

Renewable Energy Sources

FUEL CELL

Market

14:30 – 15:00 MAKING BUSINESS OUT OF ELECTROLYSERS

Lars Yde, BIC, Poland

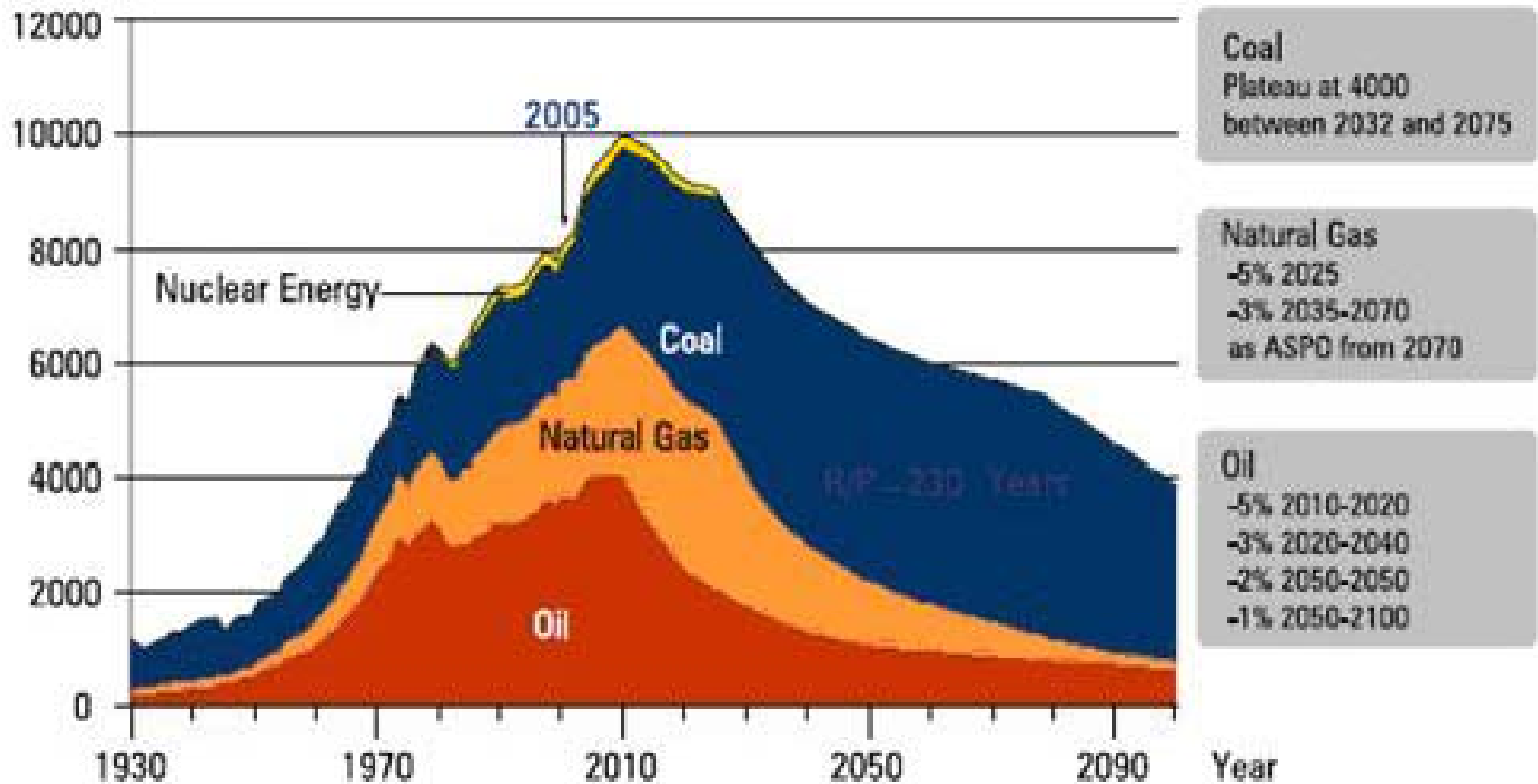
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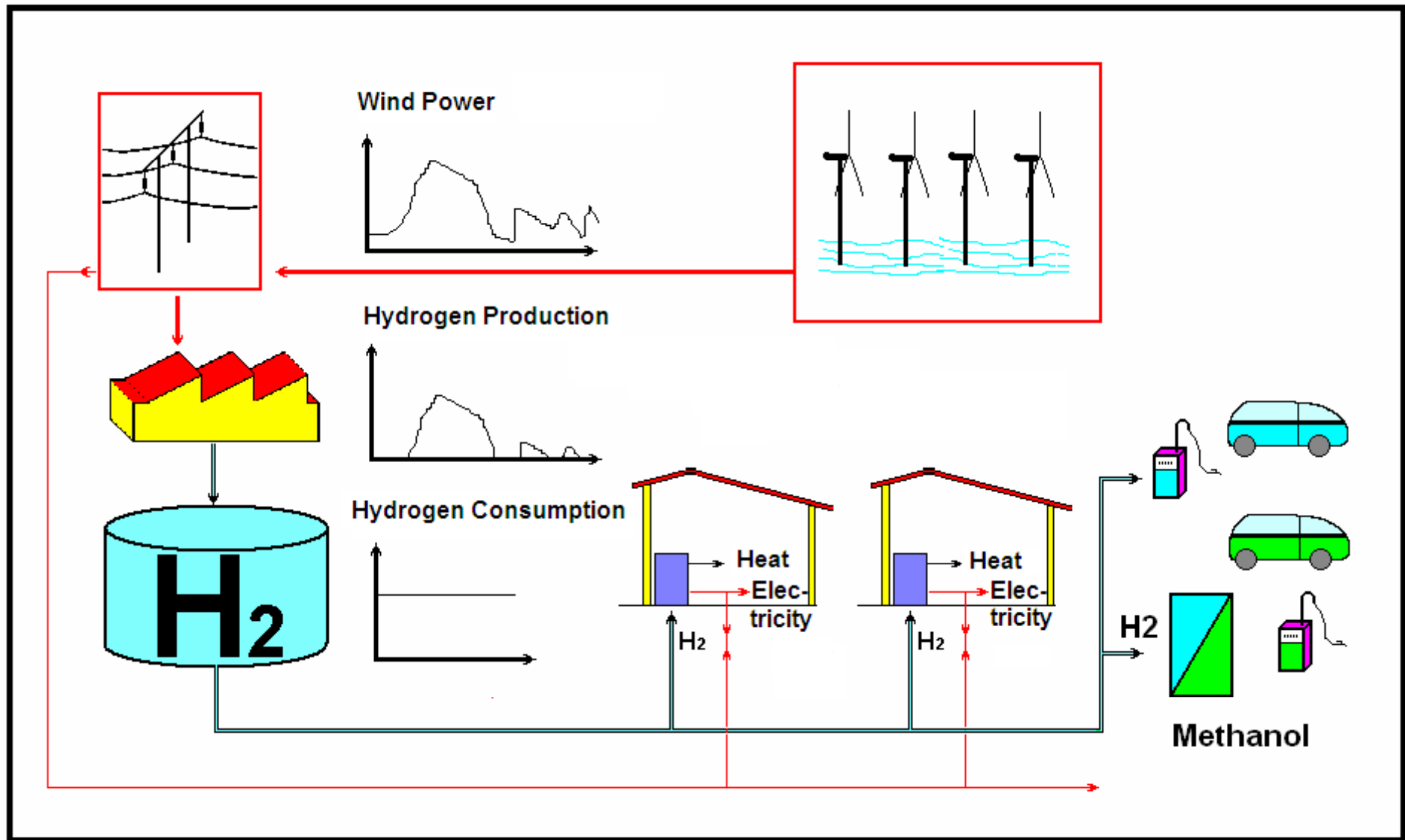
Past and future supply of fossil fuel

Mtoe [Million Tons Petroleum Equivalent]

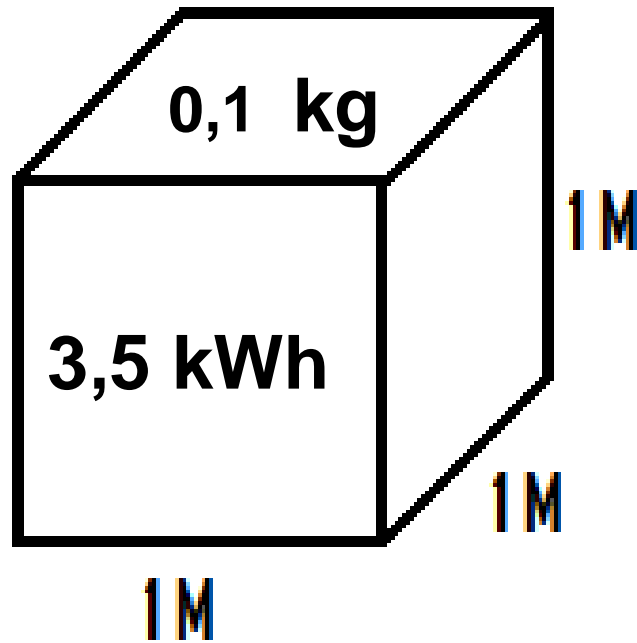


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Daimlerstrasse 15, 85521 Ottobrunn, Germany

Data source: Oil, Gas, Coal- Nuclear Senario, LBST 2005



Hydrogen (H₂)



