

# Rare Earth Phosphor Crisis

July 2011



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# What are Rare Earth Metals?

- Rare Earth Metals are a group of 17 elements from the periodic table
- Rare Earth Metals are used in a vast array of products:
  - Hybrid Cars
  - Wind Turbines
  - Solar Panels
  - Military Weapons
  - Smart Phones
  - Computers
  - Flat Screens
  - Lighting
  - » Less than 10% of the industry's needs

**Periodic Table of the Elements**

|  |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                    |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
|--|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|-------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|--------------------|--------------------|--------------------|
| 1  |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   | 18                 |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 1<br>H<br>1.01   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   | 2<br>He<br>4.00    |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 3<br>Li<br>6.94  | 4<br>Be<br>9.01    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    | 13<br>B<br>10.81   | 14<br>C<br>12.01   | 15<br>N<br>14.01   | 16<br>O<br>15.99   | 17<br>F<br>19.00  | 18<br>Ne<br>20.18  |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 11<br>Na<br>22.99  | 12<br>Mg<br>25.31  |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    | 13<br>Al<br>26.98  | 14<br>Si<br>28.09  | 15<br>P<br>30.97   | 16<br>S<br>32.07   | 17<br>Cl<br>35.45 | 18<br>Ar<br>39.95  |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 19<br>K<br>39.10   | 20<br>Ca<br>40.08  | 21<br>Sc<br>44.96  | 22<br>Ti<br>47.87  | 23<br>V<br>50.94   | 24<br>Cr<br>52.00  | 25<br>Mn<br>54.94  | 26<br>Fe<br>55.85  | 27<br>Co<br>58.93  | 28<br>Ni<br>58.69  | 29<br>Cu<br>63.55  | 30<br>Zn<br>65.41  | 31<br>Ga<br>69.72  | 32<br>Ge<br>72.64  | 33<br>As<br>74.92  | 34<br>Se<br>78.96  | 35<br>Br<br>79.90 | 36<br>Kr<br>83.80  |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 37<br>Rb<br>85.47  | 38<br>Sr<br>87.62  | 39<br>Y<br>88.91   | 40<br>Zr<br>91.22  | 41<br>Nb<br>92.91  | 42<br>Mo<br>95.94  | 43<br>Tc<br>(98)   | 44<br>Ru<br>101.07 | 45<br>Rh<br>102.91 | 46<br>Pd<br>106.42 | 47<br>Ag<br>107.87 | 48<br>Cd<br>112.41 | 49<br>In<br>114.82 | 50<br>Sn<br>118.71 | 51<br>Sb<br>121.76 | 52<br>Te<br>127.60 | 53<br>I<br>126.90 | 54<br>Xe<br>131.29 |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 55<br>Cs<br>132.91   | 56<br>Ba<br>137.33 | 57<br>La<br>138.91 | 72<br>Hf<br>178.49 | 73<br>Ta<br>180.95 | 74<br>W<br>183.84  | 75<br>Re<br>186.21 | 76<br>Os<br>190.23 | 77<br>Ir<br>192.22 | 78<br>Pt<br>195.08 | 79<br>Au<br>196.97 | 80<br>Hg<br>200.59 | 81<br>Tl<br>204.38 | 82<br>Pb<br>207.2  | 83<br>Bi<br>208.98 | 84<br>Po<br>(209)  | 85<br>At<br>(210) | 86<br>Rn<br>(222)  |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 87<br>Fr<br>(223)  | 88<br>Ra<br>(226)  | 89<br>Ac<br>(227)  | 104<br>Rf<br>(261) | 105<br>Db<br>(262) | 106<br>Sg<br>(266) | 107<br>Bh<br>(264) | 108<br>Hs<br>(270) | 109<br>Mt<br>(268) | 110<br>Ds<br>(281) | 111<br>Rg<br>(272) |                    |                    |                    |                    |                    |                   |                    |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| <table border="1"> <tr> <td>58<br/>Ce<br/>140.12</td> <td>59<br/>Pr<br/>140.91</td> <td>60<br/>Nd<br/>144.24</td> <td>61<br/>Pm<br/>(145)</td> <td>62<br/>Sm<br/>150.36</td> <td>63<br/>Eu<br/>151.97</td> <td>64<br/>Gd<br/>157.25</td> <td>65<br/>Tb<br/>158.93</td> <td>66<br/>Dy<br/>162.50</td> <td>67<br/>Ho<br/>164.93</td> <td>68<br/>Er<br/>167.26</td> <td>69<br/>Tm<br/>168.93</td> <td>70<br/>Yb<br/>173.04</td> <td>71<br/>Lu<br/>174.97</td> </tr> <tr> <td>90<br/>Th<br/>232.04</td> <td>91<br/>Pa<br/>231.04</td> <td>92<br/>U<br/>238.03</td> <td>93<br/>Np<br/>(237)</td> <td>94<br/>Pu<br/>(244)</td> <td>95<br/>Am<br/>(243)</td> <td>96<br/>Cm<br/>(247)</td> <td>97<br/>Bk<br/>(247)</td> <td>98<br/>Cf<br/>(251)</td> <td>99<br/>Es<br/>(252)</td> <td>100<br/>Fm<br/>(257)</td> <td>101<br/>Md<br/>(258)</td> <td>102<br/>No<br/>(259)</td> <td>103<br/>Lr<br/>(262)</td> </tr> </table> |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                    | 58<br>Ce<br>140.12 | 59<br>Pr<br>140.91 | 60<br>Nd<br>144.24 | 61<br>Pm<br>(145) | 62<br>Sm<br>150.36 | 63<br>Eu<br>151.97 | 64<br>Gd<br>157.25 | 65<br>Tb<br>158.93 | 66<br>Dy<br>162.50 | 67<br>Ho<br>164.93 | 68<br>Er<br>167.26 | 69<br>Tm<br>168.93 | 70<br>Yb<br>173.04 | 71<br>Lu<br>174.97 | 90<br>Th<br>232.04 | 91<br>Pa<br>231.04 | 92<br>U<br>238.03 | 93<br>Np<br>(237) | 94<br>Pu<br>(244) | 95<br>Am<br>(243) | 96<br>Cm<br>(247) | 97<br>Bk<br>(247) | 98<br>Cf<br>(251) | 99<br>Es<br>(252) | 100<br>Fm<br>(257) | 101<br>Md<br>(258) | 102<br>No<br>(259) | 103<br>Lr<br>(262) |
| 58<br>Ce<br>140.12   | 59<br>Pr<br>140.91 | 60<br>Nd<br>144.24 | 61<br>Pm<br>(145)  | 62<br>Sm<br>150.36 | 63<br>Eu<br>151.97 | 64<br>Gd<br>157.25 | 65<br>Tb<br>158.93 | 66<br>Dy<br>162.50 | 67<br>Ho<br>164.93 | 68<br>Er<br>167.26 | 69<br>Tm<br>168.93 | 70<br>Yb<br>173.04 | 71<br>Lu<br>174.97 |                    |                    |                   |                    |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |
| 90<br>Th<br>232.04   | 91<br>Pa<br>231.04 | 92<br>U<br>238.03  | 93<br>Np<br>(237)  | 94<br>Pu<br>(244)  | 95<br>Am<br>(243)  | 96<br>Cm<br>(247)  | 97<br>Bk<br>(247)  | 98<br>Cf<br>(251)  | 99<br>Es<br>(252)  | 100<br>Fm<br>(257) | 101<br>Md<br>(258) | 102<br>No<br>(259) | 103<br>Lr<br>(262) |                    |                    |                   |                    |                    |                    |                    |                   |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                    |                   |                   |                   |                   |                   |                   |                   |                   |                    |                    |                    |                    |

