Demand Response Potential Assessment in Finnish Large-Scale Industry

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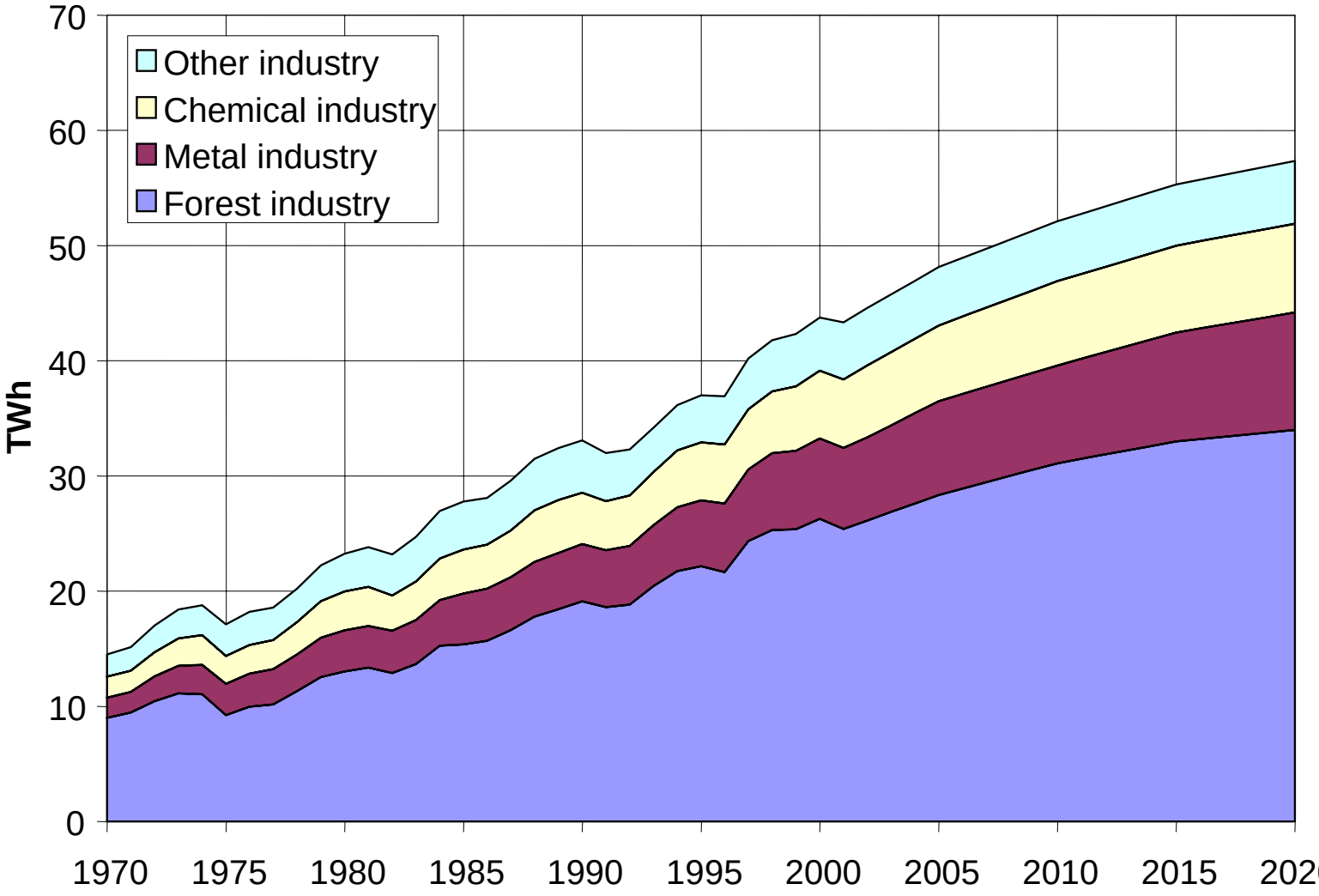
Electricity use in Finnish industry



Year 2003

Industry 45 TWh

Services and public 14 TWh

Households 10 TWh

Electric heating 9 TWh

Other 7 TWh

Total 85 TWh

Survey of Demand Response potential in industry (1/2)