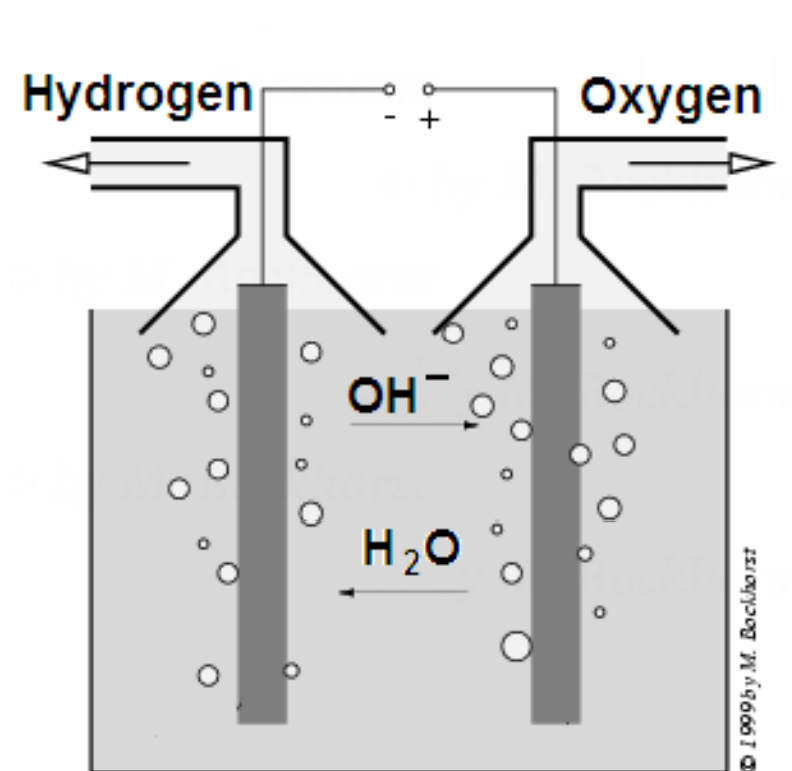
1 Week

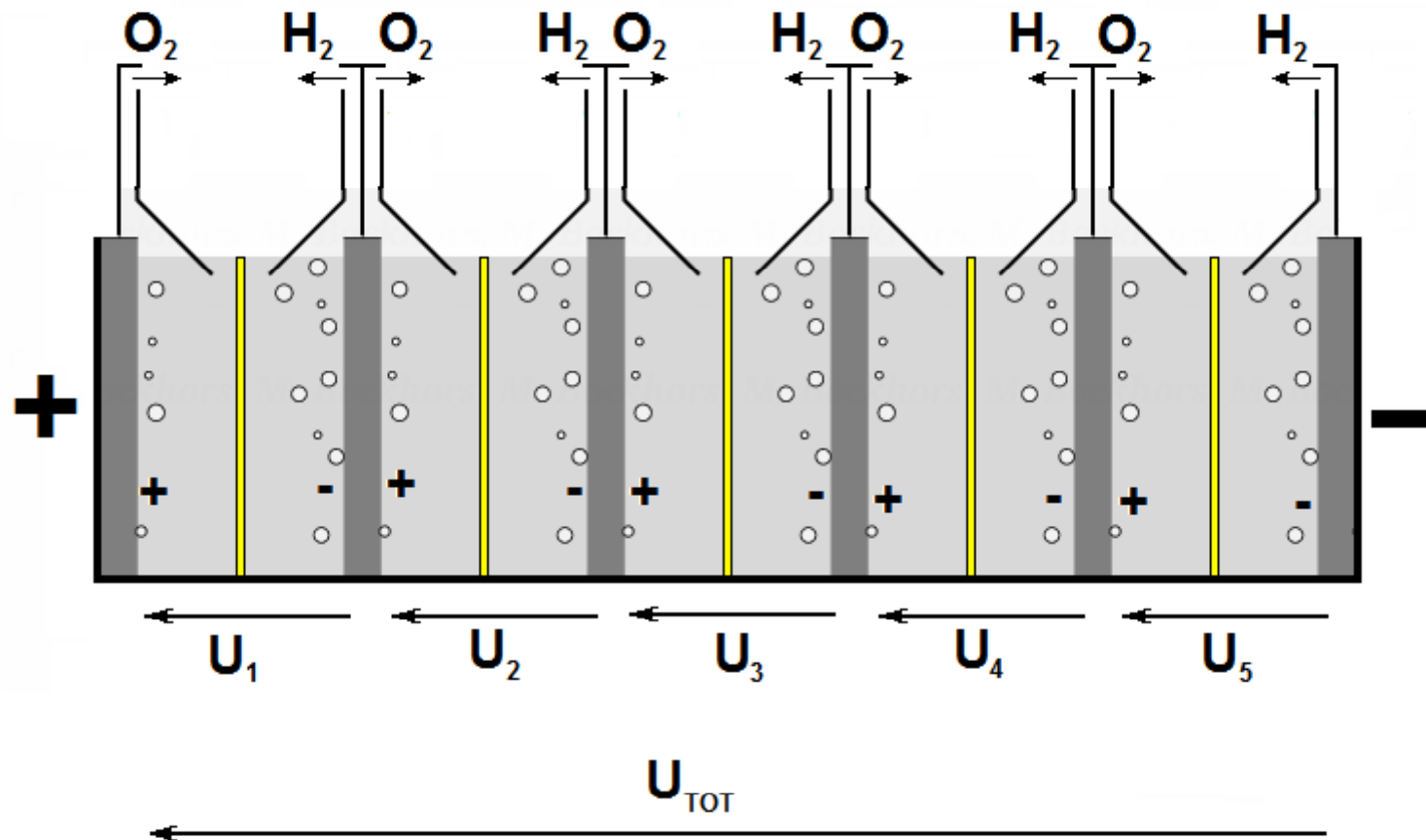


2.5 Hours



**12 km
(6 min)**



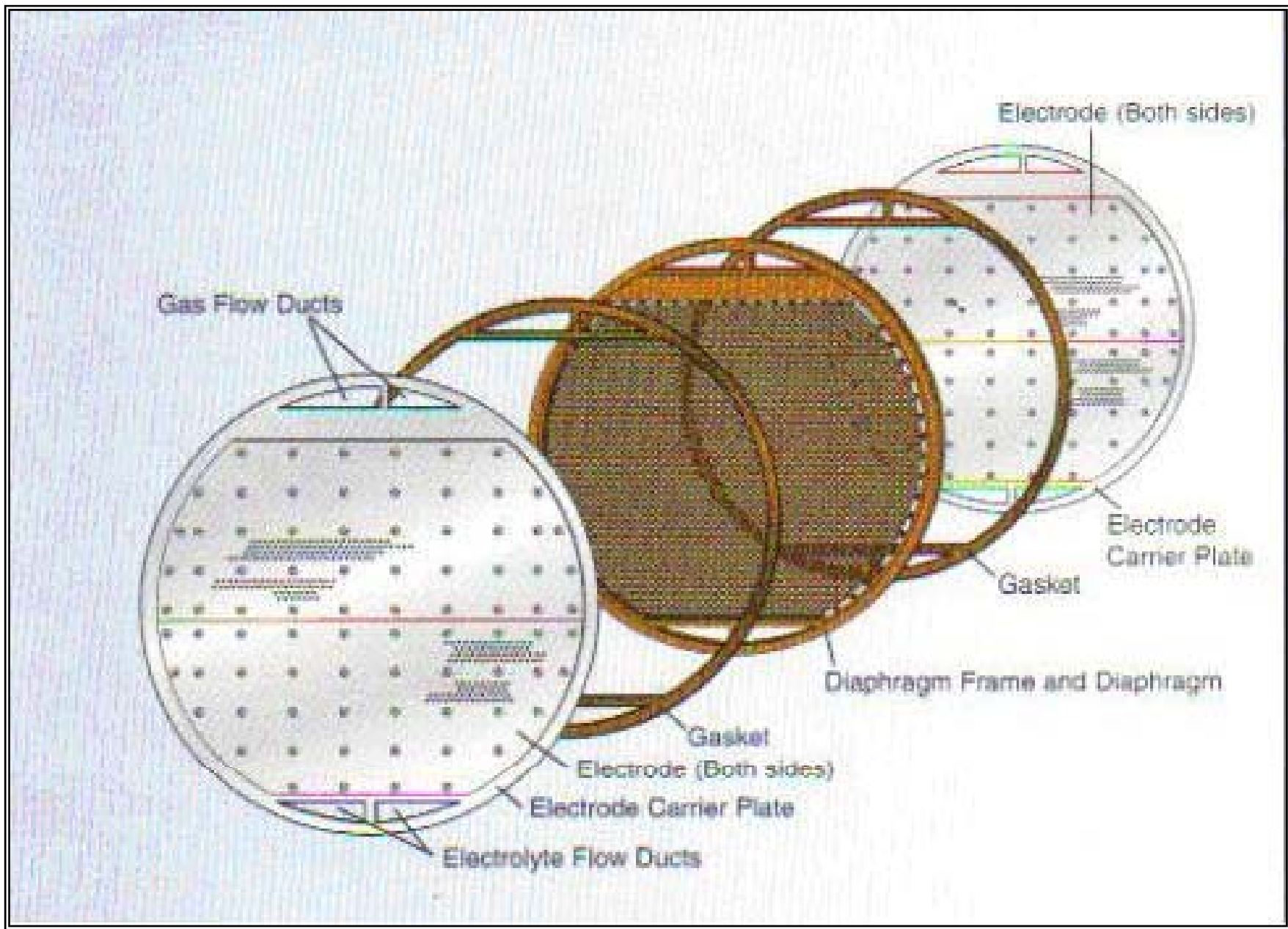




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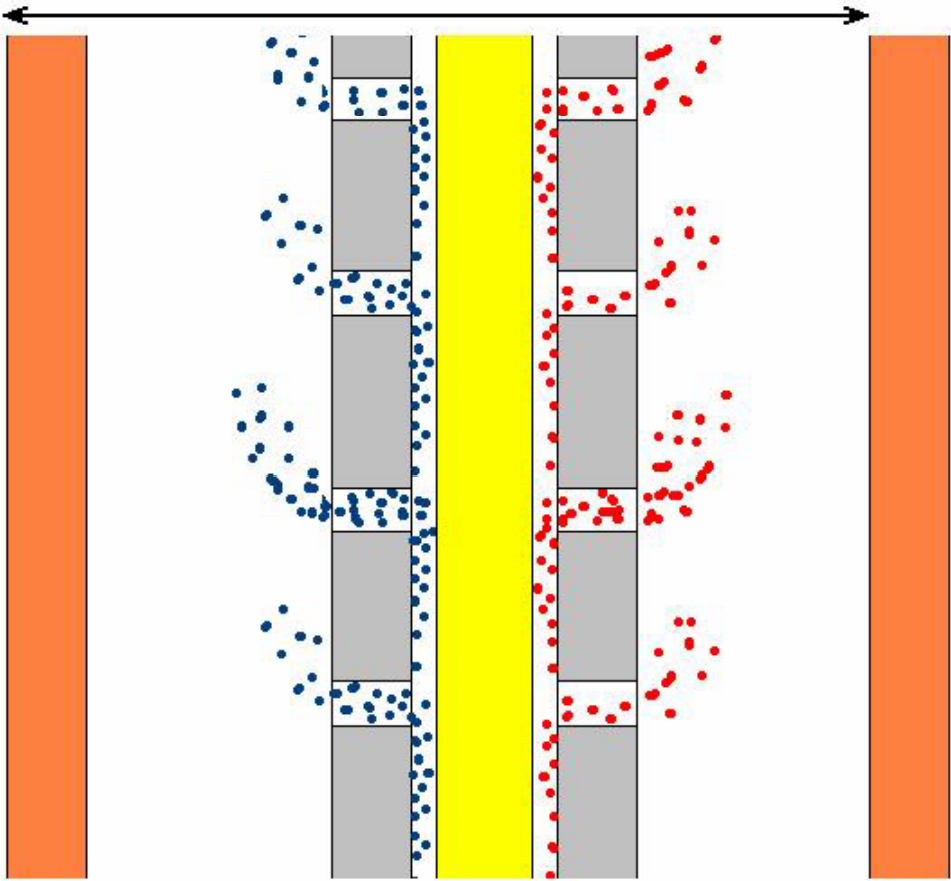