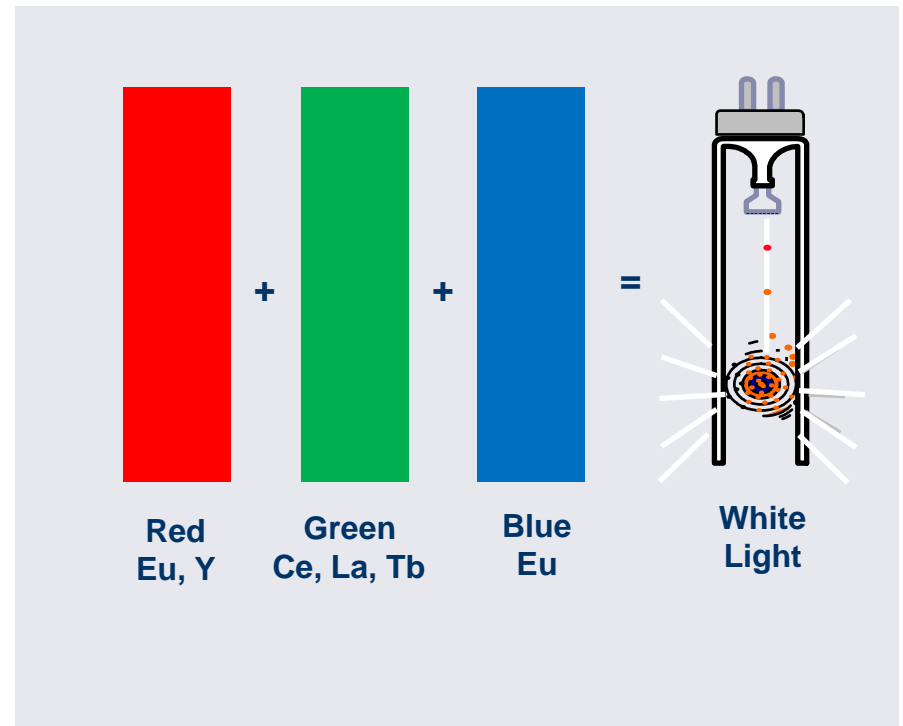
# Where are Rare Earth Elements (RE) used in Fluorescent Lighting?

