World Market Situation of Uranium

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Ronneburg 22.6.2014

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Topics

- Production countries / - volumes / terms
- The market situation / prize development (IAEA)
- Assessment by other players in U market
- World nuclear industry status report
- Conclusions

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U Producers/Production Volumes estimated in 2007 (!!)

Country	**Prod.Cap.(tU) by**	
Australia	10 000	2015 more by 2018?
Canada	10 000	stable ?
Kazakhstan	15 000	2010 18000 by 2012 ?
Niger	10 000	2012
Russia	13 000	2015 reduced recently
USA	12 000	2015 ?
Namibia	4 000	2009 6000 by 2012 ?
Uzbekistan	2 500	5000 by 2012 ?
Others	3 500 ?	
Total	**> 80 000**	2015

Source: IAEA **Proj. global demand > 85 000 (tU)**

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Uranium (U_3O_8) and Enrichment – a relationship (TL Neff, MIT, 2006)

A resource and a process.....substitute factors in the production of nuclear fuel

- Enrichment measured in SWU = separative work unit SWU (= not energy, but expression of efficiency of separation process)
- Nuclear fuel is function of U supply, enriched output and depleted tailings
- In most production processes, change in price of one factor leads to change in price of its substitute: **If both U and SWU scarce:** price of both will rise.. .(Neff, 2006)

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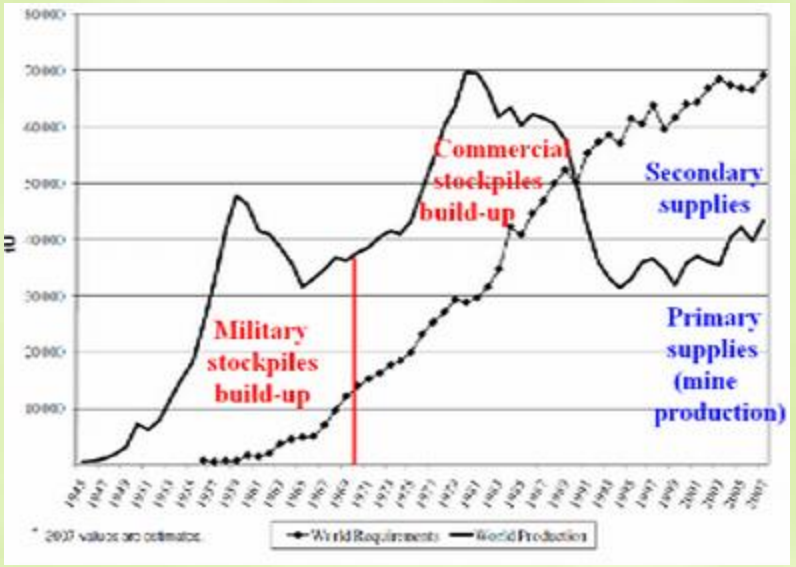
U Market today and challenges for the future

J. Slezak U resource specialist IAEA 10/09



- U market often been described as „unstable, not transparent, volatile, unpredictable“
- U production initially for purely military purposes
- Since mid 60‘s also influenced by Nuclear industry
- Since 90‘s world production of U behind global demand = Direct reason for interest of many countries to start U mining