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Possible price reductions on the electrolysis stack

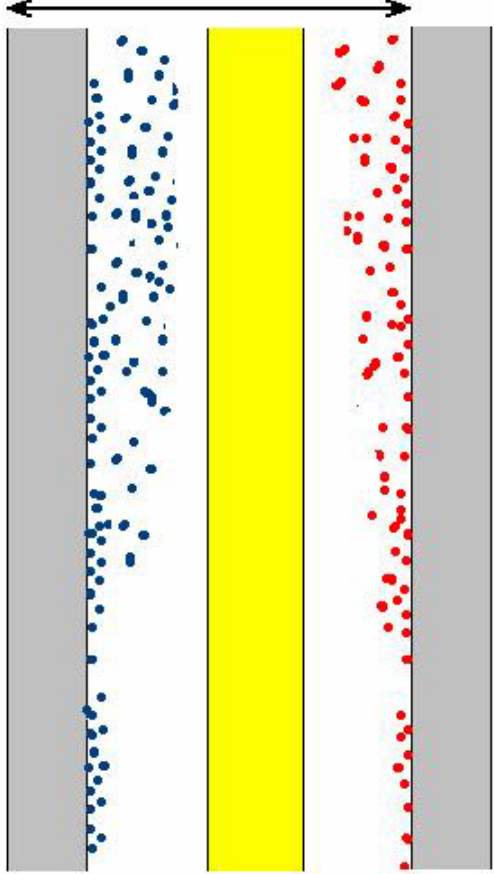
Zero gab design

18 mm



Non zero gab design

5mm



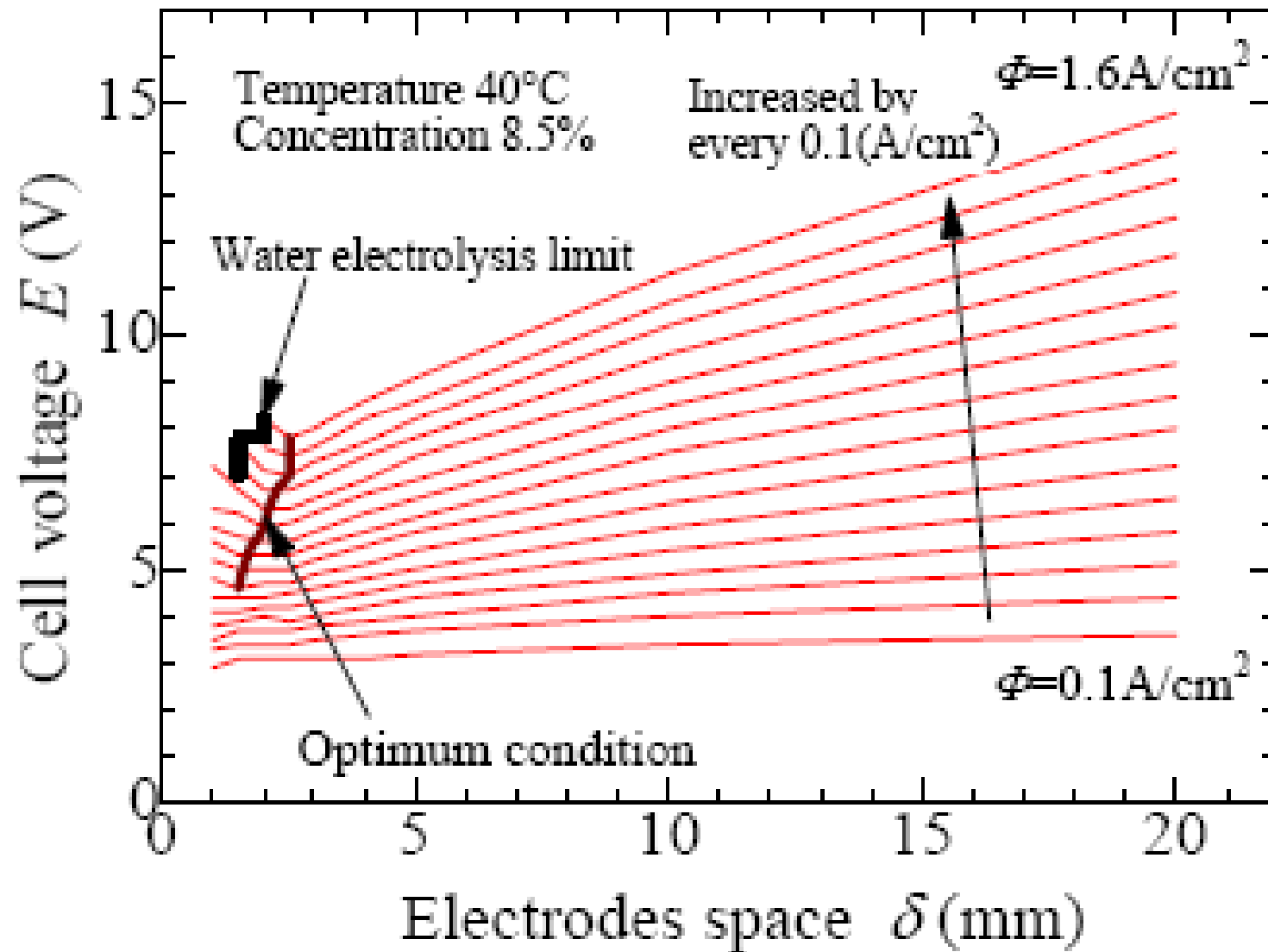
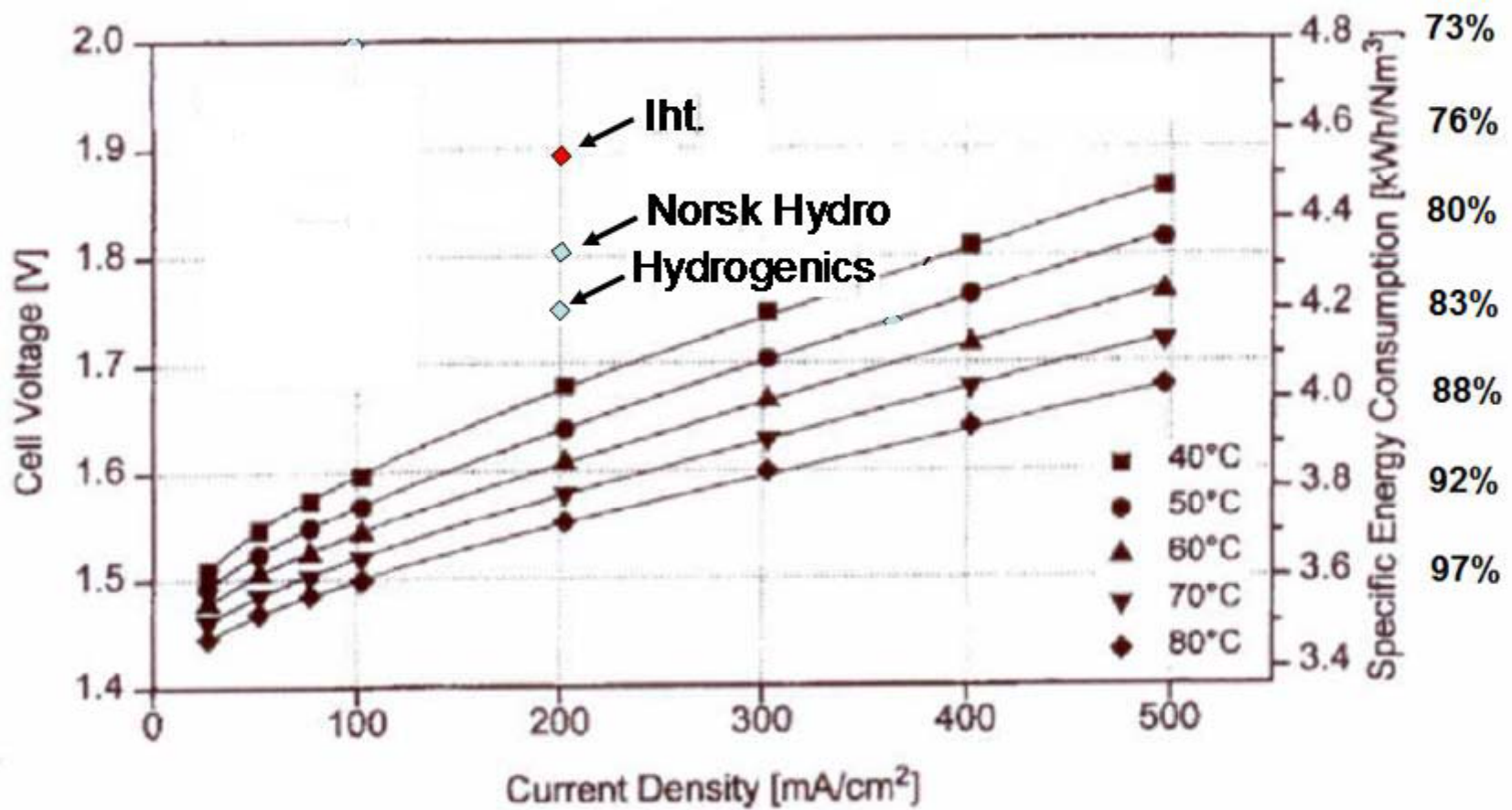


