CONSULTATION OF

GENERATION ADQUACY, CAPACITY MECHANISMS AND THE INTERNAL MARKET OF ELECTRICITY IN EU

1 General

This paper has been prepared as a response on the Consultation of generation adequacy problems found by the EU commission by energy service company Ekoenergo Oy.

Ekoenergo Oy has reminded also earlier about Electricity market laws, which have caused the existing electricity security problem in Finland. The law about Capacity Reserves (Tehoreservilaki) was created in 2006 to solve this problem.

The suppliers (e.g. Fortum) and transmission system operator (Fingrid) argued that liberal markets can solve the capacity problem. However, the adequacy situation has been becoming worse during the years 2006-2013, because the peak load has been increasing and the generation capacity has been decreasing at the same time.

2 Answers to given questions

2.1 Market prices

The prime cause of the adequacy problem comes from the fact that the market prices give no value for capacity. Thus there is no economic reason to build peaking power plants and thus nobody is building them. In an optimal power system about 25 % of the peak demand should be covered by the peaking power plants. In Finland the peak load is about 15.000 MW and 4000 MW should be covered by the peaking plants. However, the peaking plants do not exist at all and thus Finnish capacity deficit is about 3000-4000 MW.

The peaking plants would be built, if they can cover fully the costs. The investment costs of a typical gas turbine or gas or diesel engine plants are 600 €/kW. If the utilization time is 20 years and interest rate is 5 %, the annual costs will be 48 €/kWa. The variable costs are 100 €/MWh, if the plant is running on LNG. If the plant is operating 500 h/a, the electricity generating costs will be about 200 €/MWh. Thus a peaking plant should operating at least 500 h/a and the price should be at least 200 €/MWh to recover their costs.

.

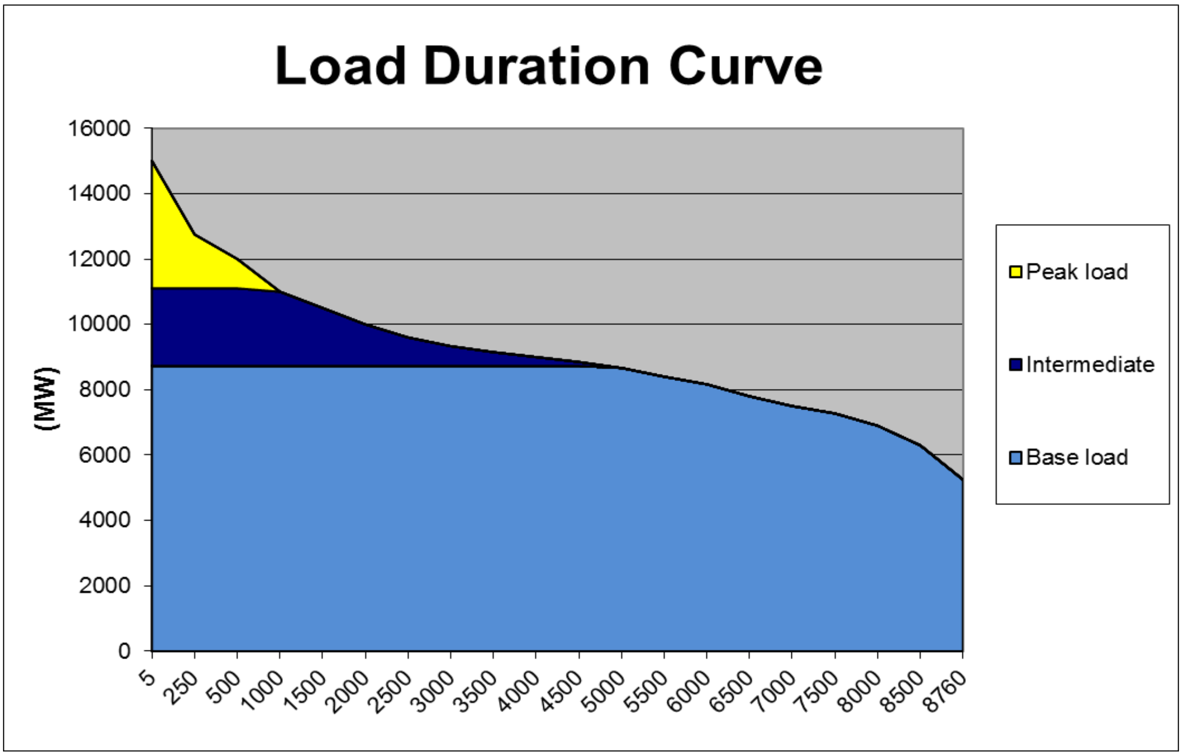

Figure 1 Peaking plants should have 25 % of the capacity.