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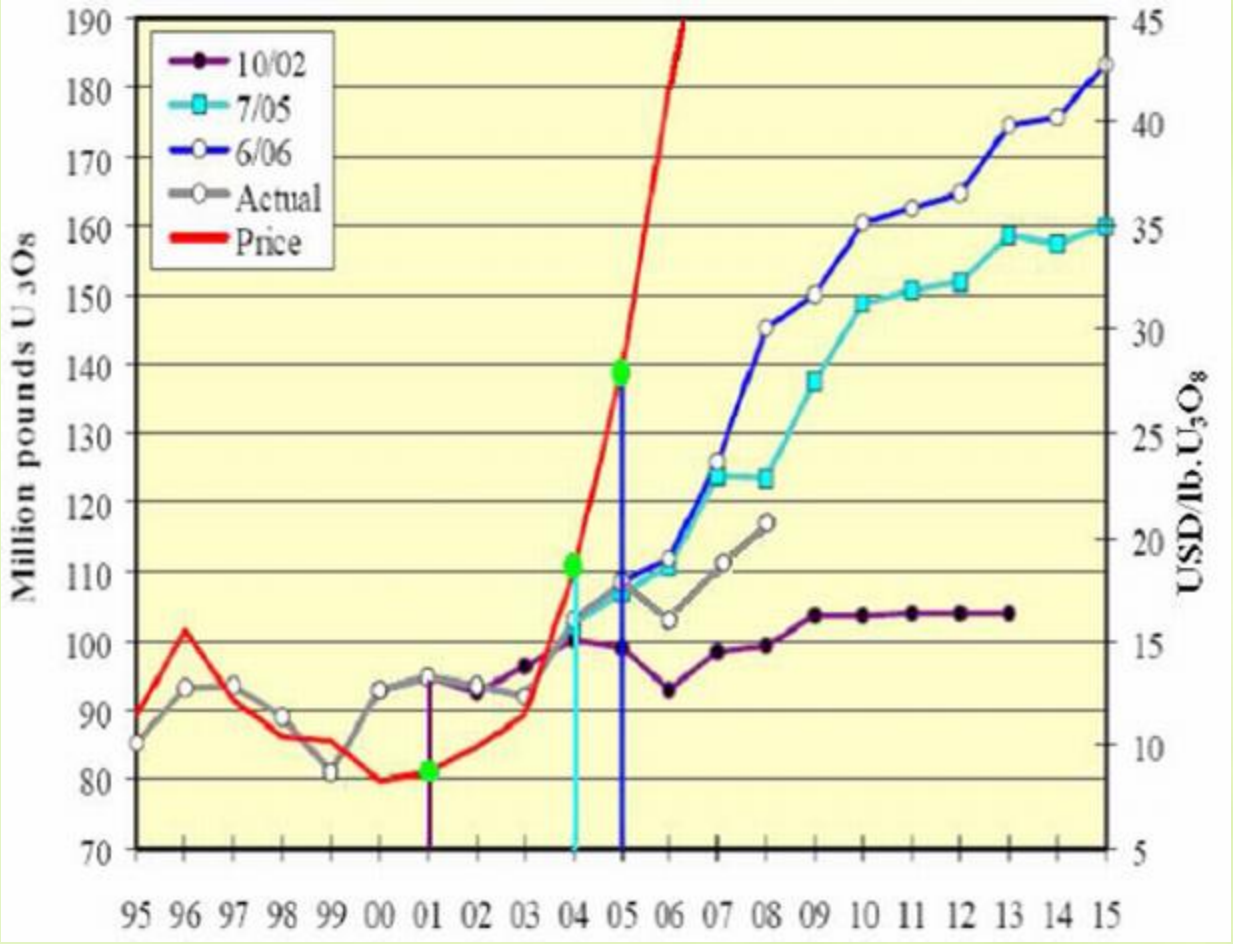
Changes in Projection of U Production ...



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U Participation Corporation (UPC): recommendations (2008) ...

- Enough resources available, but this does not necessarily mean enough production
- Production climbing slowly but still lagging behind demand. Increase needed to meet (proj.) demand
- Unknown volume of secondary sources
- Strong and stable market conditions necessary to encourage necessary investment
- **Conclusion: due to low public acceptance and volatile market still unpredictable situation, but „hope“ for future higher U market stability, otherwise ... ??**

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World Nuclear Association - Update on U market prize levels 2013

Recent opinions...

- **Uranium stocks tumble after RBC takes axe to price forecasts** (Peter Koven June 5, 2014)
- Message of U miners to investors over past couple of years: Short-term outlook bad, but no worry, a lot more uranium is going to be needed down the road.
- RBC Capital Markets Analysts agree. Only they think it will be a much longer road than most: Analyst Fraser Phillips et al. sent shudders through the industry as they **cut their uranium price forecasts:** they cut 2014 spot price forecast to US $31.50/lb down from US$45. And then the 2015 target was cut to US$40 (from US$60), and targets for the 2016 to 2018 period fell to just US$40-US$45 from US$75-US$80.

