Rare Earth Elements: Supply, demand, consumption, price

Rare Earth Elements (REE) are extensively used every day in batteries, electronics, ceramics, and high-powered magnets, and they are vital for clean energy technologies as well. In this activity we will look at REE supply, and consumption and price data, and discuss possible future strategies for balancing REE supply and demand.

China supplies the majority of the world's REE. The Chinese government sets the maximum amount of REE that can be legally exported out of the country (i.e., **export quota**) each year. The following table shows the amount of the export quota each year for the years 2000–2010 (except for 2002, for which we have no data), and the price per ton of REE adjusted for inflation with respect to the value of U.S. dollars (USD) during 1998 (shown as 98$/t, which means 1998 dollars per ton).

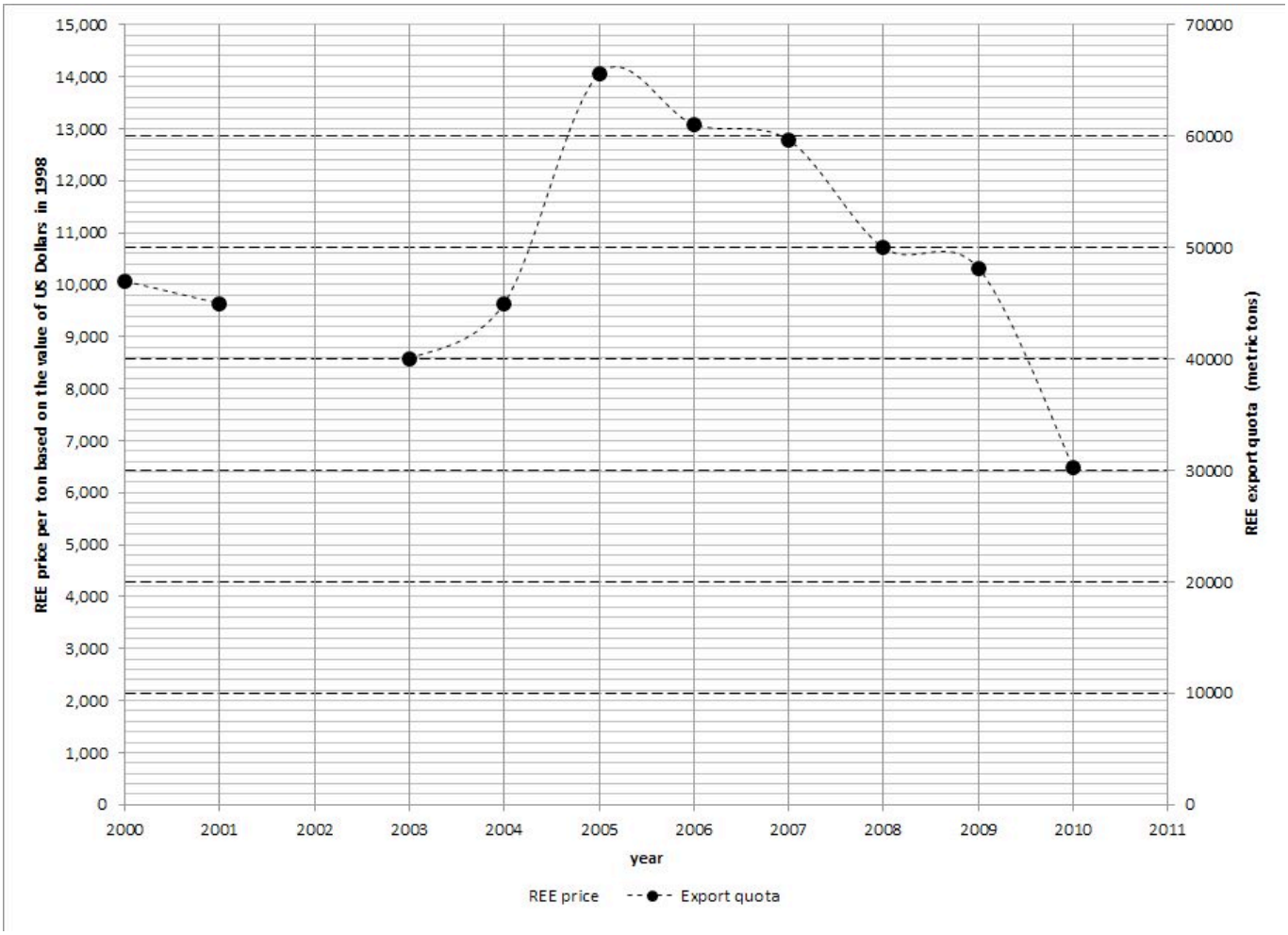
Year	Total export quota (metric tons)*	REE price per ton** in USD during 1998, expressed as (98$/t)
2000	47,000	6,110
2001	45,000	5,330
2002	N/A	6,800
2003	40,000	5,450
2004	45,000	7,410
2005	65,580	5,500
2006	61,070	3,150
2007	59,643	4,160
2008	49,990	10,300
2009	48,155	7,100
2010	30,258	14,500