Fig.5 Relation between cell voltage and electrodes space (optimum condition and water electrolysis limit)

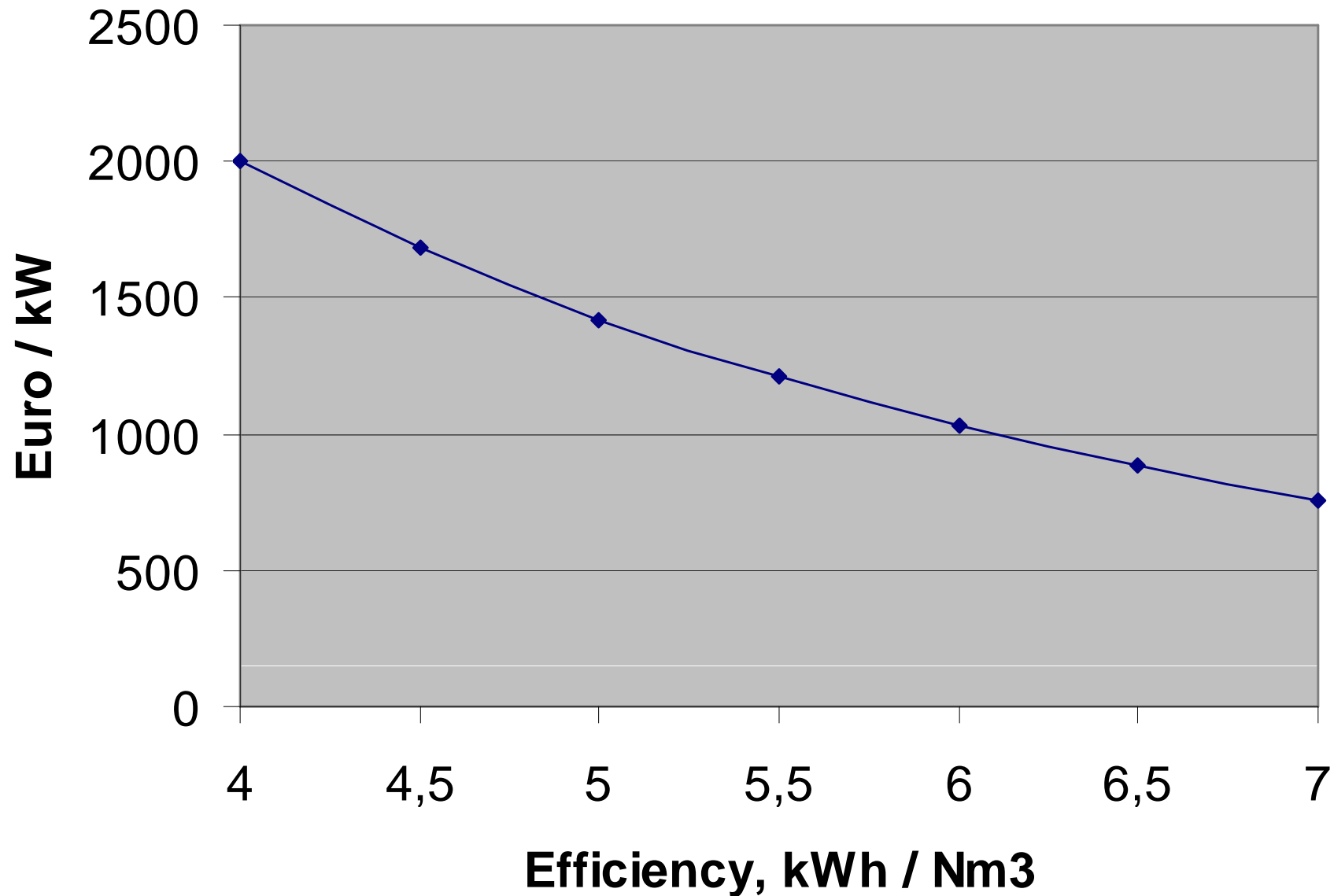


Electrolyser	kW	2	2	20	20	200	200
		Zero gab	Non zero gab	Zero gab	Non zero gab	Zero gab	Non zero gab
Current density	mA/cm2	200	200	200	200	200	200
Cell voltage	Volt	2	2	2	2	2	2
Cell thickness	mm	4,0	3,0	6,2	5,2	13,0	12,0
Power density	kW/m2	4	4	4	4	4	4
Power density	kW/m3	1000	1333	649	775	308	333
Electrode area	cm2	100	100	1000	1000	10000	10000
Electrode height	cm2	10	10	32	32	100	100
Plus electrode thickness	mm	0,5	0,25	0,5	0,25	0,5	0,25
Minus electrode thickness	mm	0,5	0,25	0,5	0,25	0,5	0,25
Bipolar plate thickness	mm	0,5	0	0,5	0	0,5	0
Diaphragm thickness	mm	1,5	1,5	1,5	1,5	1,5	1,5
Gaskets thickness per cell	mm	4,0	3,0	6,2	5,2	13,0	12,0
Gasket width	mm	10	10	10	10	10	10
Gasket circumference per cell	mm	40	40	126	126	400	400
Gaskets volume per cell	mm3	1600	1200	7795	6530	52000	48000
Number of cells		50	50	50	50	50	50
Nickel volume	cm3	750	250	7500	2500	75000	25000
Nickel weight	kg	6,8	2,25	68	22,5	675	225
Gaskets volume	cm3	80	60	390	326	2600	2400
Gaskets weight	kg	0,16	0,12	0,78	0,65	5,20	4,80
Length of stack	mm	200	150	308	258	650	600
Machining and assembling per cell	hours	0,09	0,03	0,09	0,03	0,09	0,03
Machining and assembling per stack	hours	4,5	1,5	4,5	1,5	4,5	1,5
Price of nickel per kg	kr.	800	800	700	700	500	500
Price of gaskets per kg	kr.	300	300	300	300	300	300
Price of assembling per hour	kr.	300	300	300	300	300	300
Price of nickel per stack	kr.	5400	1800	47250	15750	337500	112500
Price of gaskets per stack	kr.	48	36	234	196	1560	1440
Price of assembling per stack	kr.	1350	450	1350	450	1350	450
Price of stack	kr.	6798	2286	48834	16396	340410	114390
Price of non zero gab/price of zero gab		0,3363		0,3357		0,3360	
Price per kW	kr.	3399	1143	2442	820	1702	572

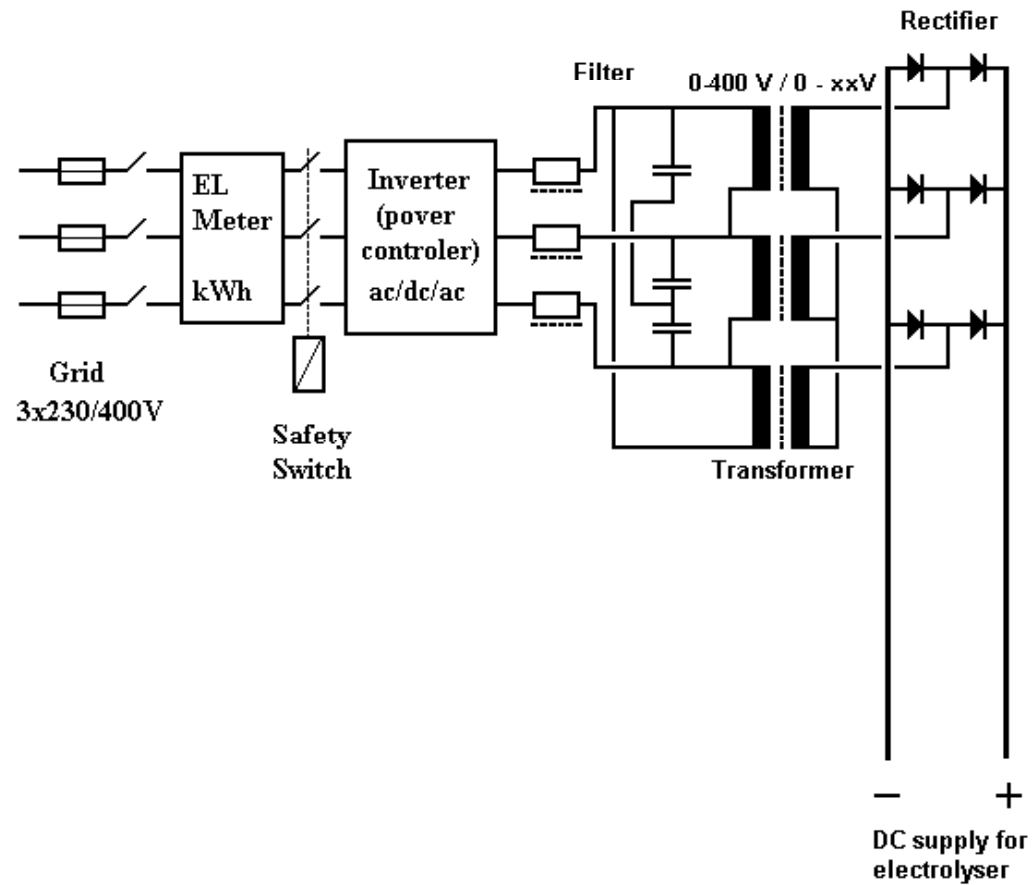


Current density/voltage characteristics and specific energy consumption of cell 2 as a function of temperature

