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World Energy Resources, Sustainable Development and Energy Economics (3E) after Rio+20

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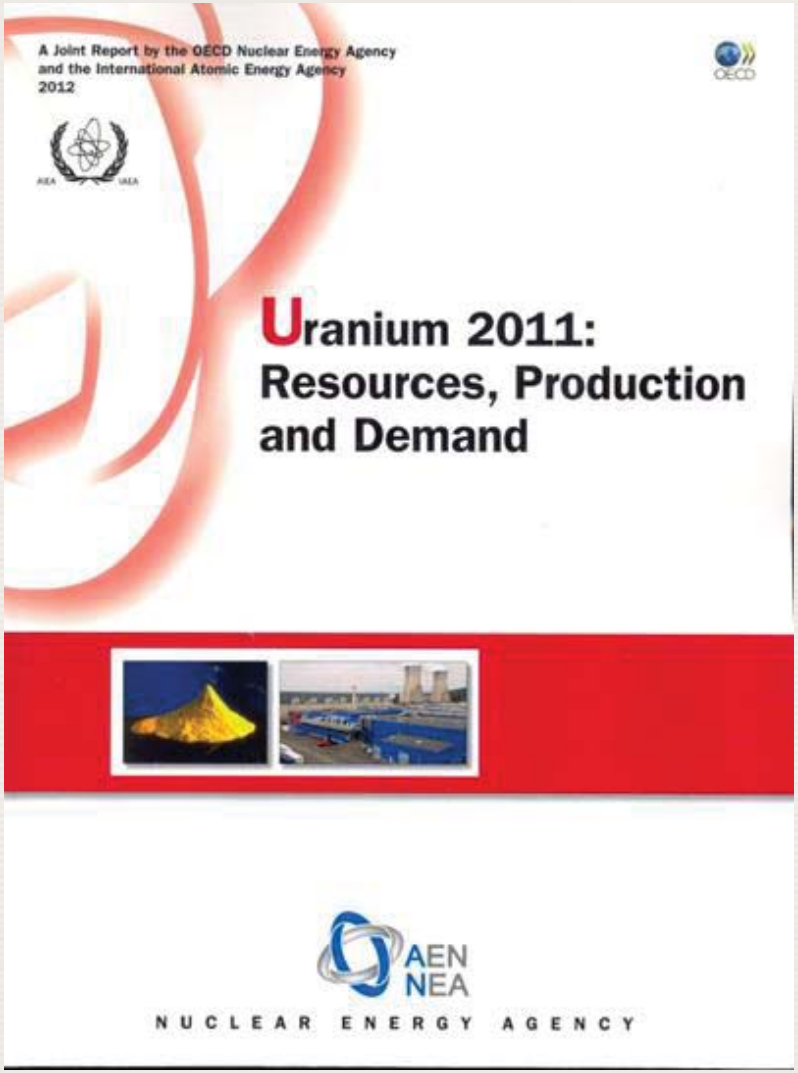
World Energy Resources, Sustainable Development and Energy Economics (3E) after Rio+20