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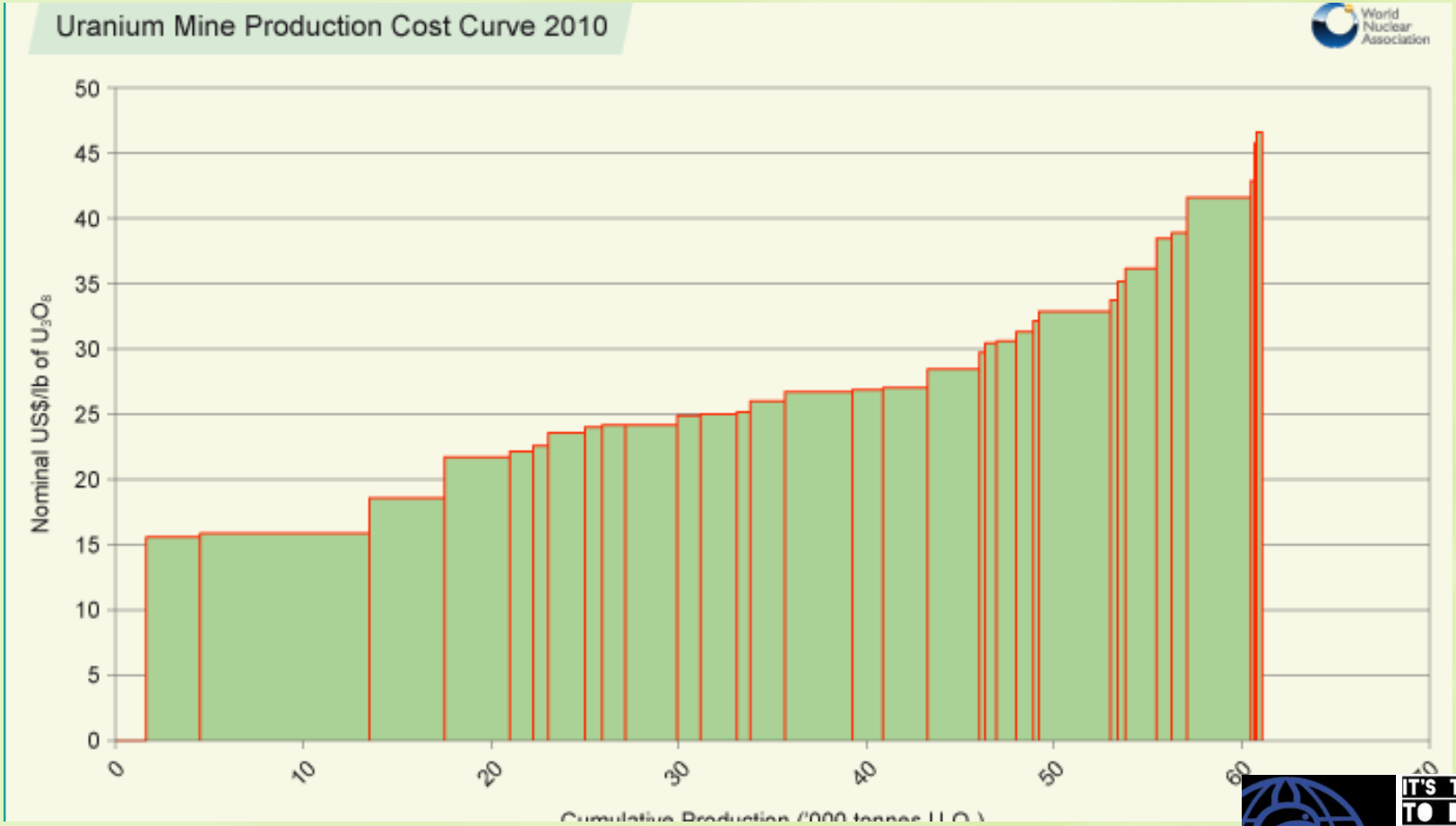
World Nuclear Association - Update on U market 2013: Prodct costs