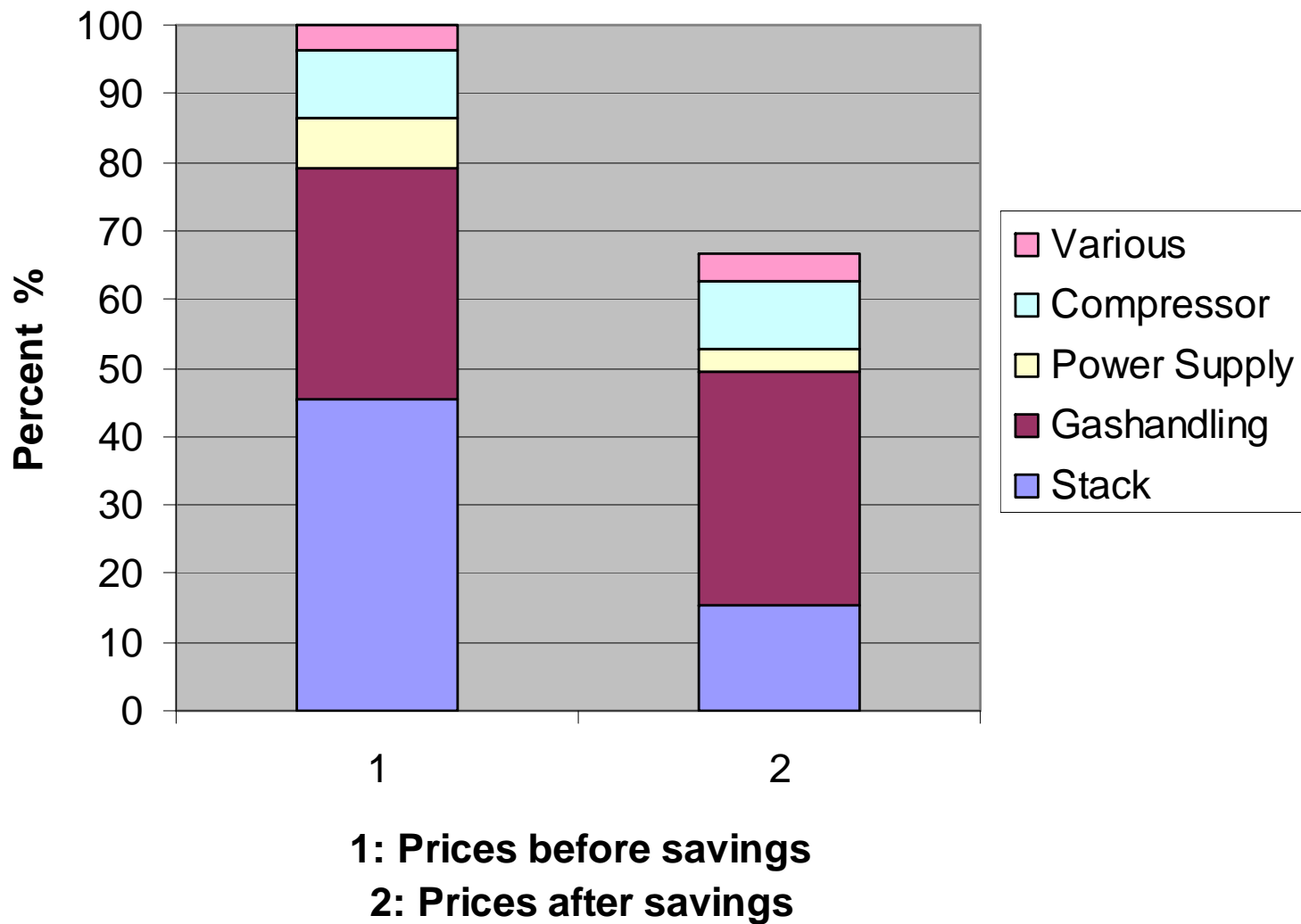
**Price of electrolysis plant as a function of efficiency
for constant hydrogen price of 0.4 Euro/Nm³**



Powersupply for Electrolyser



Possible Savings at Components of the Electrolysis Plant with Compressor



Hydrogen customers

- 1. Micro-CHP plants at isolated local hydrogen grids with central hydrogen production.**
- 2. Micro-CHP plants in a single household with decentralized hydrogen production in the house, so the heat production from the electrolyser can be used and thereby the size of the CHP reduced to half size.**
- 3. Filling stations for fuelling of hydrogen vehicles.**
- 4. Gas engines at central CHP plants for improving the combustion and thereby increase the efficiency and reduce the exhaust of not combusted natural gas which is a serious greenhouse gas.**
- 5. The natural gas grid which by time will be a hydrogen grid.**
- 6. Methanol production by gasification of biomass and reaction with hydrogen.**

H2College



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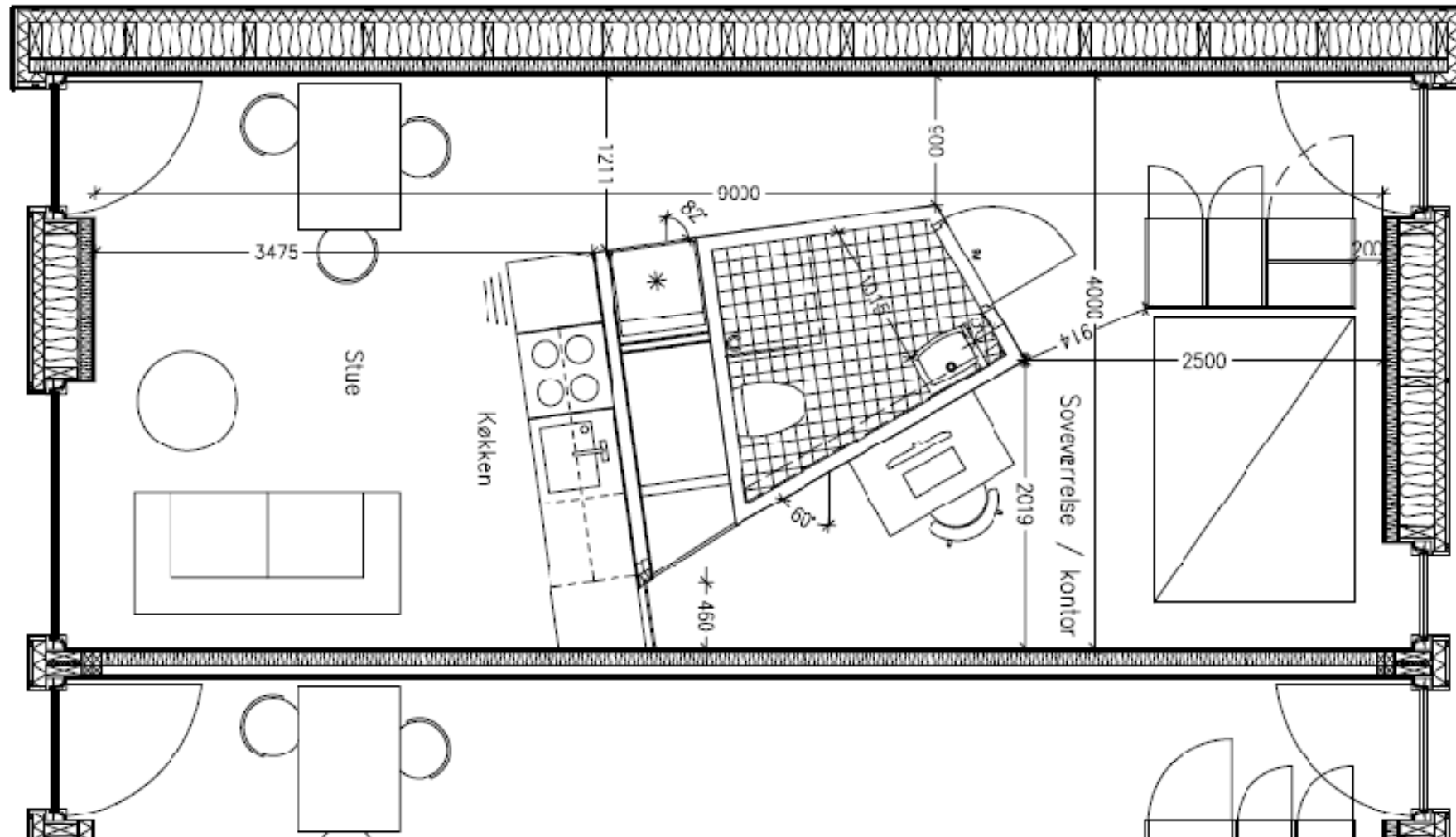


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H2 COLLEGE - 66 Passiv Ungdomsboliger