Alan McDonald

Trieste • 12 November 2012

IAEA
International Atomic Energy Agency

Uranium 2011 Resources, Production and Demand



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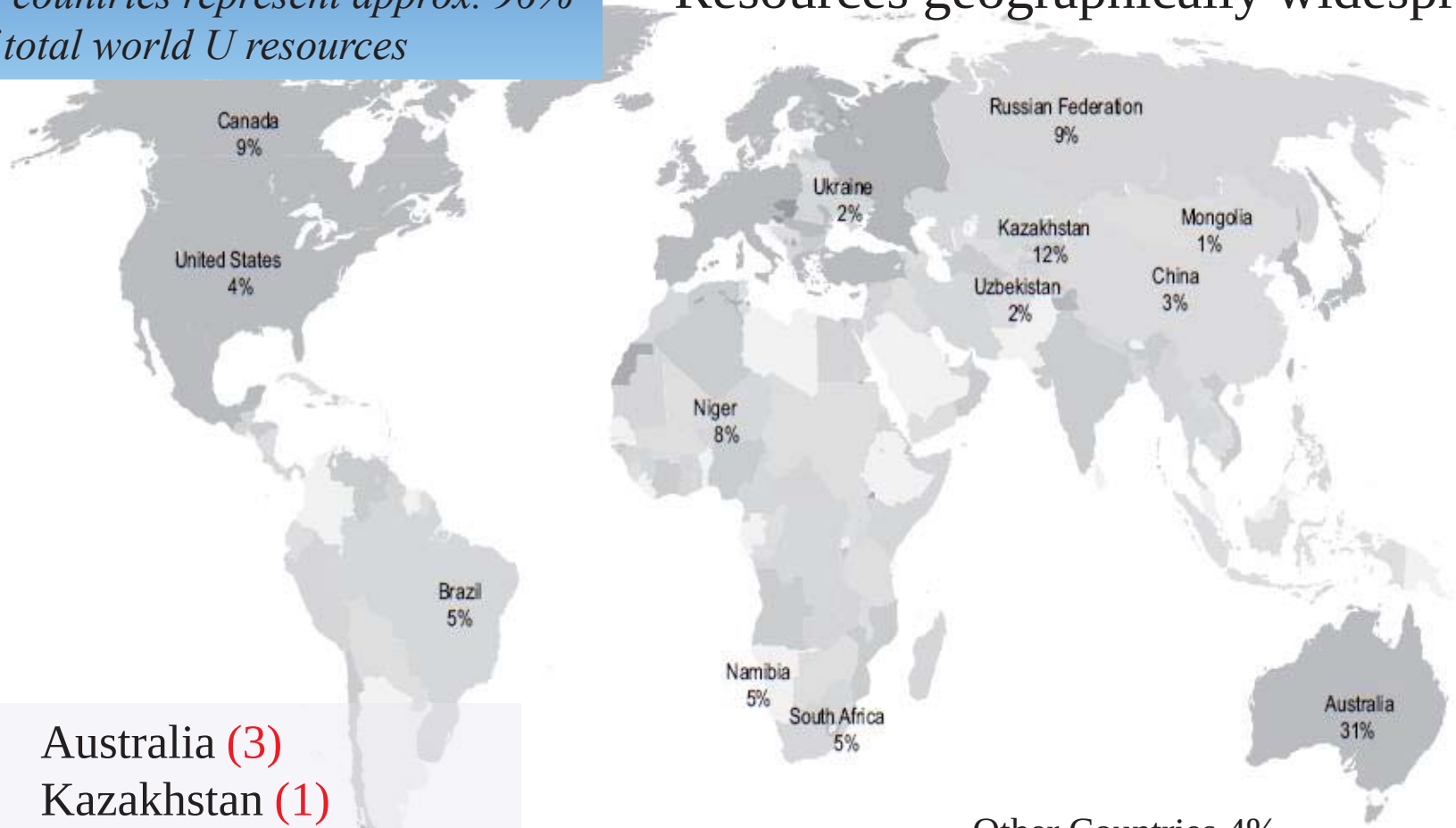
Distribution of Identified Resources

Recoverable at a cost of <USD130/kgU (<USD 50/lbU_3O_8)