## Fluorescent lamps contain Halo and Triphosphors

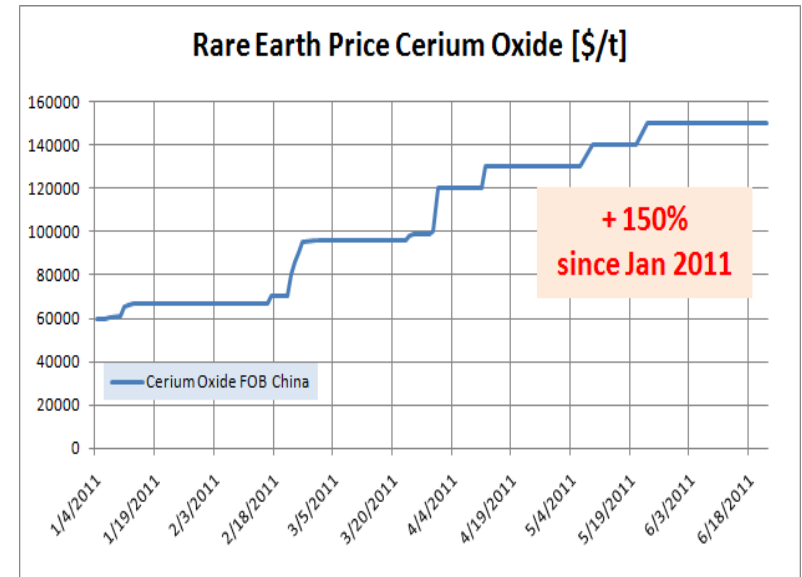
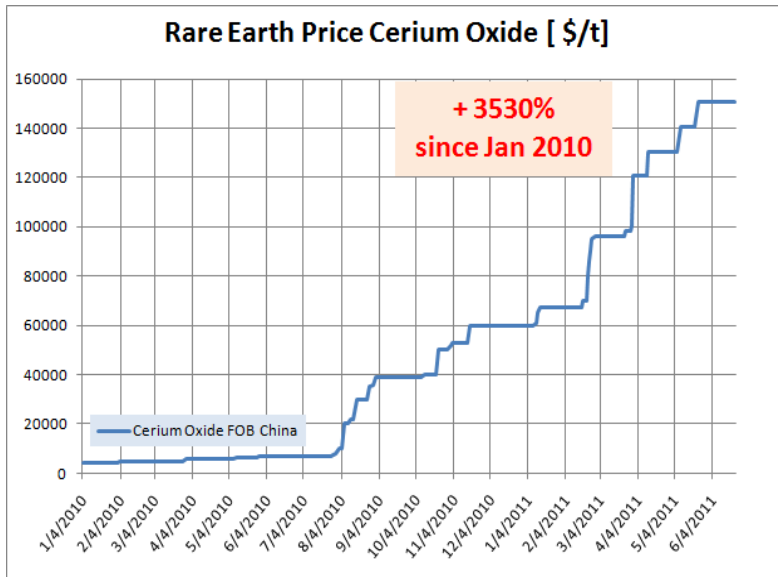
- Tri-Phosphors use Rare Earth oxides in their phosphor mix
- Rare Earth oxides are vital component in our energy efficient fluorescent lamps
- Cerium, Europium, Terbium, Yttrium are examples of RE oxides contained in fluorescent lamps