2.2 Support needed

If the market is based purely on energy trading as in case of Finnish electricity markets, the support is needed and it should cover the capital costs of the peaking plants which is about 50 €/kW annually. If the capital costs are covered by capacity payments, then the power plants will be built by the utilities.

The financial support can be arranged so the capacity payments will be collected from the transmission charges by the Transmission System Operator. Another possibility is to give capacity obligation to generators, in which case the generators will cover the costs. Especially the owners of nuclear and hydro plants make huge profits in the system and they can easily cover the costs, if they will be obliged to cover them.

2.3 Cross-border trading and timeframe

The cross-border trading will help security of supply while the peak loads in different countries are not at the same hour. Thus peak load in larger area is lower than the sum of the peak loads in the subareas. However, this creates an illusion that subareas do not have to care about capacity.

Finland has been the biggest under capacity area for long time, because it has been relying on the Nordic system, which as a whole has been in balance. The time frames for trading can remain the same as today, if each of the areas has their own capacity markets. The capacity in each subarea should be traded three years ahead so that the capacity deficit can be filled with new peaking plants.

2.4 Steps needed at the European level

The rules for capacity markets and capacity obligations should be made in EU level to ensure that the capacity is adequate. Each load serving entity should have enough capacity to fulfill its obligation for the next three years. Thus one auction should be arranged three years before the peaking winter. The auction for winter 2016 should be arranged at latest is October 2013.

The model of capacity markets should be taken from USA, which has capacity markets from 2006. PJM markets are probably the best and biggest in the world today.

2.5 Additional steps needed

Before the real capacity obligations and markets will be created, the EU countries should ensure the adequacy of the capacity by local auctions. They should be organized by the energy market authorities.

In Finland, the Energy Market Authority (Energiamarkkinavirasto) has been making the capacity auction according to the Reserve Capacity-law since 2006. However, these auctions take into account only the next winter and only the existing capacity can be sold for the market. This means that no new capacity has been created by these auctions. Only auction which consider the capacity after three years will create new capacity.

EU should create auctions, in which the capacity starting after three years and ending after 15 years of operation. This is the only way to ensure that new capacity is actually created. In Finland the auctions has been made starting from 2006, but no new capacity has been created and the capacity deficit has been becoming bigger and bigger in each year after 2006.

2.6 Consumer preference standards

On the consumer side many of the deficit situations are not caused by the peak load of the consumers but the failures in the power plants and transmission lines. Thus the costs of the failures in power plants and transmission lines should be covered by the owners of them.

There have been doubts that some of the failures in the power plants have been caused by the owners in purpose to increase the price of electricity. The Swedish nuclear plants have had very pure availability compared with the same type of power plants in Finland. Thus the owners of the large nuclear power plants should have the reserve capacity to compensate the output of the largest or two largest power plants in the system. This should be built in addition to operation reserves, which will compensate the deficit during the operating hour. These additional reserve plants should compensate the next 12 hours after the current hour.

2.7 Generation adequacy assessments

The generation adequacy assessments should be reviewed by common rules and common authorities by outside authorities at national and regional levels. Today the adequacy assessments made by the local authorities are not made scientific methods. The authorities give the available capacity without any scientific calculation and proof.

In Finland the available generation capacity has been said to be 13.300 MW according to Fingrid and Energy Market Authority. However, in 5th of December 2012, the maximum capacity of the power plants was only 10.700 MW, when also few gas turbines were called on operation, when the electricity price was 300 €/MWh during one hour. This is 2600 MW lower than the data of the capacity given by Fingrid and Energy Market Authority.