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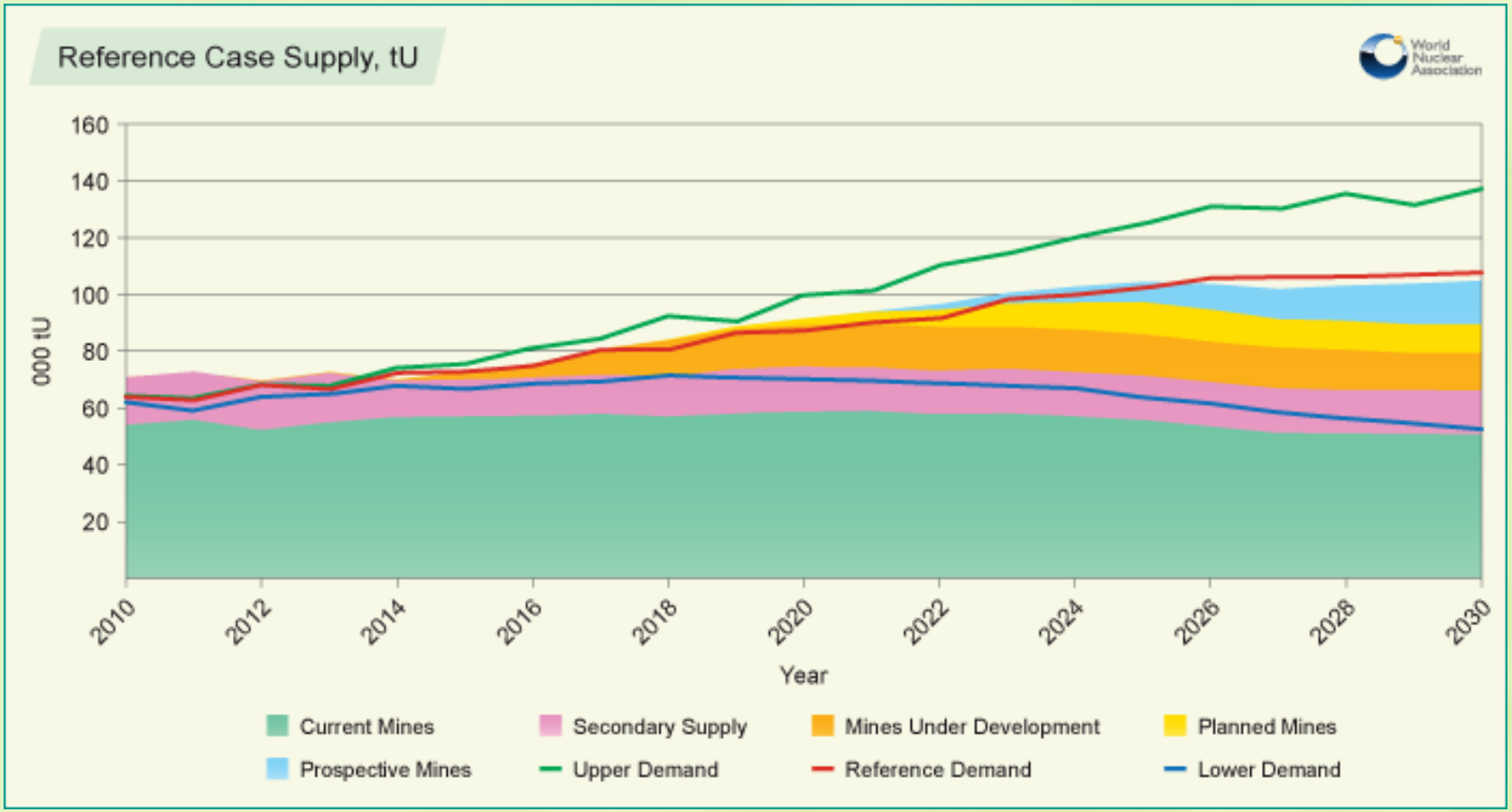
Production & Demand: Scenarios?



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World Nuclear Assctn: explanations...

- Mineral commodity markets = cyclical. Quoted “spot prices“ usually represent less than 20% of supply. Most trade is via long term contracts with producers selling directly to utilities.
- Reasons for fluctuation in mineral prices relate to demand and perceptions of scarcity. U price cannot indefinitely be below the cost of production, nor will it remain at very high levels for longer than it takes for new producers to enter market and anxiety about supply to subside
- **Conclusion: logically new producers (e.g. Tanzania, Mali) will need to compete with established ones and very likely will meet low price levels...**

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Roessing: 2nd exporter in Africa nearly closed...

http://allafrica.com/stories/201305300555.html by C KAIRA, 30.5.13

THE management of Rio Tinto's Rössing mine was considering placing the uranium mine on care and maintenance like Areva's Trekkopje as a way of arresting the perilous financial situation the company is facing.