- The objective was to get an overall view of the large-scale industry Demand Response potential available to the market
- To find out the most important factors affecting the potential
- The survey was financed by Fingrid Oyj and Ministry of Trade and Industry
- The survey was carried out by VTT in the beginning of 2005
- The Confederation of Finnish Industries EK was representing industry in steering and monitoring the project
- The company specific information from the survey is confidential

Survey of Demand Response potential in industry (2/2)

- Main focus on pulp and paper, basic metal and basic chemical industry (10 companies, 31 business locations)
- Also some cases from mineral (glass and cement) and food (meat and dairy) industry (4 companies, 22 business locations)
- These sectors use 33 TWh of electricity (73 % of total industry use)
- Surveyed companies use 16 TWh electricity (extended to cover whole pulp and paper industry)
- Mainly in-person interviews by visiting company locations, some by telephone and by mail
- Some part of the loads under survey belong already to the disturbance reserve of Fingrid (TSO)

Energy and demand data of the industry in the survey

	Business locations	Electric demand (one hour peak value)	Electric energy	Peak duration
	Number	*MW*	*TWh/a*	*h/a*
All sectors together yr. 2002	955	4 600	33	7 200
Surveyed companies				
1. Pulp, paper and board industry	16	1150	8,5	7400
2. Metal industry	5	656	4,5	6 820
3. Chemical industry (basic chemicals)	10	329	2,5	7 450
4. Mineral industry (glass, cement)	7	43	0,3	6 500
5. Food industry (meat, dairy)	15	35	0,2	5 600
Total	53	2 213	16	7 200

Technical potential of DR in pulp and paper industry

Flexible loads: Groundwood plants and mechanical pulping plants
Values have been extended to cover whole pulp and paper industry (23,5 TWh)

	year 2004	year 2010
Total power demand of whole pulp and paper industry	3 200 MW	
Total power demand of all flexible loads	790 MW	790 MW
- reserved for disturbance reserve (Fingrid)	327 MW**	650 MW**
- available for electricity markets	463 MW	140 MW
Peak load duration of flexible loads h/a	5 800 h	5 800 h

Response power that can be offered for the electricity market [yr2004&(yr2010)]
First and last column (0 h, total) are cumulative, rows are non-cumulative

Response duration	notice time/ preparatory interval				
	0 h	2 h	8 h	24 h	total
1 h	463(140)* MW				463(140)* MW
1 – 3 h	463(140)* MW				463(140)* MW
3 – 6 h					
6 – 12 h					
> 12 h					

* in brackets demand response power available after the new nuclear power unit comes on-line

** these values are based on 7000 h availability

DR potential

790 MW

Technical potential of DR in basic metal industry

Flexible loads: Electrolysis, arc furnaces, rolling mill
Values cover only companies in the survey (4,5 TWh)

	year 2004	year 2010
Total power demand of metal industry in the survey	660 MW	
Total power demand of flexible loads	379 MW	380 MW
- reserved for disturbance reserve (Fingrid)	75 MW	150 MW
- maximum power available for electricity markets	243 MW	167 MW
- non-flexible part of loads in processes	61 MW	63 MW
Peak load duration of flexible loads h/a	7500 h	7500 h

Response power that can be offered for the electricity market [yr2004&(yr2010)]
First and last column (0 h, total) are cumulative, rows are non-cumulative

Response duration	notice time/ preparatory interval				
	0 h	2 h	8 h	24 h	total
1 h	101(45)* MW	114(94)* MW		28 MW	243(167)* MW
1 – 3 h	101(45)* MW	30 MW		31 MW	162(106)* MW
3 – 6 h	101(45)* MW		30 MW		131(75)* MW
6 – 12 h	101(45)* MW			30 MW	131(75)* MW
> 12 h	101(45)* MW			30 MW	131(75)* MW

* in brackets demand response power available after the new nuclear power unit comes on-line

DR potential

320 MW

Technical potential of DR in basic chemical industry

Flexible loads: Electrolysis, grinding plants, extruders, gas compressors
Values cover only companies in the survey (2,5 TWh)

	year 2004	year 2010
Total power demand of chemical industry in the survey	330 MW	
Total power demand of all flexible loads	230 MW	240 MW
- reserved for disturbance reserve (Fingrid)		
- maximum power available for electricity markets	101 MW	101 MW
- non-flexible part of loads in the processes	129 MW	139 MW
Peak load duration of flexible loads h/a	4000 h	4000 h