The difference in actual and estimated figures was 20 % and it is so large that available generation capacity figures given by the authorities are misleading. They should give also confidence figures, how they are calculated. One way to make a capacity assessment is to look the hours when the electricity prices were peaking in Finland and take this capacity as the base value for the assessment. The peak generation values in Finland have been given in Figure 2 (source: Fingrid).

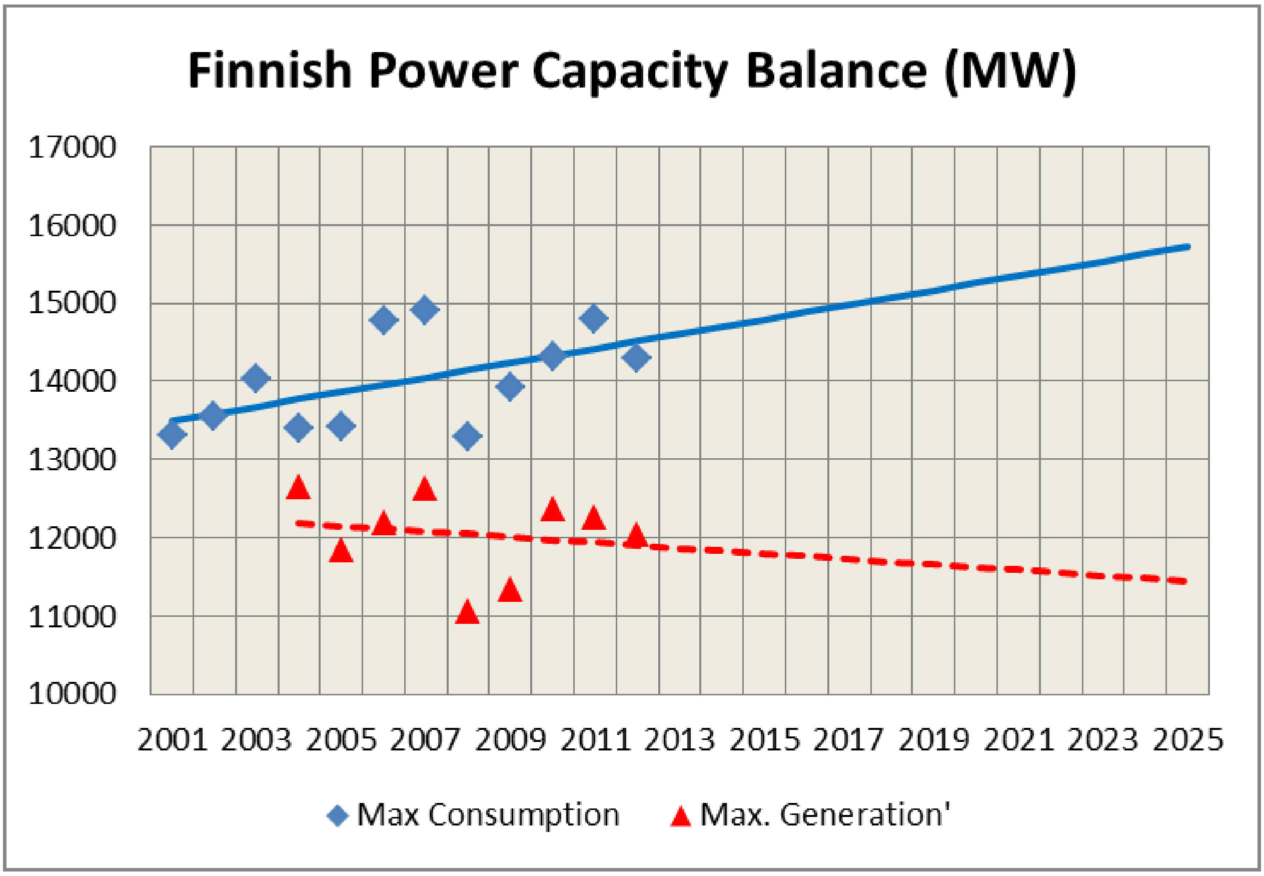

Figure 2 Peak consumption and peak generation figures in Finland based on the data given by Fingrid. The trend lines of the figures show that the capacity deficit has been worsening.