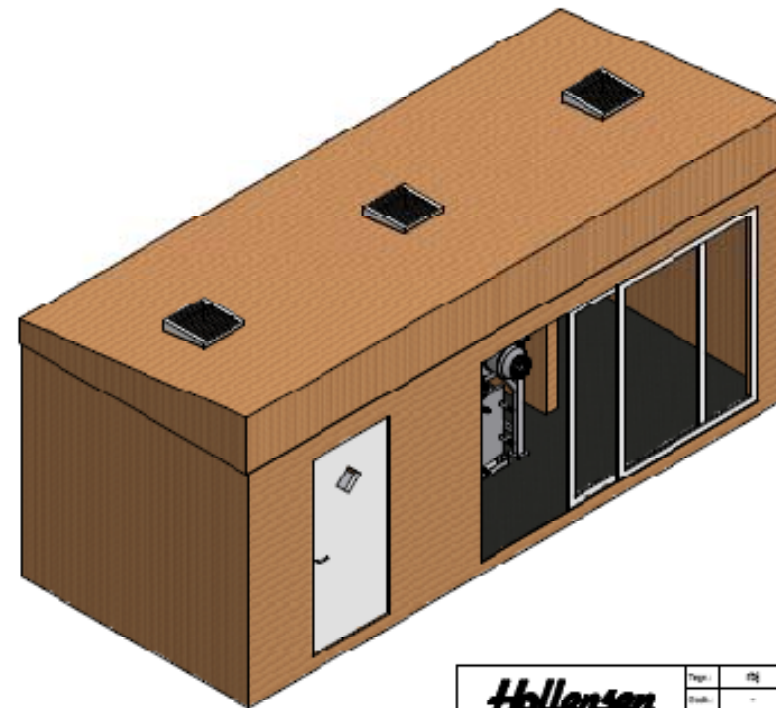
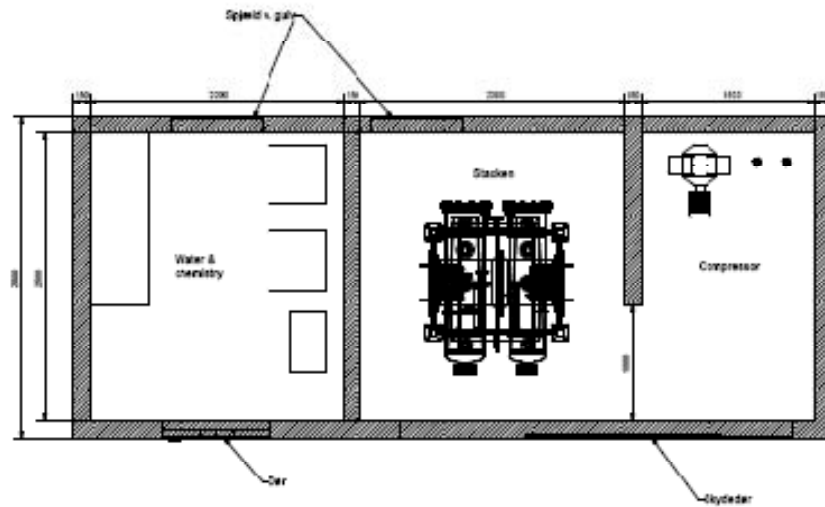
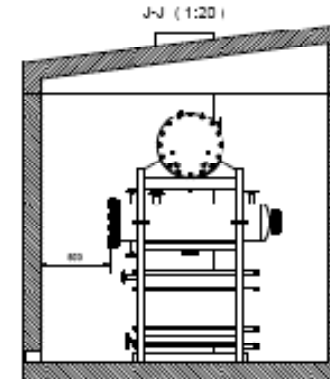
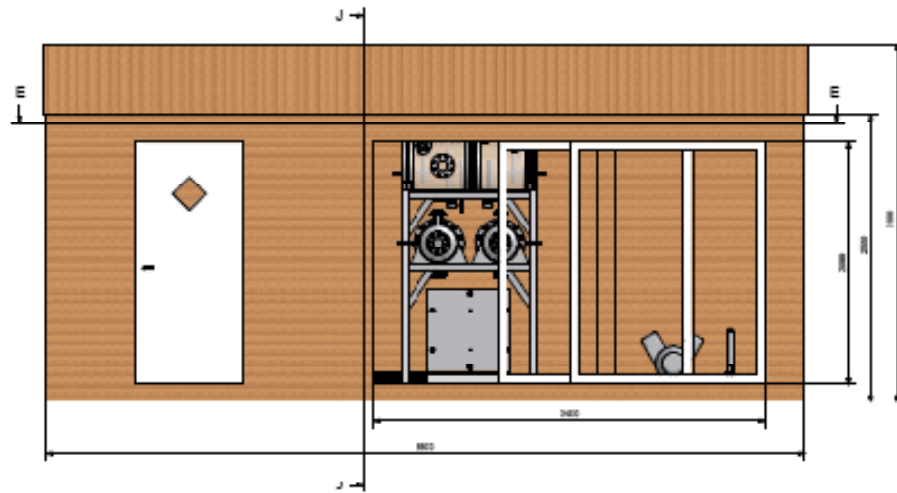




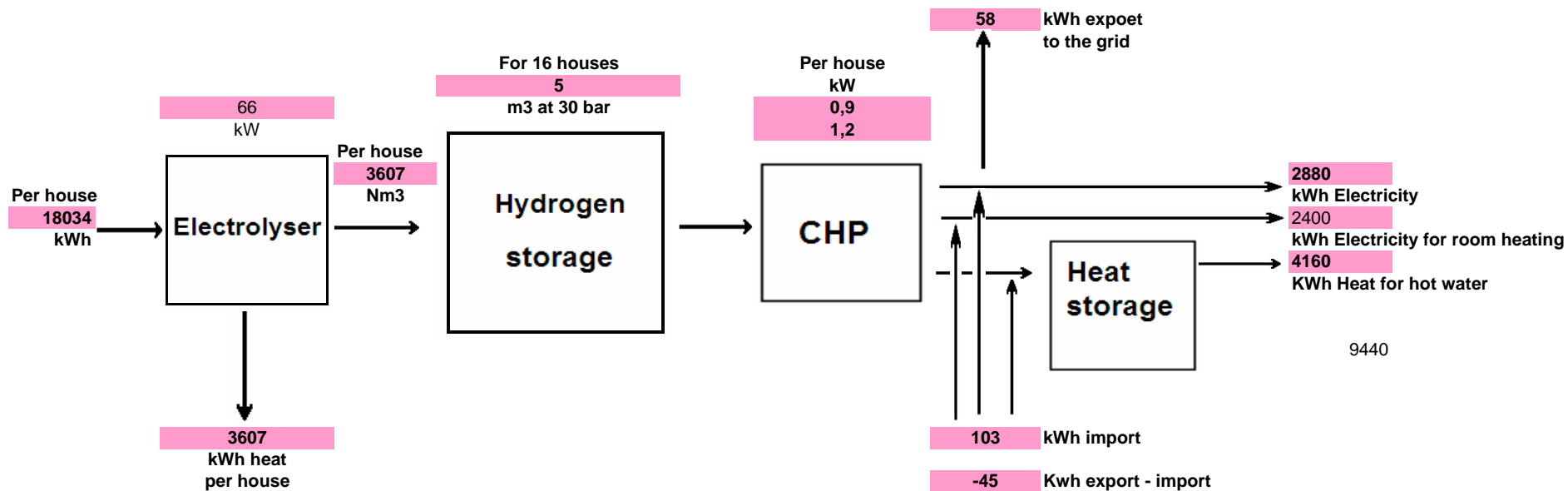
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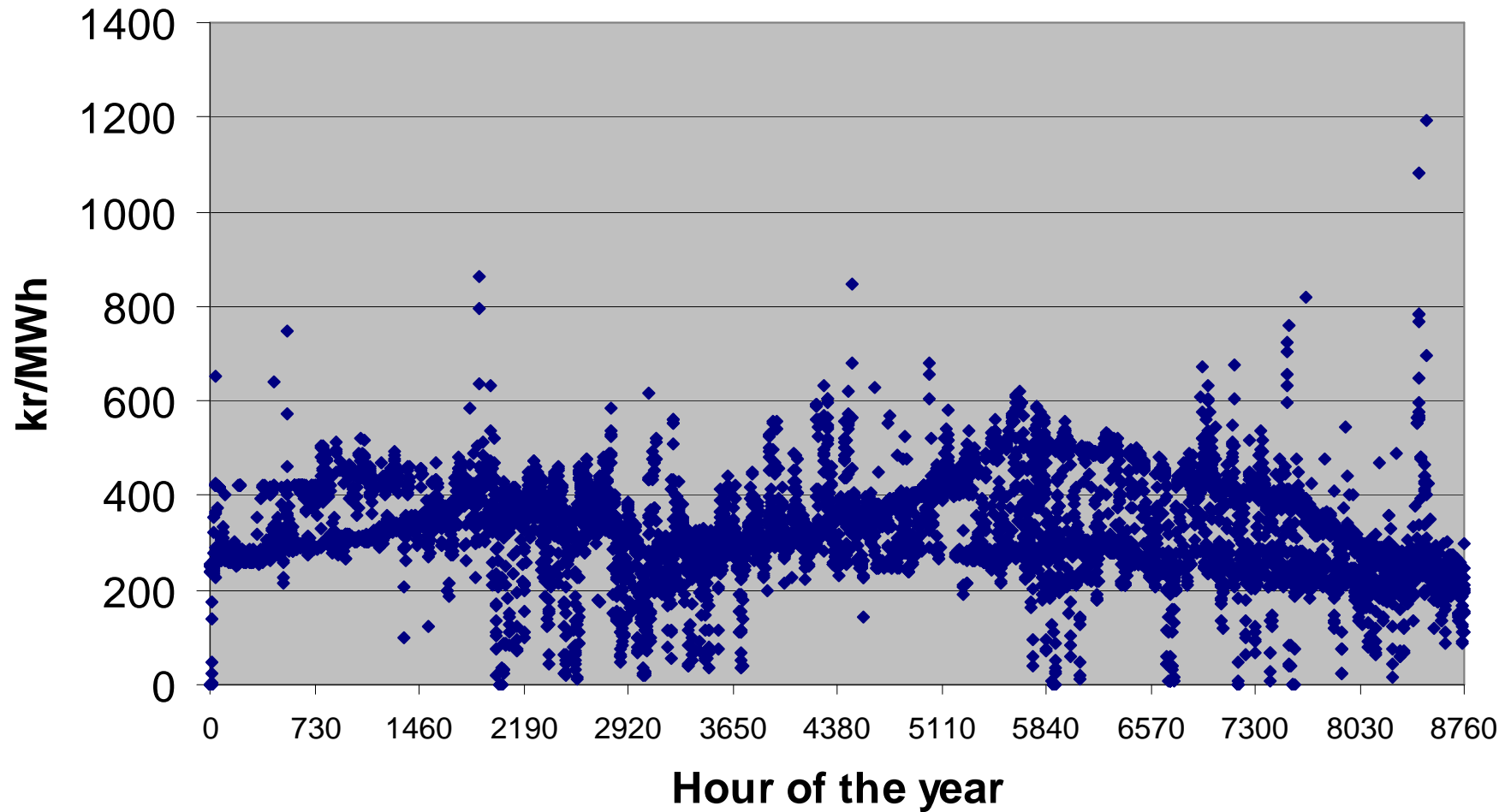
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Lagret:					
Skrevet:					
Genes hydrogen					05-0121
Prosjekt nr.:					