“The situation is bad,” a source said and that „Rio Tinto, the Australia-based majority owner of the mine, has also been considering selling the mine“.

What are U customers doing?

- Nuclear weapons producers: dismantle old nukes (although not as quickly as we like...) and use HEU from weapons to produce low enriched reactor fuel, supply approx 15 % of demand only
- Nuclear power plant operators: inspite of NE growth in China, Russia, S-Korea, global park of NPP shrinking ...
- What does the nuclear industry status report 2013 say ??

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World Nuclear Industry Status Report 2013 (published 7/2013)... (I)

Key results:

- 10% of global electric energy demand are met NP (down from 17% 1993). Share of global commercial energy prod 4.5%
- 66 reactors under construction in 14 countries (average construction time is 8 years) but
- 9 reactors listed „under construction for > 20 yrs
- 45 projects without official start-up date on IAEA database
- 23 reactors have multiyear construction delays. The other 43 reactors have not yet reached projected start-up dates. 44 of the units in China, India and Russia

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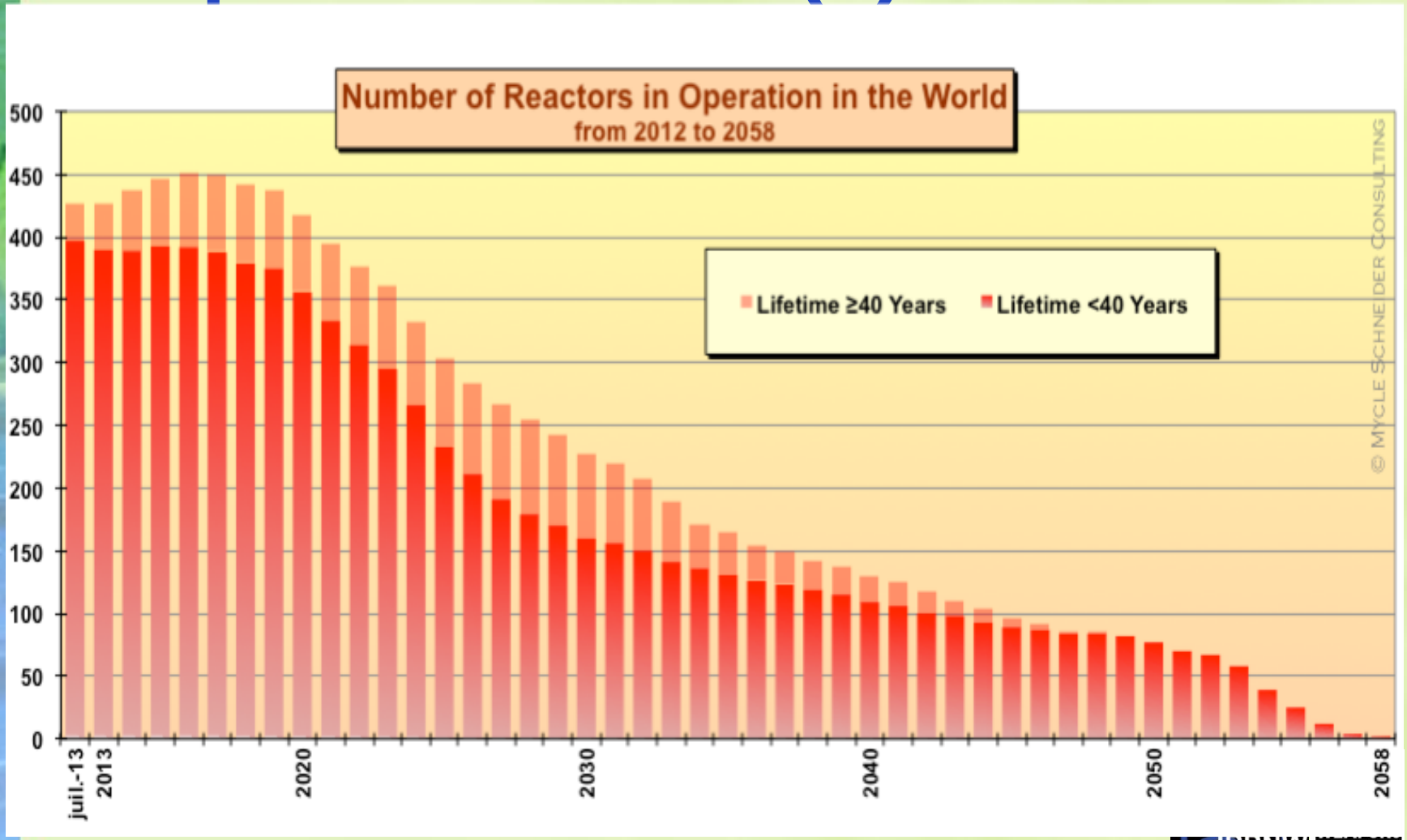
World Nuclear Industry Status Report in 2013... (II)