Response power that can be offered for the electricity market [yr2004&(yr2010)]
First and last column (0 h, total) are cumulative, rows are non-cumulative

Response duration	notice time/ preparatory interval				
	0 h	2 h	8 h	24 h	total
1 h	56 MW	35 MW		10 MW	101 MW
1 – 3 h	56 MW	35 MW		10 MW	101 MW
3 – 6 h	48 MW	35 MW			83 MW
6 – 12 h				30 MW	30 MW
> 12 h	5 MW			30 MW	35 MW

DR potential

100 MW

Technical potential of DR in large-scale industry (1/2)

Flexible loads: Grounwood plants and mechanical pulping plants, electrolysis, arc furnaces, rolling mill, grinding plants, extruders, gas compressors

	year 2004	year 2010
Total power demand of the industry in survey	4 180 MW	
Total power demand of all flexible loads	1 400 MW	1 400 MW
- reserved for disturbance reserve (Fingrid)	402 MW**	800 MW**
- maximum power available for electricity markets	814 MW	410 MW
- non-flexible part of loads in flexible processes	184 MW	190 MW
Peak load duration of flexible loads h/a	6000 h	6000 h

Response power that can be offered for the electricity market [yr2004&(yr2010)]
First and last column (0 h, total) are cumulative, rows are non-cumulative

Response duration	notice time/ preparatory interval				
	0 h	2 h	8 h	24 h	total
1 h	625(241)* MW	149(129)* MW		38 MW	812(408)* MW
1 – 3 h	625(241)* MW	65 MW		41 MW	731(347)* MW
3 – 6 h	155(99)* MW	35 MW	30 MW		220(164)* MW
6 – 12 h	107(50)* MW			30 MW	137(80)* MW
> 12 h	106(50)* MW			35 MW	141(85)* MW

* in brackets demand response power available after the new nuclear power unit comes on-line

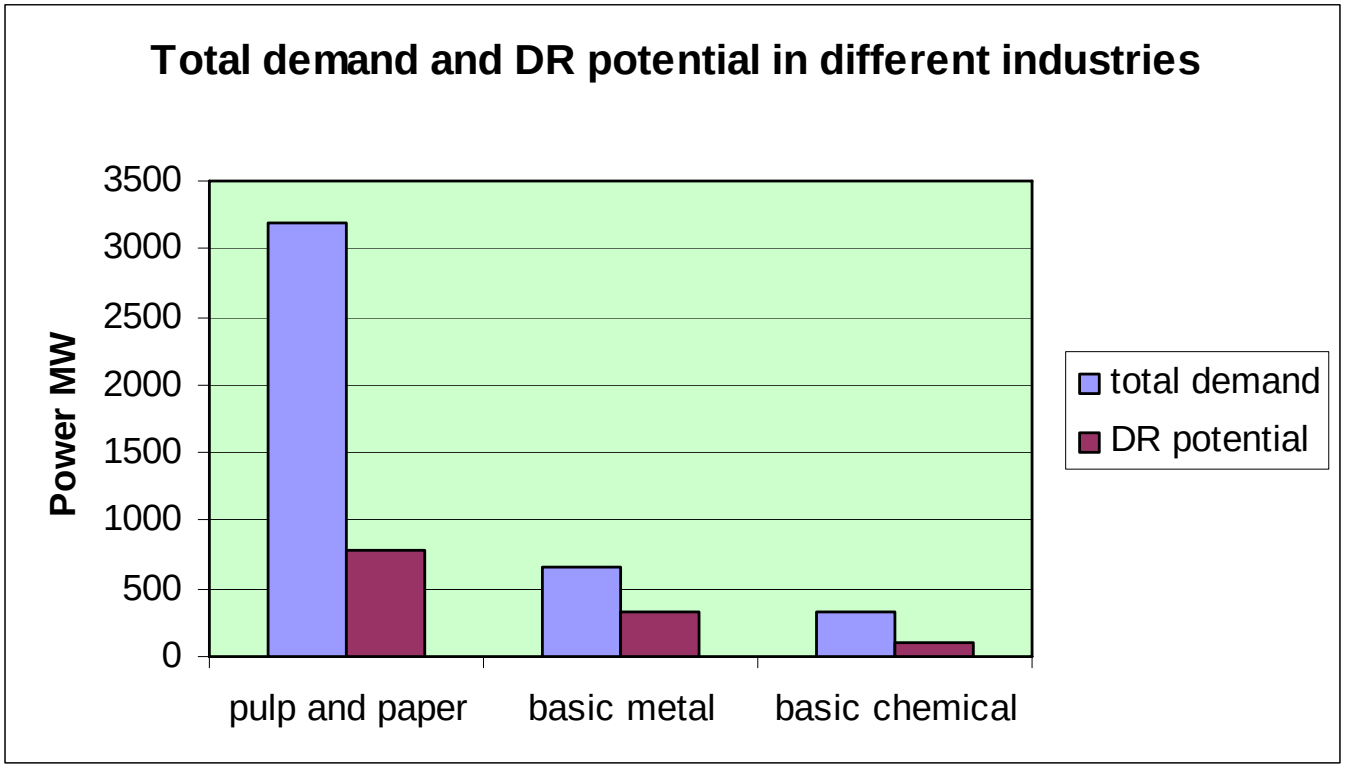
** these values are based on 7000 h availability