It is misleading to say that the available capacity is 13.300 MW, if the maximum peak of generation has been 12.200 MW during last five years according to Fingrid data. The market authorities and transmission system operators should give figures, which are the facts and make the assessments transparent that independent people can really find how they have been calculated. Main reason of the false figures may be coming from the fact that Fingrid was controlled by the largest electricity companies Fortum and PVO and they dictated the opinions there. Now Fingrid is independent from them, because this ownership was ended because of the electricity market directives.

2.8 Adequacy forecast by ENSTO-E

The adequacy forecasts made by ENTSO-E are the same as made by national transmission operators. Thus they are not transparent and reliable enough. They do not make any assessment of the flexible capacity and fluctuations in generation capacity. The generation capacity should be evaluated separately as base load capacity and peak load capacity. Peak load flexible capacity should be at least 25 % of the total capacity, which corresponds the first 1000 peaking hours (Fig. 1).

The capacity deficit in Finland has been increasing constantly and is now about 3000 MW and will be 3500 MW at 90 % confidence before the new 1600 MW nuclear plant will be in operation in 2015 (Figure 3). The estimates given by ENSTO-E are misleading or their calculation has been made based on the other assumptions.

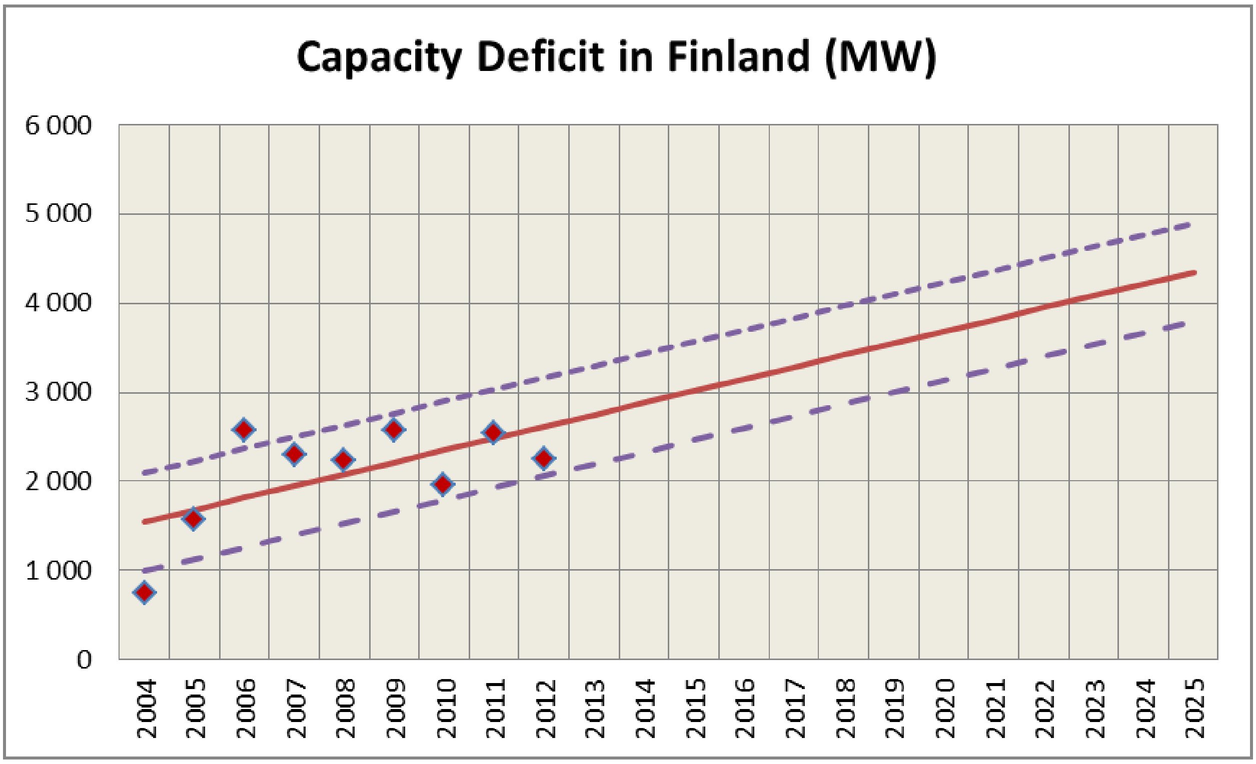

Figure 3 Capacity deficit based on the data given in Figure 2 indicates that at 90 % confidence level (Upper curve) the deficit will be about 3500 MW before the new nuclear plant will be taken into operation in 2015.

