ESS study for Denmark



Danish energy system characteristics year 2000

Power sector

- Large share of coal (43%) and natural gas (24%)
- Extensive use of combined heat and power (very efficient power plants).
- Large share of wind (18 %)

Residential sector

- Generally good insulation
- Warming mainly from combined heat and power and natural gas boilers, only little cooling (not needed so far north)
- Extensive use of electrical appliances

Personal transport

- Large car park, small and medium sized cars
- Good public transport
- Little use of domistic air and ship transport (but large international use)

Freight transport

- Major transport mode is medium / large truck
- Little use of rail, plane and ship for domistic transport

Future baseline trend.....

Relative constant emissions of about 50 Mt CO2/yr in the next decades since emissions and economic growth are decoupled



Countermeasure vision: Green and Dynamic

- Danish population remains stable
- Generally unchanged urban/rural structure
- Economic growth of 2-3 %
- Little change in primary, secondary and tertiary sector. Strong focus on R&D.
- Strong public support for use of renewables and new energy technologies, high status on environmental sound behavior.
- People are ready to change habits if it benefits the environment.
- People still wants to maintain the convenient lifestyle obtained at the beginning of the 21st century
- People are happy with the European working environment and would like also to have time with family and friends.
- Economic wealth is attractive, but most people have already reached a high living standard
- Denmark continues to have very high equality and there is strong public support for the social welfare system.

Power sector - changes

- Reduced fossil fuel use
- Increased efficiency
- Large-scale use of CCS
- Significant increase in renewables
- → Electricity emission factor decreases from 1,65 to 0,12 MtC/Mtoe

	1			
	Sha	are of electricity supply	2000	2050
l		Total	100%	100%
I		COL	43%	20%
1		Oil	3%	3%
í		Gas	24%	10%
5		NUC	0%	0%
6		HYD	0%	1%
		HYD(P)	0%	0%
		GEO	0%	3%
		BMS	11%	23%
		S/W	18%	40%
	Tł	nermal Efficiency		
	CO	L	38,6%	44,0%
	OII	-	35,1%	38,0%
	GA	S	37,9%	65,0%
	BM	S	25,6%	40,0%



Residential sector – key demand changes

Reduction in space heating (46 %)

• Reduction in hot water heating (28%)

• Reduction in lighting (28%)

Small increase in appliances use (5%)



Residential sector - changes in service share and efficiency

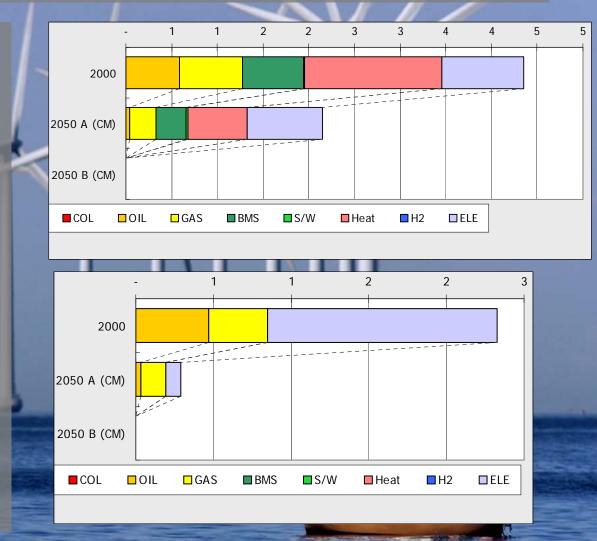
	Unit					2000									50 A (
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Space heating	-		16%	17%	16%		46%			100%		2%	15%	14%		36%			100%
Space cooling	-								100%	100%						_			100%
Hot water heating	-		21%	28%	3%	2%			46%	100%		3%	8%	3%	15%			71%	100%
Refrigerators and freezers	-								100%	100%								100%	100%
Cloth dryer	-								100%	100%								100%	100%
Cooking	-			28%					72%	100%			10%					90%	100%
Cloth washers	-								100%	100%								100%	100%
Dish washers	-								100%	100%								100%	100%
Other energy uses	-									0%									0%
Miscellaneous electric energy	-								100%	100%								100%	100%
Lighting	-								100%	100%								100%	100%
		2000									2050 A (CM)								
	Unit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Space heating	toe/toe		1,00	1,00	0,80		1,00		1,00	-		1,00	1,00	0,80		1,00		2,00	-
Space cooling	toe/toe								1,00	-								3,00	-
Hot water heating	toe/toe		1,00	1,00	1,00	1,00	1,00		2,00	-		1,40	1,40	1,40	1,40	1,40		8,00	-
Refrigerators and freezers	toe/toe								1,00	-								1,10	-
Cloth dryer	toe/toe								1,00	-								1,10	-
Cooking	toe/toe		1,00	1,00	1,00	1,00			2,00	-		1,20	1,20	1,20	1,20			2,50	-
Cloth washers	toe/toe								1,00	-								1,10	-
Dish washers	toe/toe								1,00	-								1,10	-
Other energy uses	toe/toe								1,00	-								1,10	-
	toe/toe								1,00	-								1,10	-
Lighting	toe/toe								1,00	-								1,10	-



Results for residential sector

 Reduction in energy consumption of ~ 50%

 Reduction in CO2 emissions of ~ 90%



Passenger transport – changes in demand

Demand	changes
--------	---------

- Slight decrease in car use
- Increase in bus and rail use.