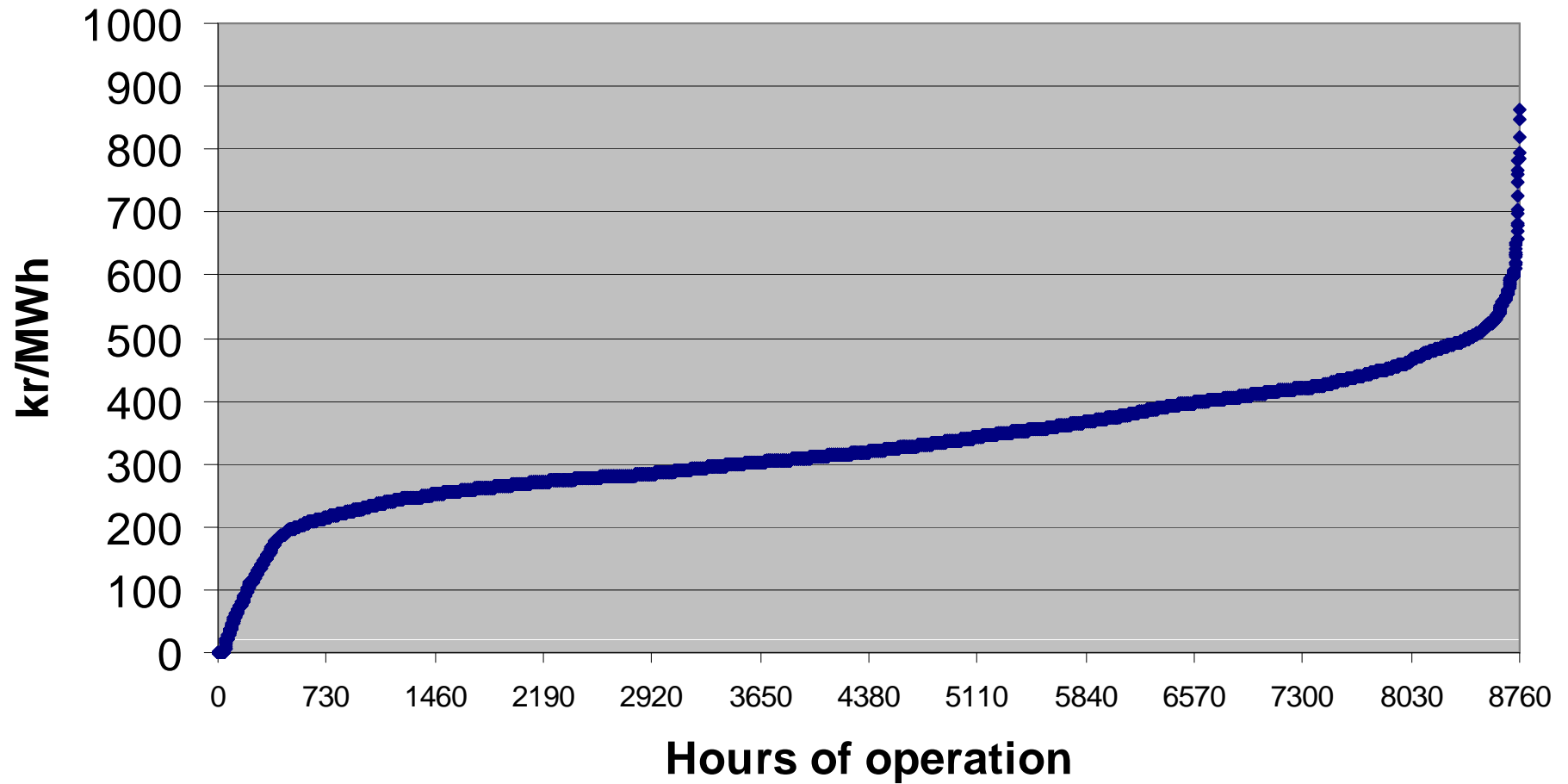
System input:		
Electricity from wind turbines	18034 kWh / year	
System outputs:		
Heat from electrolyser	3607 kWh / year	
Electricity to one house	2880 kWh / year	
Electricity for room heating	2400 kWh / year	
Heat to one house	4160 kWh / year	
Netto export of electricity	-45 kWh / year	
Sum of outputs	13002 kWh / year	
System energy efficiency		0,72