2.9 Electricity Security of Supply Directive

It seems that the directive is not enough because big capacity deficit exists in Finland and other countries. There should be capacity obligation and capacity markets in each of the areas, which could then force the utilities to build enough capacity. Capacity obligation was in force in Finland before the market liberalization in 1996.

2.10 Mandatory risk assessments

The capacity calculations should include risk assessment and probability evaluation. The risk assessments should consider outages of two largest power plants and largest transmission lines at the same time. They should also give confidence limits, which have been used in estimation.

2.11 Harmonization of adequacy standards

The standards should be harmonized within EU.

2.12 Introduction of capacity mechanisms

The capacity mechanisms should be introduced in all EU countries without delay. The present market does not work properly.

2.13 Market functioning

a) The necessary peak load and flexible capacity does not exist in Finland at all
b) The capacity deficit is now about 20-25 % of the peak load

2.14 Relation to strategic reserves

a) Strategic reserves (Capacity Reserves in Finland) are definitely need as long the capacity obligations and capacity markets will be created
b) The strategic reserves help the countries to cover peak load situations, but todays reserves in Finland are not flexible enough to cover sudden fluctuations in generation or load. Thus at least 800 MW of the reserves should be able to start within 30 minutes to cover imbalances after the current hour.
c) There should be also an obligation of local strategic reserves, which can maintain the heat supply pumps in the district heating networks and power potable and sewage water pumps and electric traffic during the total blackout of the country. This could be arranged by installing one or two about 10 MW size diesel engines in the sites of heat supply power plants in the cities.

2.15 Capacity markets and payments

a) PJM models in USA have been planned so that they take into account of many things at the same time. The day-a-head market of energy and reserves are optimized at the same time. The capacity markets are made three years ahead and new capacity can be part in the auctions
b) PJM is the right model
c) Same

2.16 Capacity model costs

The capacity market costs should be divided between the generators and consumers. The generators should cover the capacity costs of reserves needed to compensate the unreliability of their power plants. The unreliability of the largest power plants should be evaluated in each year based on the reliability records.

It the power plant has large outage rate, the owner should be obliged to build or buy more reserve capacity than others. The total reliability of the utility power system can be easily evaluated by adding the unreliability variances of each power plant in the system. This has been shown in the book "Planning of Optimal Power Systems" in page 140 tables 6.2.1 and 6.2.2.

2.17 Capacity mechanisms and balancing markets

Capacity markets and regulation markets should be connected so that also flexible capacity will be purchased at the same time. The regulation market requirement in the future should qualify only capacity which is reached within 5 minutes from the call. This 5 minute market is already in PJM system.

2.18 Blueprint of EU capacity mechanisms?

Future market should take into account following markets:

a) Capacity markets three years a head

   Should sell and buy capacity in August for the winter, which will begin three years from this date. Each load serving entity should have 90 % of the capacity needed

b) Capacity market two years a head

   Each load serving entity should have 100 % of the capacity needed two years ahead. They should include 50 % of the capacity of the largest unit as 30 minute reserve capacity.

c) Capacity market for the next winter

   Each load serving entity should have 105 % of capacity needed for the next winter and 50 % of the capacity of the largest unit as a 30 minute reserve capacity.

d) Day-a-head market

Day-a-head market shall ensure that each load system entity has 105 % of capacity available for the forecasted peak load and 50 % of the capacity of the largest unit as a 30 minute reserve capacity. Day-a-head market shall include also market for 5-10 minute regulation and non-spinning reserves, which will be optimized at the same time as energy markets.

e) Hour-a-head market

Market for 5-10 minute and 30 minute reserves and hour-a-head energy should trade the balance for the next hour.

2.19 Detailed criteria

Should be developed

2.20 Given criteria

They should evaluated case by case.