			and the second s				1						
			2050										
	Unit	2000	RI	EF	С	M	CM/	REF					
			Α	В	А	В	Α	В					
Motorbike	B p-km	0	0		0	0	100%						
Car	B p-km	61	49		49	0	100%						
Bus	B p-km	13	17		17	0	100%						
Railway	B p-km	5	11		11	0	100%						
Aviation	B p-km	1	1		1	0	100%						
Maritime	B p-km				0	0	100%						
COLUMN TWO IS NOT						2							
	4	1.00	1.00	311	100								
			-	and a state of the									
						1							

Passenger transport – changes in service share and efficiency

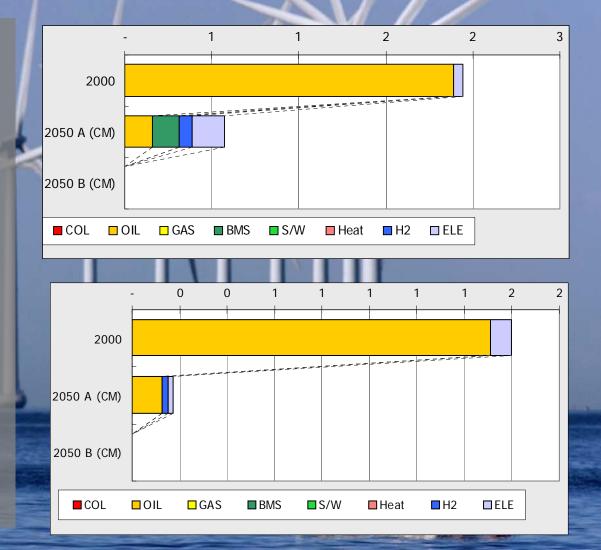
\																			
	Unit					2000								2050	A-scei	nario			
	Unit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Motorbike	-		100%							100%		30%		30%			10%	30%	100%
Car	-		96%						4%	100%		30%		30%			20%	20%	100%
Bus	-		100%							100%		10%		30%			20%	40%	100%
Railway	-		71%						29%	100%		5%		5%				90%	100%
Aviation	-		100%							100%		30%		70%					100%
Maritime	-									0%		30%		70%					100%
	-									0%									0%
	-									0%									0%
	-									0%									0%
	-									0%									0%
	-									0%									0%
		1						100								1 1			
		10																	
	Unit					2000									A-scel				
		COL	OIL	GAS	BMS	S/W	Heat	H2		Total	COL	OIL	GAS	BMS	S/W	Heat	H2		Total
Motorbike	'00=1.0		1,00		1,00			3,00	3,00	-		2,00		2,00			4,00	5,00	-
Car	'00=1.0		1,00		1,00			3,00	3,00	-		3,00		3,00			4,00	5,00	-
Bus	'00=1.0		1,00		1,00			3,00	3,00	-		3,00		3,00			4,00	5,00	-
Railway	'00=1.0		1,00		1,00			3,00	3,00	-		2,00		2,00				5,00	-
Aviation	'00=1.0		1,00		1,00					-		1,40		1,40					-
Maritime	'00=1.0		1,00		1,00					-		1,30		1,30					-
	'00=1.0									-									-
	'00=1.0									-									-
-										-									-
										-									-
										-									-



Results for passenger transport

• Reduction in energy consumption of ~ 70%

• Reduction in CO2 emissions of ~ 90%



Freight transport – changes in demand

Demand changes

• Slight increase in use of large freight vehicles

 Slight increase in rail use

				2050								
	Unit	2000	R	EF	C		CM/	REF				
			А	В	Α	В	Α	В				
Small Freight Vehicle	B t-km	0	0		0		100%					
Large Freight Vehicle	B t-km	18	21		21		100%					
Freight Train	B t-km	2	3		3		100%					
Freight Ship	B t-km	1	1		1		100%					
Freight Air	B t-km	0	0		0		100%					
			_									
	1											
	100											

Freight transport - changes in service share and efficiency

			100													100			
	Unit					2000								2050	A-scei	nario			
	Onit	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Small Freight Vehicle	-		96%						4%	100%		10%					40%	50%	100%
Large Freight Vehicle	-		100%							100%		30%		40%			30%		100%
Freight Train	-								100%	100%								100%	100%
Freight Ship	-		100%							100%		50%		50%					100%
Freight Air	-									0%									0%
	-									0%									0%
	-									0%									0%
	-									0%									0%
	-									0%									0%
	-									0%									0%
	· ·		_			_				0%	_	_	_	_					0%
				1															
						2000					2050 A-scenario								
		COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total	COL	OIL	GAS	BMS	S/W	Heat	H2	ELE	Total
Small Freight Vehicle	'00=1.0		1,00		1,00			3,00	3,00	-		3,00		3,00			4,00	5,00	-
Large Freight Vehicle	'00=1.0		1,00		1,00			3,00	3,00	-		1,52		1,52			4,00	5,00	-
Freight Train	'00=1.0								1,00	-		3,00		3,00				5,00	-
Freight Ship	'00=1.0		1,00		1,00					-		1,33		1,33			1,33		-
Freight Air	'00=1.0		1,00		1,00					-		1,50		1,50					-
										-									-
										-									-
										-									-
										-									-
										-									-



Results for freight transport

 Reduction in energy consumption of ~ 70 %

• Reduction in CO2 emissions of ~ 90%