* Quota data from "China's Rare-Earth Production, Consumption, and Export Quotas for 2000 through 2011." (Tse, Pui-Kwan, 2011, China's Rare-Earth Industry: U.S. Geological Survey Open-File Report 2011–1042, 11 p.) Data from 2005 onward show total export quota for domestic producers and traders, plus Sino–foreign joint ventures.

** Price data from: "U.S. Geological Survey, 2011, REE statistics," in Kelly, T. D., and Matos, G. R., comps., "Historical Statistics for Mineral and Material Commodities in the United States," U.S. Geological Survey Data Series 140, at http://pubs.usgs.gov/ds/2005/140/.

1. The amount of REE allowed to be exported out of China is plotted on the graph below. Plot the REE price from the above table (the third column) on the same graph, using connected symbols. Please use a different symbol (not a filled circle) for your plot, and indicate your symbol on the legend below the graph.

   Note: This graph has TWO vertical axes. The vertical axis on the left indicates the price of REE expressed in terms of dollars per ton adjusted for inflation (98$/t). Use this axis for the data you need to plot. The vertical axis on the right shows the amount of REE export quota from China for the years listed. This data is already plotted for you.

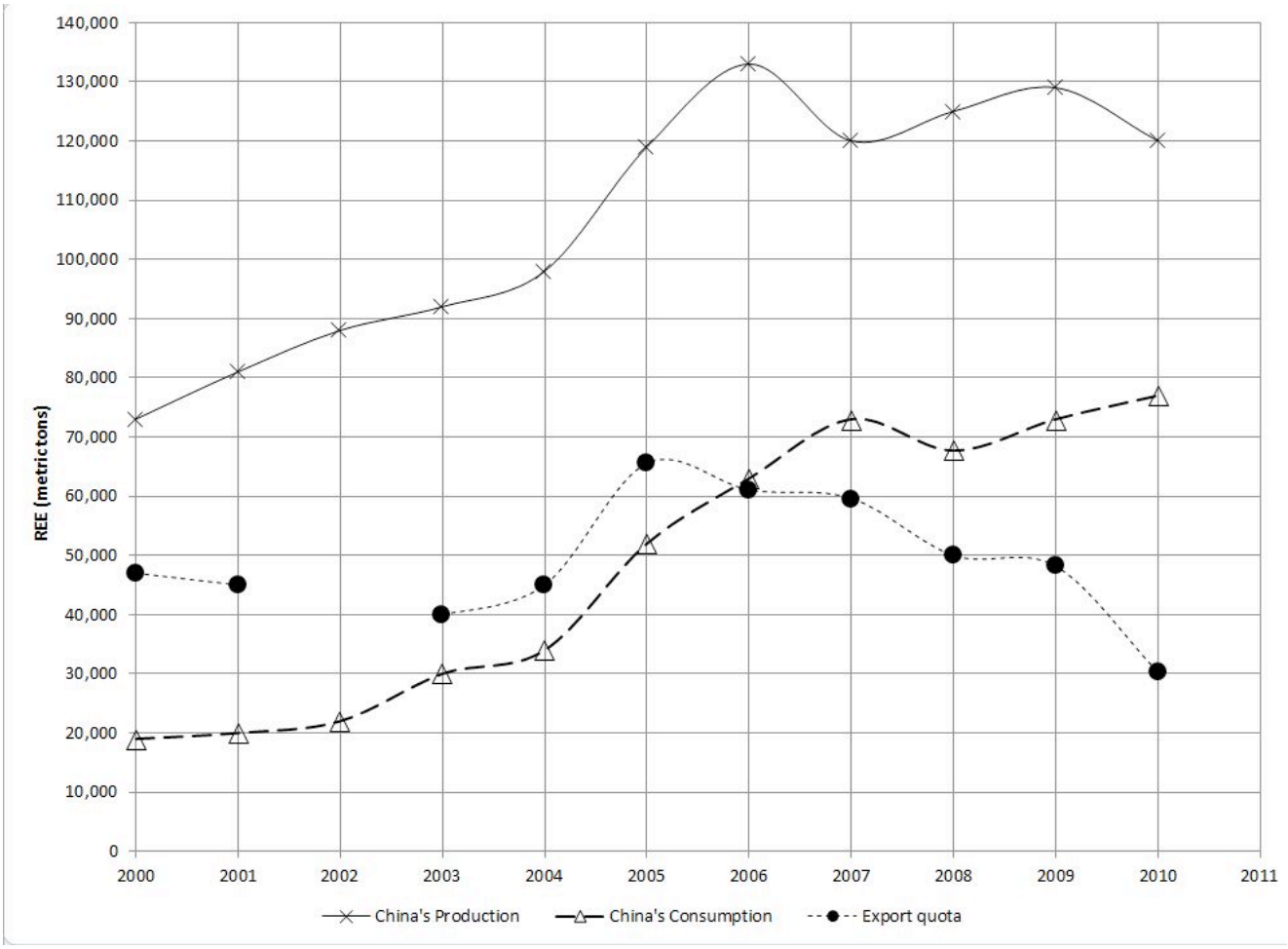


Answer the following questions based on the plot shown above:

2. The trend of the REE export quota is shown by black dots and the dotted line. By how much was the REE export quota reduced between 2005 and 2010?

3. When did the price of REE reach its lowest value? What was the approximate lowest value for REE?

4. Based on this graph, what can you say about the relationship between the REE export quota out of China (supply) and the price of REE?