Ekoenergo Oy

Ekoenergo Oy has been helping electricity customers in finding suppliers of electricity by maintaining internet pages (www.energianet.fi) for asking bids for consumer's electricity purchasing. It has also published a book about energy and energy markets, "**Energiankäyttäjän käsikirja**" (Energy User's handbook).

Another book **"Planning of Optimal Power Systems**" describes how national and municipal power systems can be planned. The book also shows in detail how the reserves in a power system are planned and how adequacy in power system should be evaluated. . It has been used as a text book in Doctoral course in Lappeenranta University of Technology in autumn 2012. The overheads of the course and the book can be downloaded from www.askovuorinen.fi at Energy and climate studies. The both books are available at www.ekoenergo.fi

Asko Vuorinen

Asko Vuorinen has a licentiate degree in Engineering from Aalto University. He has worked as a design engineer in Imatran Voima Oy, Nuclear Project Group (1971-1980) and as a chief design engineer of investment studies at Imatran Voima Power plant department 1980-1991. During this time he served as a member of Capacity Group in the Electricity Producer's Coordination Committee (Sähköntuottajien Yhteistyövaltuuskunta, STYV),

He was 1991-2010 managing director at Modigen Oy, which was a development company in Wärtsilä Oy Group. He is currently CEO at Ekoenergo Oy, which an independent energy service company. He has written five books and three of them include energy and power system planning. He has been a teacher in Doctoral Course of Power Systems during autumn 2012 in Lappeenranta University of Technology (LUT).

Espoo, Finland

January 9th, 2013

Ekoenergo Oy

Asko Vuorinen

Lokirinne 8 A 25, 02320 Espoo   Tel. +358 440 451 022

Table 1 Generation costs of peaking power plants at 500 h/a

Fuel		**Coal**	**Gas**	**Gas**	**Heavy oil**	**Bio oil**	**Diesel oil**
Type		**steam**	**GTCC**	**engine**	**engine**	**engine**	**engine**
Performance							
Electricity output	MW	500	250	250	250	250	250
Efficiency	%	42 %	53 %	42 %	42 %	42 %	42 %
Fuel input	MW	1 190	472	595	595	595	595
CO2-content	kg/MWh	341	341	198	284	-	273
Operation							
Full power hours	h/a	500	500	500	500	500	500
Electricity generation	GWh	250	125	125	125	125	125
Fuel consumptio	GWh	595	236	298	298	298	298
CO2-emissions	kt	203	80	59	84	-	81
Prices							
Electricity	€/MWh	220	220	220	220	220	220
Fuel	€/MWh		35	35	50	70	70
CO2-allowance	€/t	12	20	20	20	20	20
Taxes	€/MWh	-	-	-	-	-	-
Fuel costs	€/MWh	10	10	7	10	10	10
Investment	€/kW	1 600	800	600	700	700	600
Revenues							
Electricity	k€	55 000	27 500	27 500	27 500	27 500	27 500
Annual costs							
Fuel	k€	7 143	8 255	10 417	14 881	20 833	20 833
CO2-allowances	k€	2 433	1 606	1 180	1 689	-	1 625
Taxes	k€	-	-	-	-	-	-
O&M	k€	2 500	1 250	875	1 250	1 250	1 250
Total	k€	12 075	11 111	12 471	17 820	22 083	23 708
	€/MWh	**48,3**	**88,9**	**99,8**	**142,6**	**176,7**	**189,7**
Operation profit	k€	42 925	16 389	15 029	9 680	5 417	3 792
Investment	k€	800 000	200 000	150 000	175 000	175 000	150 000
Capital costs	k€	64 194	16 049	12 036	14 042	14 042	12 036
(5 %, 20 a.)	€/MWh	**256,8**	**128,4**	**96,3**	**112,3**	**112,3**	**96,3**
Generation costs	k€	76 269	27 160	24 508	31 862	36 126	35 745
Specific costs	**€/MWh**	**305,1**	**217,3**	**196,1**	**254,9**	**289,0**	**286,0**
Simple payback time	**a**	**18,6**	**12,2**	**10,0**	**18,1**	**32,3**	**39,6**