DR total potential

1 210 MW

Technical potential of DR in large-scale industry (2/2)

- Technical potential of DR (1 210 MW) is about 8.6 % from the peak power of Finland (14 000 MW)



Effect of electricity price on activating Demand Response

Effect of electricity price on activating power response		
Price limit that activates the response	Response duration	
	max 3 h	**over 12 h**
100 EUR/MWh		5 MW
200 EUR/MWh	148(128)* MW	182(126)* MW
300 EUR/MWh	646(300)* MW	186(130)* MW
500 EUR/MWh	650(300)* MW	186(130)* MW
1000 EUR/MWh	740(300)* MW	266(190)* MW

* in brackets demand response power available after the new nuclear power unit comes on-line

- Price limits and demand response are very sensitive to market fluctuations (product prices)
- Electricity costs vary from 6 % to 80 % of production costs

How companies prepare to high electricity prices

- All use price hedging when they purchase electricity (typically 95...98 % from electricity purchase)
- Some have set fixed price limits, in the case of high spot-prices they purchase less
- Own electricity production, ownership in power production companies
- Processes have been developed in order to get more electricity from the process itself (e.g. new nitric acid manufacturing plants)

Barriers to participate on DR (1/2)

Production process based

- To stop and to restart a process equipment (DR action) can increase production costs and lead to faults in equipment
- Equipment restarting after DR action is not always certain, in the case of failure a whole production line can come to a standstill
- During winter time there is a risk of freezing because of cold weather and decrease of heat produced from the production equipment
- Production processes are integrated (e.g. DR action in a production process can also stop district heating production or fuel production to a power plant)
- There is no or too little intermediate storage in production lines in order to carry out DR actions
- Unbundling of processes and electricity management