13 countries represent approx. 96% of total world U resources

Resources geographically widespread



1. Australia (3)
2. Kazakhstan (1)
3. Russian Fed/Canada (2)

Other Countries 4%

Uranium spot price

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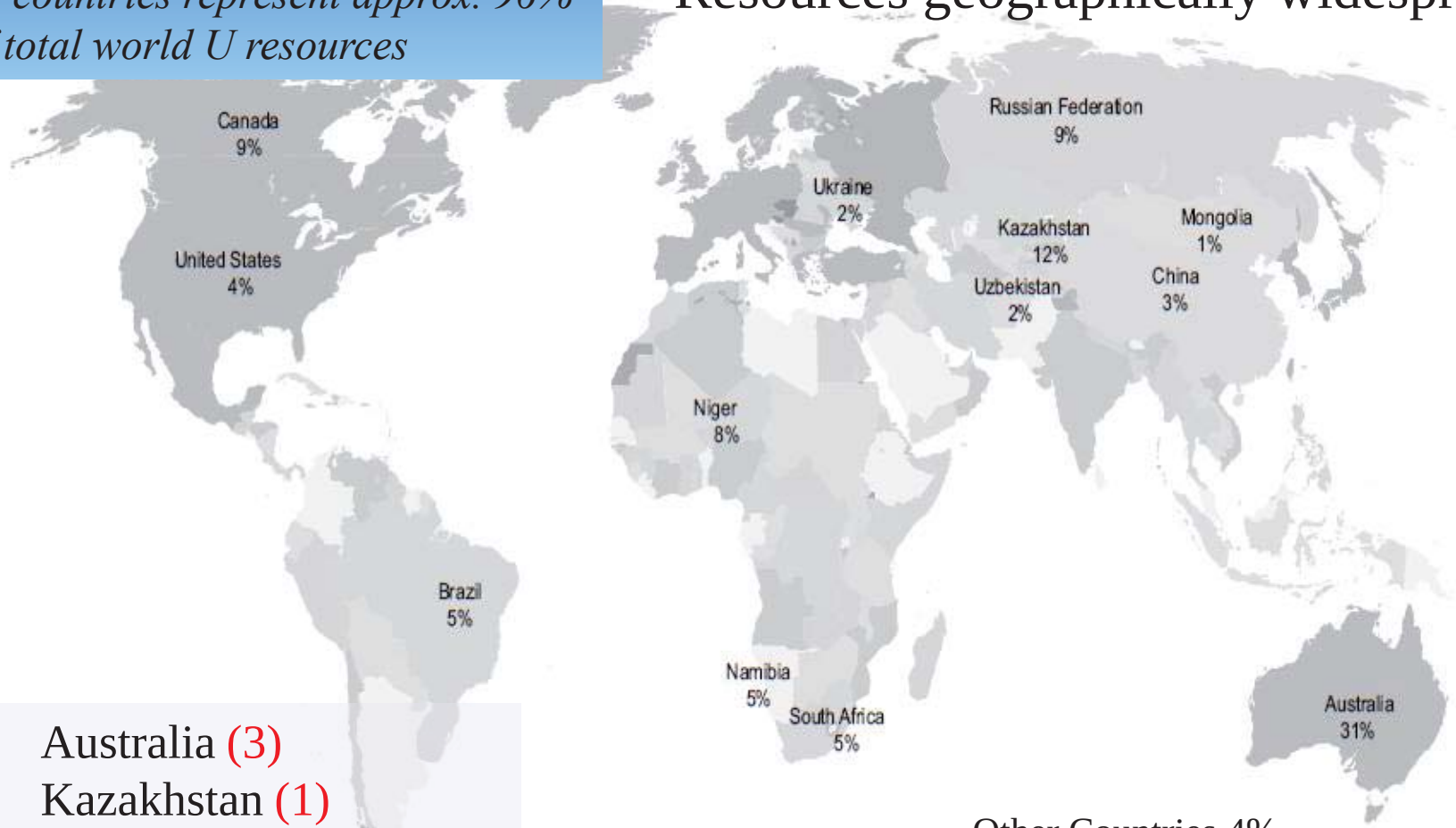