## Triphosphors are used in the following products:

- All T8's
- All T5's
- Deluxe T12's
- All CFL pin and self-ballasted



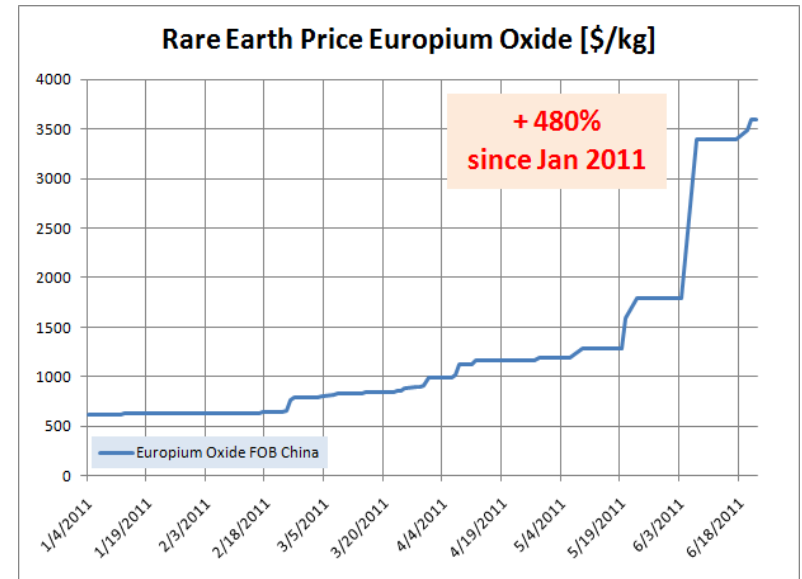
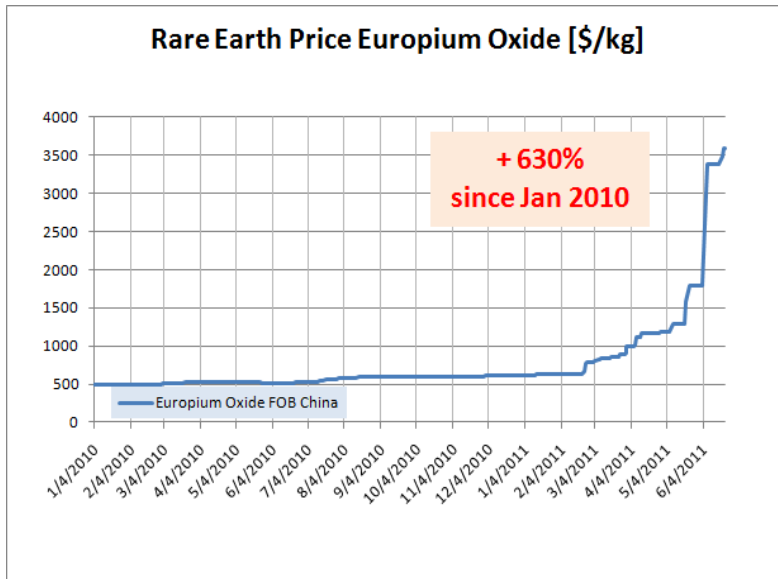
# Rare Earth Oxide Continue To Climb...Cerium



Source: [www.asianmetal.com](http://www.asianmetal.com)