5. China's REE production (Xs), consumption (open triangles), and export quota (filled circles) for 2000–2011 are shown in the above chart. Why do you think China is currently reducing its export quota? Give two reasons.

Rare Earth Element	Partial list of uses in clean energy technology fields				Demand* (Tons)	Supply* (Tons)
	Magnets (to generate electricity, in wind turbines, hybrid cars, etc.)	**NiMH batteries in some hybrid cars**	**Phosphors in energy-efficient light bulbs (CFL)**	**Catalysts in cars (catalytic converters, to reduce pollutants)**		
Lanthanum		**X**	**X**	**X**	41,200	30,500
Cerium		**X**	**X**	**X**	43,900	38,400
Praseodymium	**X**	**X**		**X**	9,800	7,000
Neodymium	**X**	**X**			27,000	24,400
Europium			**X**		400	390

*Data from Roger Bade (2010), "Rare Earth Review: Is the Hype Justified?" http://www.slideshare.net/RareEarthsRareMetals/libertas-rareearthreview

6. Some common uses, demand, and supply, for five of the rare earth elements are shown in the above table. You'll notice that supply and demand are out of balance. What can consumers, REE producers (e.g., mining companies), and technology manufacturers do to reduce the imbalance, and how will these actions affect the adoption and use of clean-energy technologies? Create a concept map to illustrate your answers.

Optional end-of-unit reflection question (this can also be used as a post-unit homework assignment or can be used as a unit-based question for an exam)

7. Describe two measures that you can personally take to reduce the supply/demand imbalance of REEs. Explain how those measures could either increase REE supply or reduce REE demand or both.