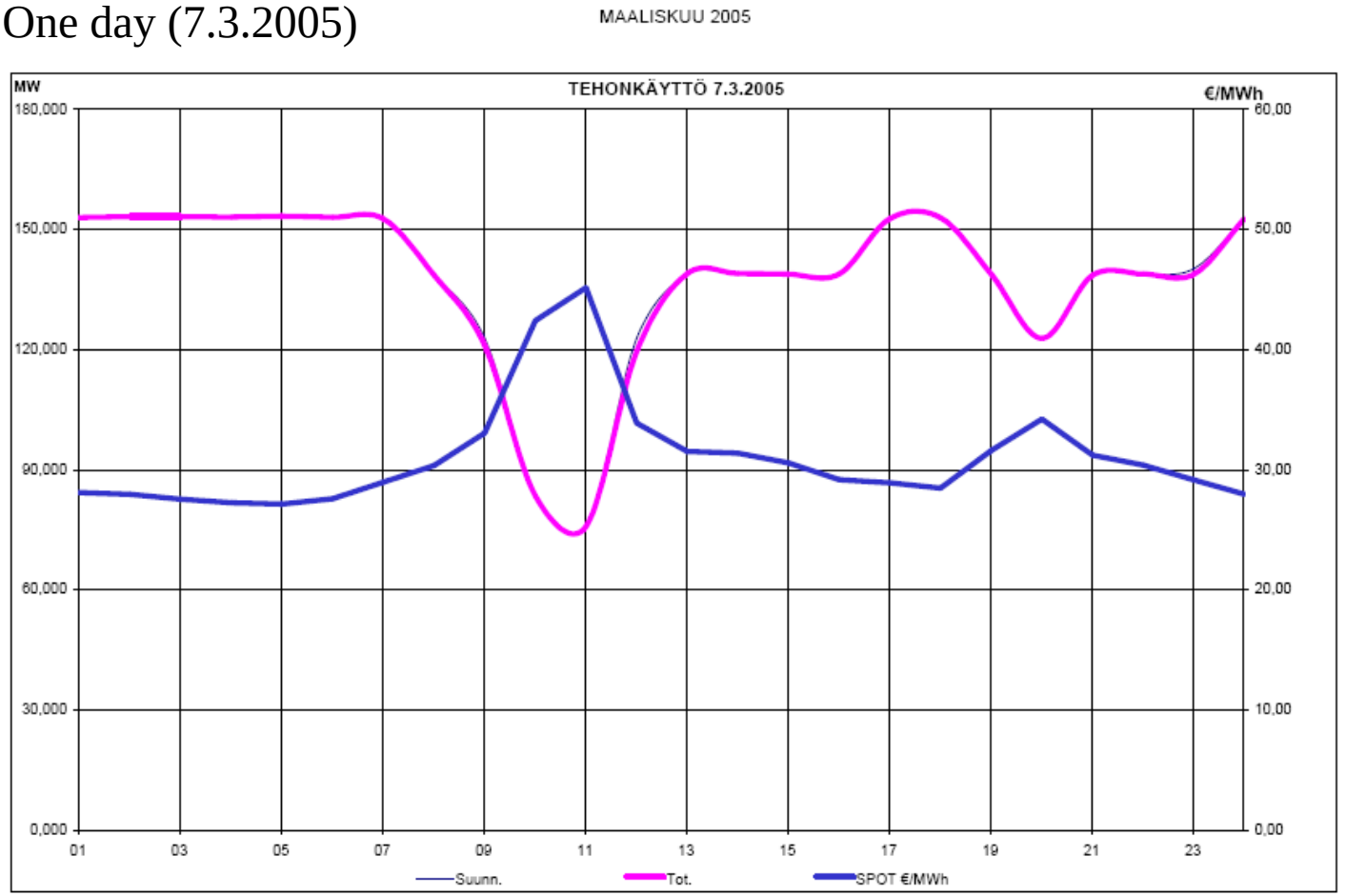
Barriers to participate on DR (2/2)

Human or organisational based

- Difficult to motivate persons responsible for production to participate on DR (DR actions can result to equipment faults)
- Things like DR actions that happen seldom are not very comfortable
- If DR action means reduction in production, usually fixed cost remain (labour etc.), persons in production should be able to do something else like maintenance work
- Decisions concerning production timing and the amount of production can be done far away from the production site e.g. abroad
- Hedging of almost all electricity purchase
- Disappearing of incentives related to the the old whole sale tariff structure due to competition

Example of DR in a chemical company

One day (7.3.2005)



Demand

Spot price

Standby aggregates in the survey

Type of standby aggregates	Size kVA		
	< 500	500...1000	> 1000
Manual, running isolated	1		
Manual, running parallel to the grid			
Automatic, running isolated	6		
Automatic, running parallel to the grid	1	8	17
Total number and (power MW)	8 (2,5 MW)	8 (6 MW)	17 (20 MW)

- Use in the case of power failure to halt the processes in a controlled way
- Lowest price limit to use aggregates to produce peak demand is 200...250 EUR/MWh
- Automatic operation, parallel to the grid

Conclusions

- Total DR potential in Finnish large-scale industry 1 210 MW (8.5 % from the Finnish power demand peak)
- DR for disturbance reserve: 400 MW (year 2009: 800 MW)
- DR available for electricity market: 810 MW (year 2009: 410 MW)
- DR potential in pulp and paper industry 790 MW (65 %), in basic metal industry 320 MW (27 %) and in basic chemical industry 100 MW (8 %)
- Very small DR potential in mineral and food industry compared to pulp and paper, metal and chemical industry
- 300 EUR/MWh electricity price activates 650 MW DR
- Many barriers to participate on DR: integrated processes, too little storages, risk of equipment faults, opposition of production personnel, new market conditions