Rare Earth Phosphor Crisis, July 7, 2011

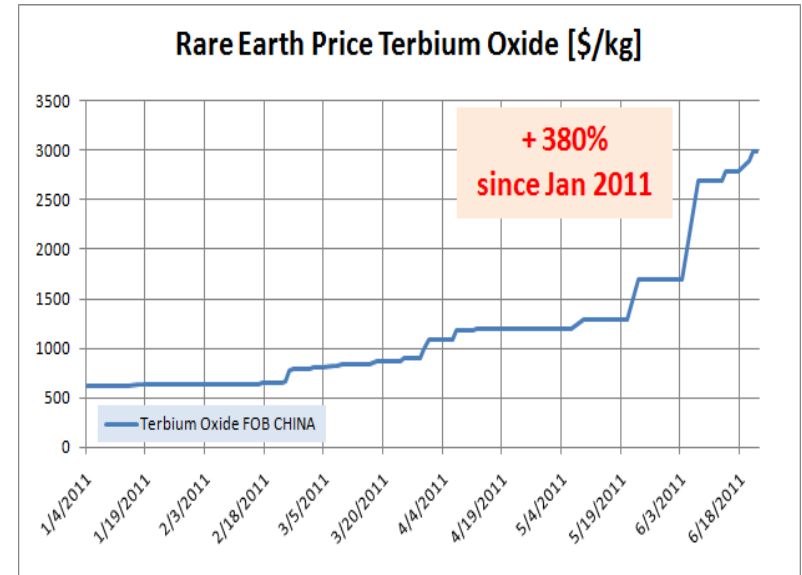
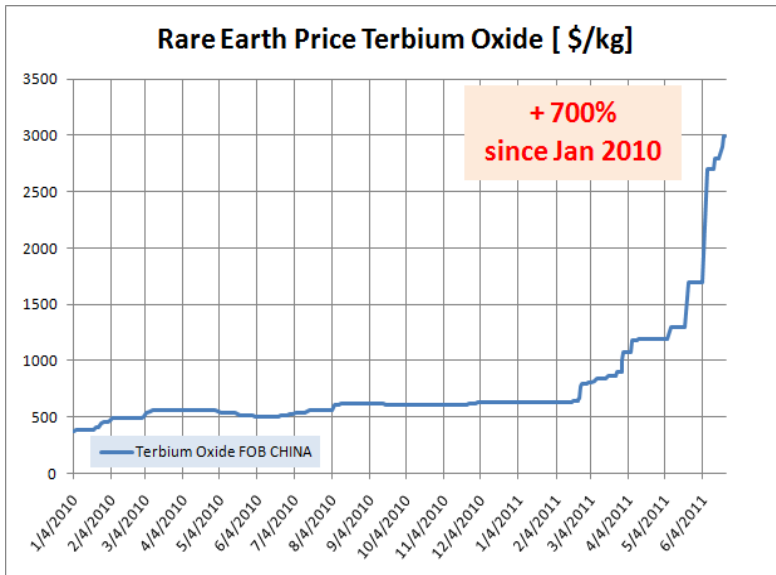
# Rare Earth Oxide Continue To Climb...Europium



Source: [www.asianmetal.com](http://www.asianmetal.com)

Rare Earth Phosphor Crisis, July 7, 2011

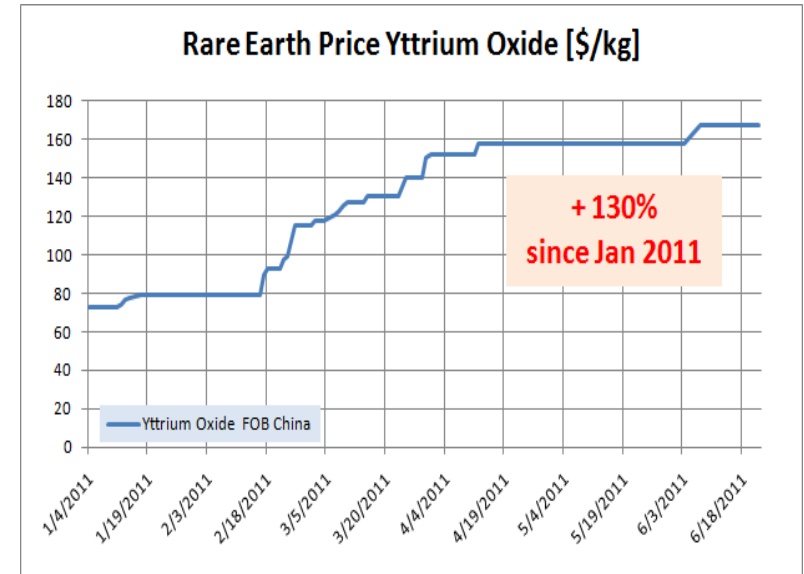
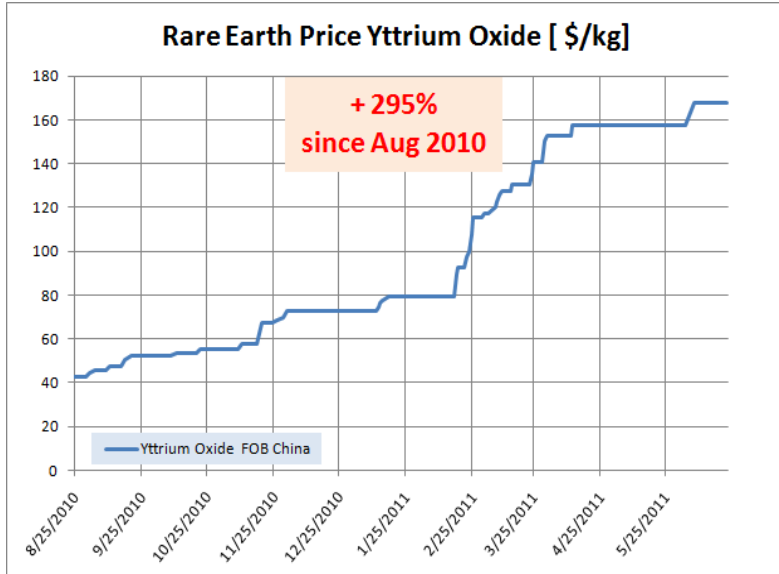
# Rare Earth Oxide Continue To Climb...Terbium