World Nuclear Industry Status Report 2013...(III) Financial issues

- 2/3 of nuclear companies and utilities downgraded by Standard and Poor's in past 5 years. Nuclear investmts considered „risky" ....
- Shares of world's largest nuclear operator, French state utility EDF, lost 85% of their value. Shares of world's largest nuclear corp, AREVA, fell by 88%
- Capital costs: Cost estimates have increased in the past decade from $1,000 to $7,000 per kW installed.
- Operating costs have escalated so rapidly that avge. reactor's operating costs is barely below the normal band of wholesale power prices.
- Fukushima: addtl. costs due to upgrading and backfitting: substanital impact in future!

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Nuclear sending shock waves through Wall Street

By Barbara Vergetis Lundin , Fierce Energy, August 7, 2013

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Duke Energy has announced that it will retire its Levy nuclear reactor project in Florida. This is the second such announcement in just a few weeks.....

OAK HARBOR, Ohio — Davis-Besse is identified in a new economic report as one of a dozen U.S. nuclear reactors most likely to be closed by their utilities before their licenses expire because of changing energy markets, including falling natural gas prices, rising costs of nuclear operations, repairs, and post-Fukushima retrofits (7/22/2013).

- "The Duke decision to pull the plug on Levy follows by just one day the announcement that the French-subsidized nuclear giant EDF is pulling out of the U.S. nuclear power market due to the inability of nuclear power to compete with alternatives and the dramatic reduction in demand growth caused by increasing efficiency of electricity consuming devices,"

World Nuclear Industry Status Report 2013...(IV) The alternatives

- In contrast, renewable energy shows rapid growth figures. China, Germany, Japan generate more power from renewables than from nuclear
- Global investment in renewable energy totaled US$268 billion in 2012, 5 x 2004 amount. In same period, total cumulative investment in renewables is over US$1 trillion. Compares to nuclear power invstmnt of about $120 billion
- Global nuclear capacity decreased again in 2011, while the annual installed wind power capacity produced 500TWh and Solar 100 Twh more than in 2000 alone. While nuclear produced 100 TWh less in same time perio. In China Solar electricity generation grew by 400%

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World Nuclear Industry Status Report in 2011...(V)

Quotes by 2 co-authors:

- **„Portrait of an industry suffering from the cumulative impacts of the world economic crisis, effects of Fukushima, ferocious competition and its own planning and management difficulties“ (M. Schneider)**
- **„The market for nuclear is shrinking year by year, while renewable energy deployment continues at pace and in an ever increasing number of countries. With nuclear power becoming more expensive than a widening range of renewable energy technologies, this trend will only continue” (A. Froggatt)**

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Nuclear Renaissance anywhere … ??

Invest in Nuclear Power plants …??

Invest in new Uranium Mines ….??

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World Nuclear Association: explanations...(1)

- Mineral commodity markets = cyclical, ie. prices rise and fall substantially over the year
- These fluctuations superimposed on long-term trend decline in real prices, due to technological progress.
- In the U market high prices in the late 1970s gave way to depressed prices in the whole of the period of the 1980s and 1990s, with spot prices below the cost of production except for lowest cost mines. In 1996 spot prices briefly recovered but they then declined again and only started to recovery in late in 2003.

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Uranium and Enrichment: relation-ship also reflectd in prize levels...