**Reduction of operation costs
by
purchase of electricity
at the best price.**

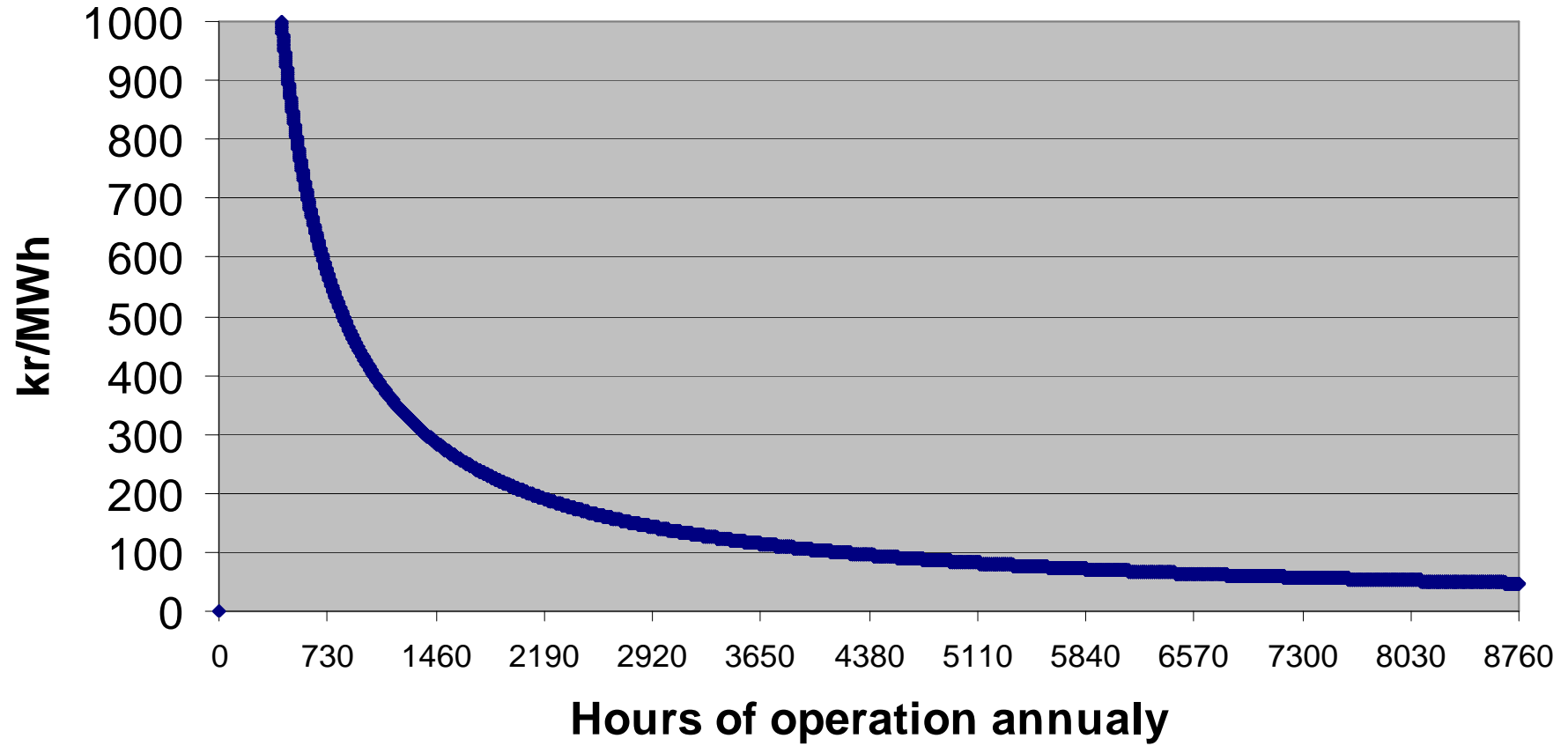
Prices of electricity 2006



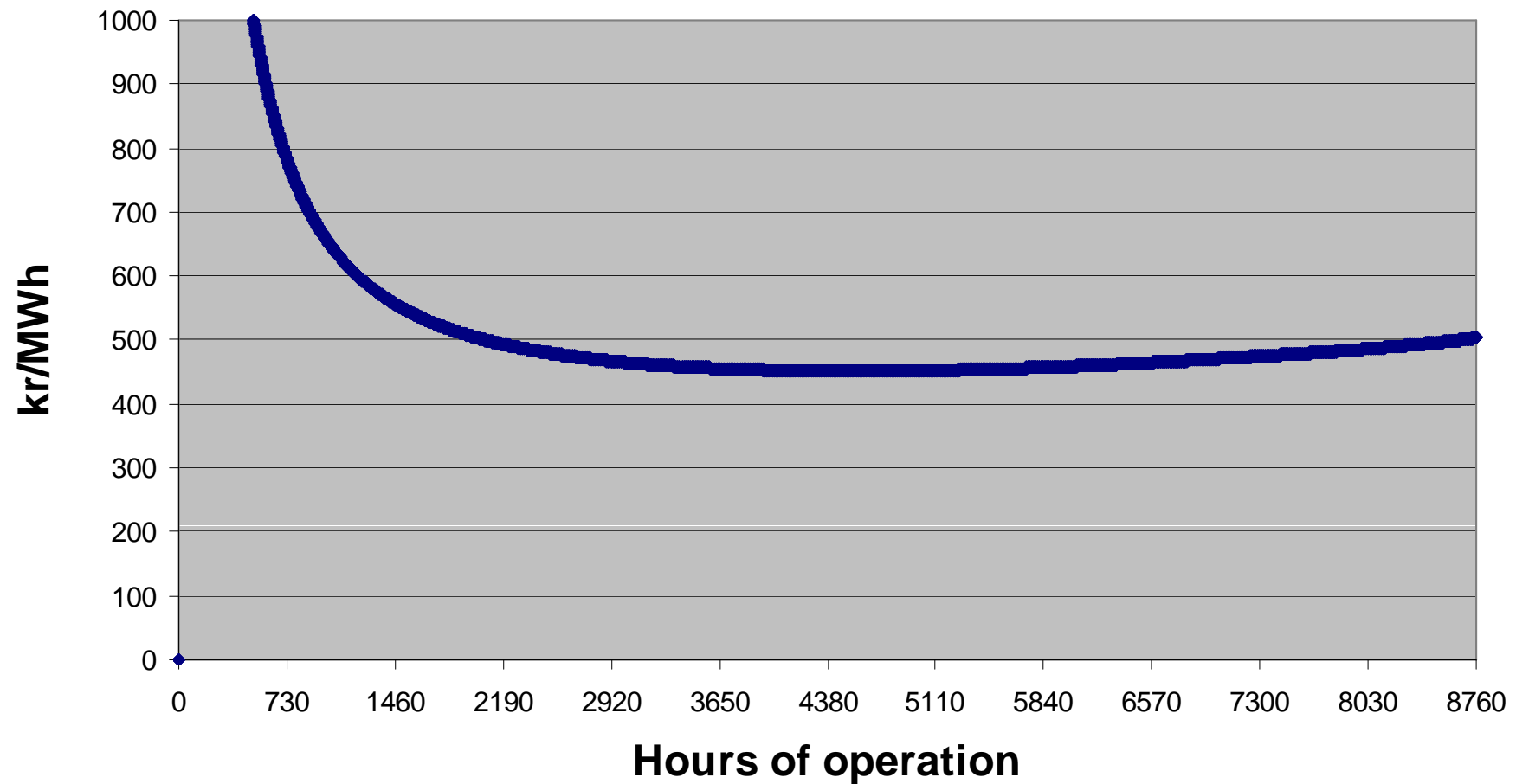
Prices of Electricity 2006 in order



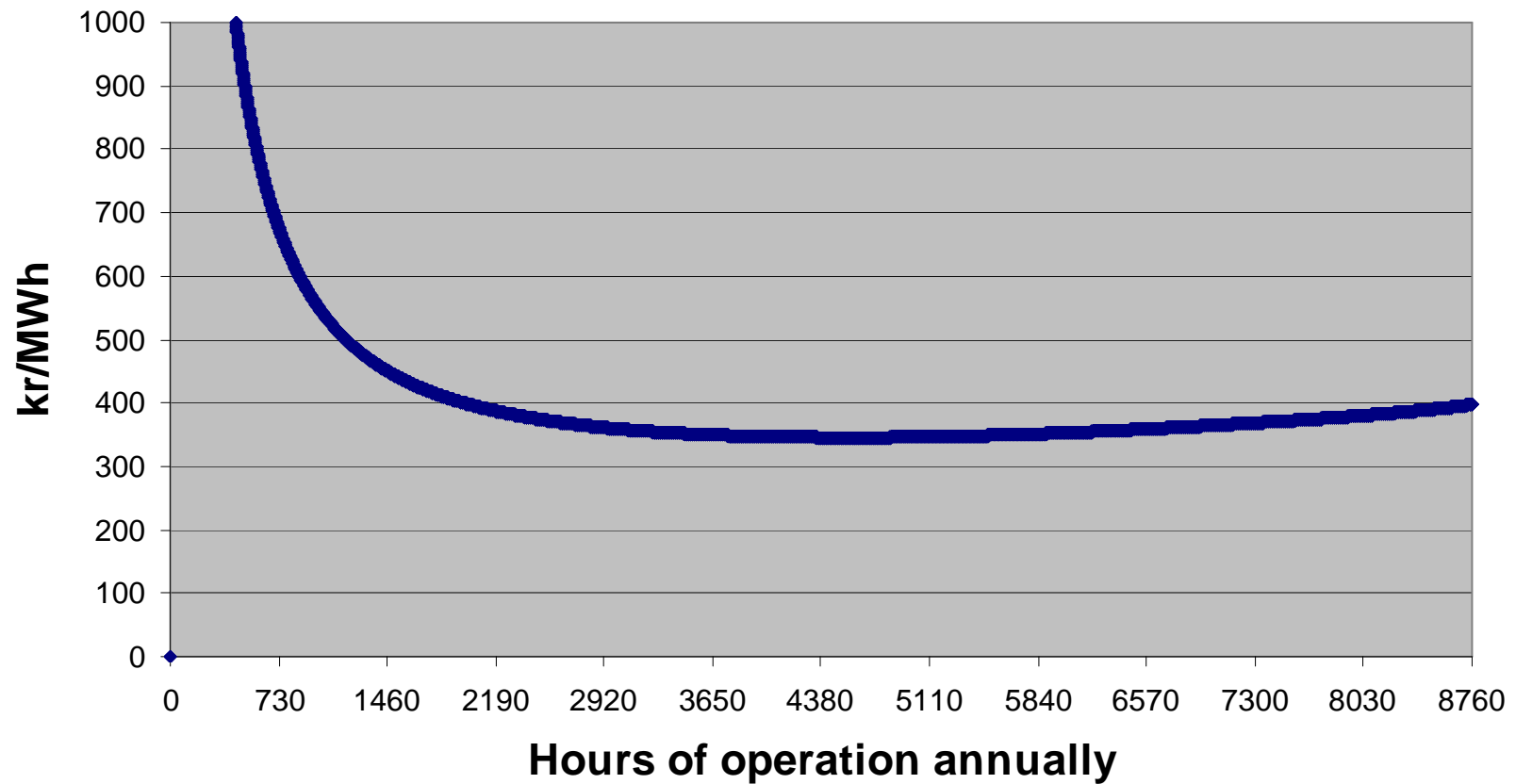
Depreciation



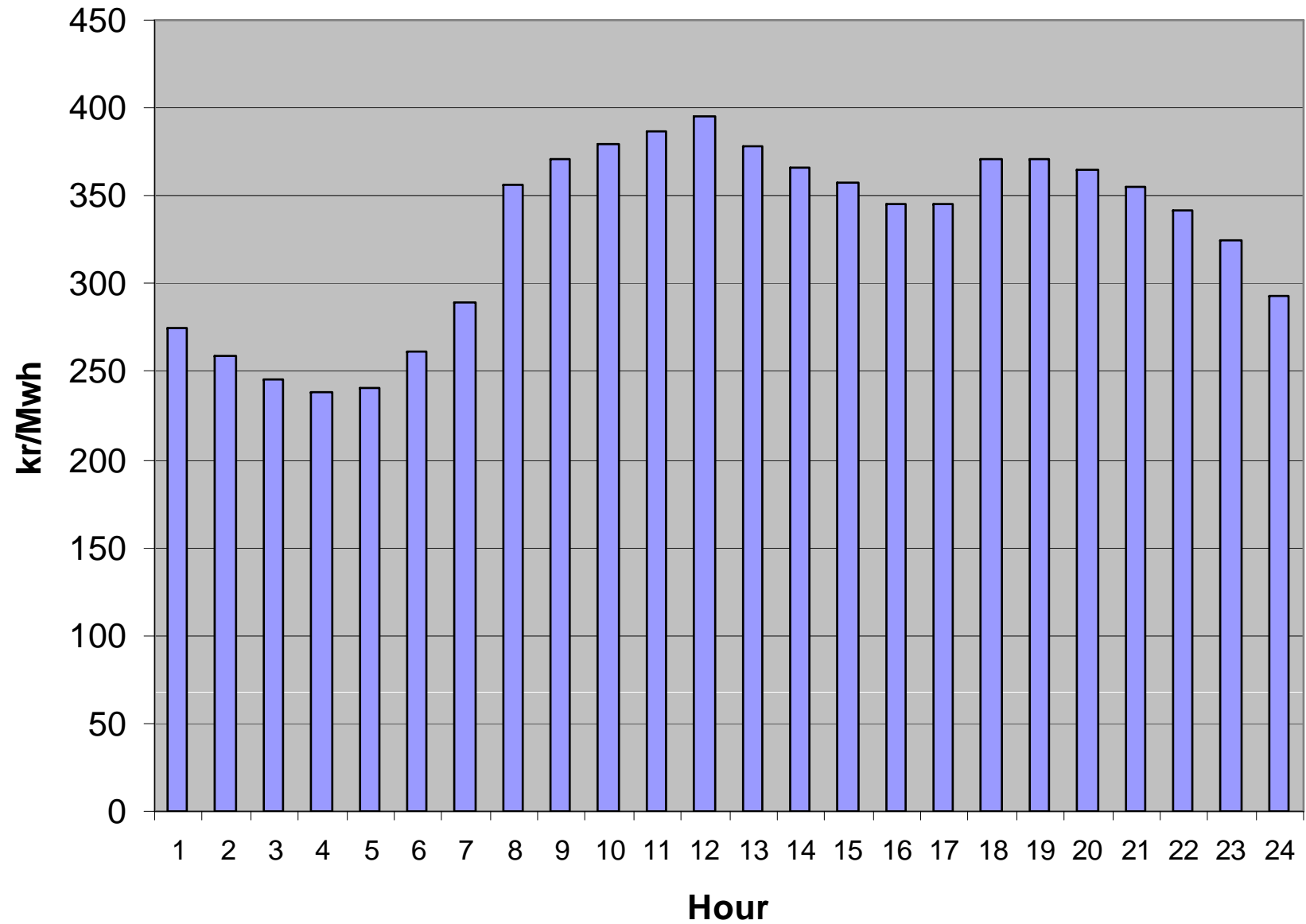
Prices of hydrogen 2006



Prices of hydrogen if oxygen and heat is sold



Daily average prices 2006



Conclusion

- Due to the near foreseen peak in the supply of fossil fuel, there will be a huge business opportunity in supply of renewable energy.
- By research and development, industrial electrolysers for hydrogen production must be developed to energy plants for production of cheap hydrogen.
- The electricity for the hydrogen production must be purchased at the best price.