Source: [www.asianmetal.com](http://www.asianmetal.com)

Rare Earth Phosphor Crisis, July 7, 2011

# Rare Earth Oxide Continue To Climb...Yttrium



Source: [www.asianmetal.com](http://www.asianmetal.com)

Rare Earth Phosphor Crisis, July 7, 2011

# Rare Earth Mineral Mining

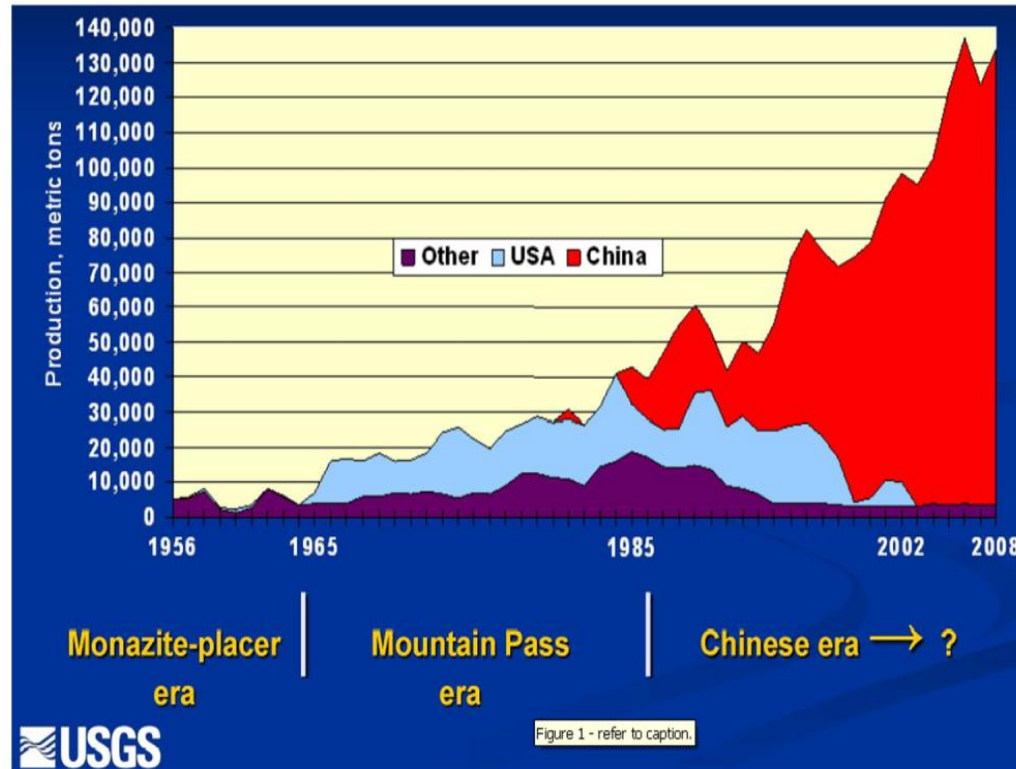


Figure 1. Global rare-earth-oxide production trends. The Mountain Pass deposit is in California, U.S.A. Graph from D.J. Cordier (U.S. Geological Survey, written commun., 2011) was updated from Haxel and others (2002, fig. 1).