- In most production processes, change in price of one factor leads to change in price of its substitute
- This was not true for U or enrichment – over-supply allowed prices to be set independently. Oversupply has ended and prices for U and enrichment will be strongly coupled, and pre-dicted to be significantly higher, because

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Literature on low level radiation:

- 1. Bithell JF, Stewart AM: Pre-natal irradiation and childhood malignancy: A review of British data from the Oxford Survey. Br J Cancer. 1975 March; 31(3): 271– 87.
  http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2009418/

- 2. Doll R, Wakeford R. Risk of childhood cancer from fetal irradiation. Brit J Radiol 1997; 70: 130-9http://bjr.birjournals.org/cgi/reprint/70/830/130.pdf

- 3. U.S.National Academy of Sciences, National Research Council, Committee to Assess Health Risks from Exposure to Low Levels of Ionizing Radiation. (9. Environmental Radiation Studies), BEIR VII Phase 2 Washington DC: National Academic Press, 2006. http://www.nap.edu/openbook.php?record_id=11340&page=207

- 4. Dubrova YE; Monitoring of radiation-induced germline mutation in humans. Swiss Med Wkly 2003; 133: 474–78
  http://tchernobyl.verites.free.fr/sciences/Dubrove_swiss_med.pdf

- 5.a . Spix C, Schmiedel S, Kaatsch P, Schulze-Rath R, Blettner M; Case-control study on childhood cancer in the vicinity of nuclear power plants in Germany, 1980-2003. Eur J Cancer. 2008 Jan; 44(2): 275-84. Epub 2007 Dec 21. http://www.ncbi.nlm.nih.gov/pubmed/18082395

- 5.b. Kaatsch P, Spix C, Schulze-Rath R, Schmiedel S, Blettner M; Leukaemia in young children living in the vicinity of German nuclear power plants Int J Cancer. 2008 Feb 15; 122(4): 721-6
  http://www.rachel.org/lib/leukemias_near_german_nukes.080215.pdf

- 6. Spycher BD, Feller M, Zwahlen M, Roesli M, von der Weid NX, Hengartner H, Egger M, KuehniCE. Childhood cancer and nuclear power plants in Switzerland: A census based cohort study. International Journal of Epidemioloy 2011 doi:10.1093/ije/DYR115.http://ije.oxfordjournals.org/content/early/2011/07/11/ije.dyr115.full.pdf+html

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  www.strahlentelex.de/Stx_11_590_S14-16.pdf

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Literature on low level radiation:

- 8a. Reproductive Toxicology Volume 23, Issue 4, June 2007, p. 593-599 Trends in the human sex odds at birth in Europe and the Chernobyl Nuclear Power Plant accident http://www.ncbi.nlm.nih.gov/pubmed/17482426

- 8b. Kusmierz R, Voigt K, Scherb H. Is the human sex odds at birth distorted in the vicinity of nuclear facilities (NF)? A preliminary geo-spatial-temporal approach, 24th International Conference on Informatics for Environmental protection in cooperation with InterGeo 2010, Integration of Environmental Information in Europe, Cologne an Bonn, October 6th – 8th, 2010, EnviroInfo 2010 Shaker Verlag 2010 http://www.helmholtz-muenchen.de/ibb/homepage/hagen.scherb/KusmierzVoigtScherb2010BonnProceedings%20short.pdf

- 9. Scherb H, Voigt K. The human sex odds at birth after the atmospheric atomic bomb tests, after Chernobyl, and in the vicinity of nuclear facilities (2011). Environmental Science and Pollution Research 18: 697 – 707 (EPub 19 Feb 2011) DOI 10.1007/s11356-011-0462-zhttp://www.springerlink.com/content/w822527526045772/fulltext.pdf

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- 13. Edwards G: continued blog on nuclear power <ccnr@web.ca>, (GE mathematician and nuclear expert in Montreal Canada, recipient Nuclear free future award 2011)

- World nuclear industry status report 2011 , download www.worldnuclearreport.org/spiü.php?article30

World Nuclear Industry Status Report in 2011 (7/2012) ...(I)

Key results:

- 3% of global electric energy demand are met NP
- Only 7 new reactors started, while 19 were shut down
- Japan: 2/54 reactors back to grid in July: future NE in Japan?
- 4 countries will phase out nuclear power
- 5 countries will not engage / re-engage in nuclear programs
- Of 59 units under construction, >18 are experiencing multiyear delays. 41 projects started within past 5 years/ have not yet reached projected start-up dates.
- Construction costs rapidly rising. Adjusted for inflation new EPR cost estimates have increased by factor of 4 over the past ten years.
- 2/3 of nuclear companies and utilities downgraded by Standard and Poor's in past 5 years

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Topics to be discussed

- The nuclear chain
- The U mine: from prospecting to production
- The market situation / prize development (IAEA)
- Production countries / volumes
- World nuclear industry status report

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Looking at demand for U:
- Nuclear weapons and
- Nuclear Power plants ...

