSTRIALIZATION OF OFFSHORE

OPTIMIZED PLANNING AND EXECUTION OF PIPELINE
Strong in-house to secure portfolio synergies construction competences

SIEMENS AGREEMENT
1,800 MW supply agreement with steady supply

OPTIMAL OFFSHORE INSTALLATION
Acquisition of A2SEA world-leading installation vessels and crew

Capacity*	MW
In operation	1,098
Under construction	1,074
Project pipeline	4,000

Note *:
In operation: Annual report 2009 excluding minorities' ownership of Storrun (6 MW)
Under construction: Adjusted by reduced Walney ownership and increased according to Lincs ownership and Anholt
Project pipeline: Strategy document March 2010 (MAS/Renewables)