Since 2002 China controls 95% of the world's rare earth oxide production

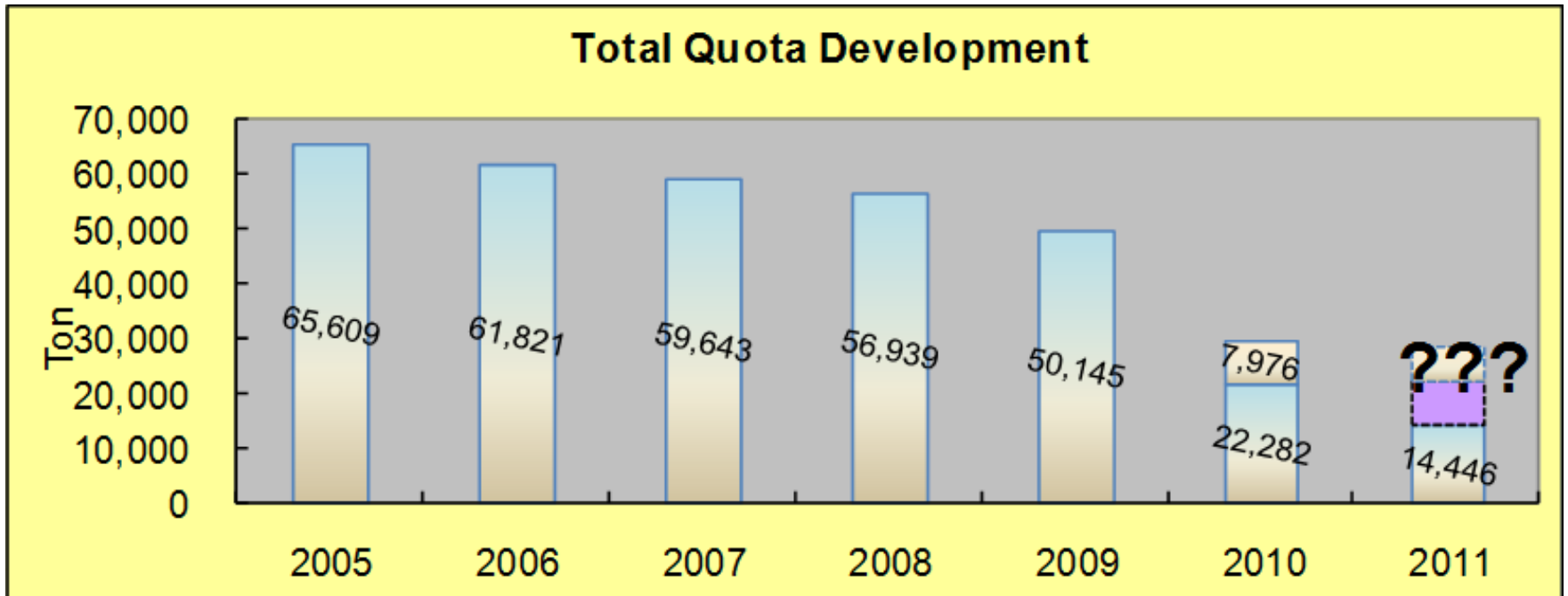


# Why are the prices for RE from China rising?

- Imposed new taxes and tariffs from Chinese government
- Enforced new mining rules and regulations from Chinese government
- Control of the amount of Rare Earth available to the market through administrating export quotas from Chinese government



# Rare Earth Export Quota History



- **Export Quotas continue to be reduced**
  - ~40% reduction from 2009 to 2010
  - 1<sup>st</sup> half 2011 vs. 1<sup>st</sup> half 2011 saw a reduction of >35%
- **Next quota release is expected to be end of June**

# SYLVANIA's Targeted Actions

## Government Activities

- Pending Legislation (DOE2012)
  - Promoting through NEMA to delay implementation
- US Launches Unfair Trade Investigation of Alleged China Green Tech Subsidies
- Pursuing globally to re-open previously closed mines

## What are we doing?

- Continue to strengthen our supply chain
- Drive development innovation:
  - Options to reduce powder weight
  - Evaluate alternative substitutes
  - Ways to reclaim and recycle materials
- Raising prices
  - Announced Increases will go into effect July 1, 2011, August 1, 2011 then monthly until the costs of rare earths stabilize
- Support customers with ease of doing business in implementing price increases
- Create tools and materials to pass price increases onto end users

**Thank you for your  
attention.**