- Nuclear weapons ... Inspite of resistance by nuclear powers, relentless strong global efforts towards nuclear abolition (ICAN) !
- Nuclear power: so called nuclear renaissance (?)
- Facts: recent World nuclear Industry Status Report (July/12) by M.Schneider):
- Portrait of an industry suffering from the cumulative impacts of the world economic crisis, Fukushima, ferocious competitors and its own planning and management difficulties

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Looking at status of Nuclear Power industry...

Key results:

- 3% of global electric energy demand are met NP
- Only seven new reactors started up, while 19 were shut down in 2011.
- Japan: In July 2012 two reactors from 54 back to grid. However, it remains highly uncertain, how many others will receive permission to restart operations in Japan.
- Four countries announced that they will phase out nuclear power within a given timeframe.
- At least five countries have decided not to engage or re-engage in nuclear progra

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World Nuclear Industry Status Report in 2011... (II)

Key results:

- Shares of world's largest nuclear operator, French state utility EDF, lost 82% of their value. Shares of world's largest nuclear builder, French AREVA, fell by 88%
- In contrast, renewable energy shows rapid growth figures.
- Global investment in renewable energy totaled US$260 billion in 2011, 5x 2004 amount. In same period, total cumulative investment in renewables is over US$1 trillion. Compares to nuclear power invstmnt of about $120 billion
- Global nuclear capacity decreased again in 2011, while the annual installed wind power capacity increased by 41 GW in 2011 alone. Installed wind power and solar capacity in China grew by a factor of around 50 in the past five years, while nuclear capacity increased by a factor of 1.5

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Looking at status of Nuclear Power industry...

Key results:

- Of the 59 units under construction in the world, at least 18 are experiencing multi-year delays, while the remaining 41 projects were started within the past five years or have not yet reached projected start-up dates.
- Construction costs are rapidly rising. European EPR cost estimate has increased by a factor of four (adjusted for inflation) over the past ten years.
- 2/3 of nuclear companies and utilities were downgraded Standard and Poor's in past 5 years.

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Looking at status of Nuclear Power/ U industry...

Key results:

- The market for nuclear is shrinking year by year, while renewable energy deployment continues at pace and in an ever increasing number of countries. With nuclear power becoming more expensive than a widening range of renewable energy technologies, this trend will only continue" (A. Froggatt)
- Mid- and longterm influence on U Prodctn ?

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U as Resource

- **RESOURCE: U** = non-renewable! mined in many countries (India, China, Australia, Canada, Mongolia, Niger etc.)
- U used yearly by the 440 NPPs. Stocks for approx. 80 years, IF same number of power plants!
- High prize of U makes mining profitable, but
- Decreasing demand = lower world marked prize (Japan?)
- Alternative resources:

  Thorium: industry „fuel of the future“! Thorium-produced uranium-233 can be used without reprocessing. Thorium reactors = rel. inefficient "breeders“: pose serious financial disincentives to developers. Russia, China, India interstd. **Nuclear weapons derived U**: by blending highly enriched uranium (HEU) from warheads to produce low enriched reactor fuel and reprocessing of spent fuel, will also grow in importance as a fuel source.

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Uranium and Enrichment: complex relationship ...

- Low U prices and high tails assay have led to lack of enrichment capacity to substitute for U
- Given a U price, enrichers can raise price to point that utilities seek to substitute more U for SWU (by raising tails assay) and
- Given a SWU price, U suppliers can raise price to point that utilities seek to substitute more SWU for U

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UPC assessment of development limitatons.

- Market still not transparent and very volatile
- Public acceptance ?
- Regulatory requirements ?
- Government initiatives ?
- Market turmoil still present

- All in all: unpredictable situation, but „hope“ for future higher U market stability, otherwise ... ??