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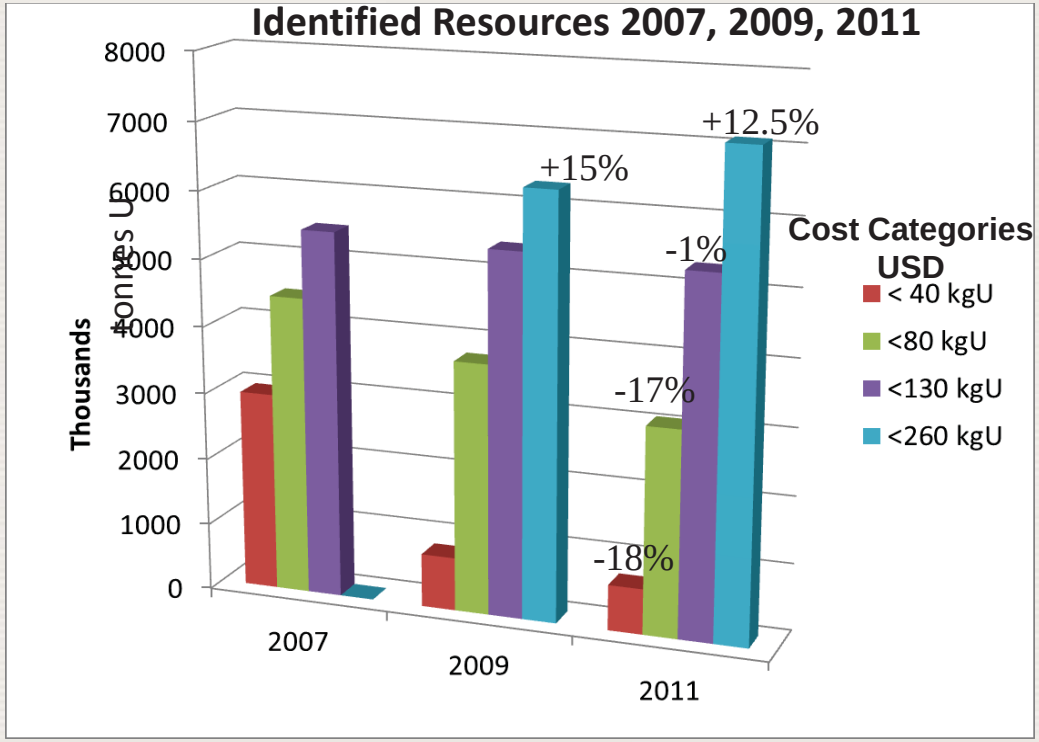
Uranium Resource Inventory

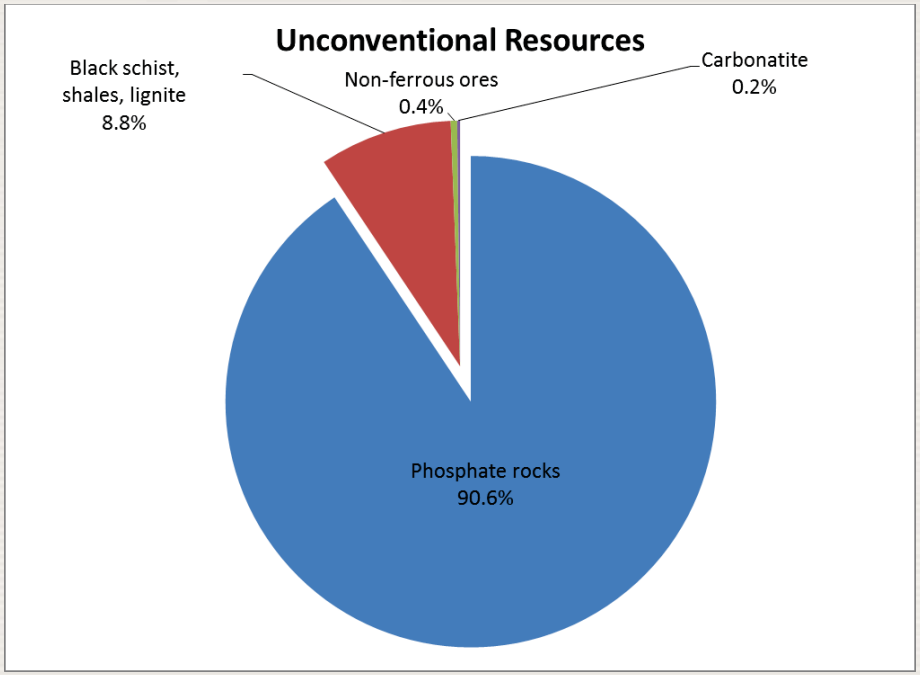


Total identified uranium resources are ~ 7.1 Mt U and have increased by 12.5 % since 2009, but costs of production have also increased

2007 to 2011: +30 %

Overall trend-increased costs

Unconventional Resources (01/01/2011)

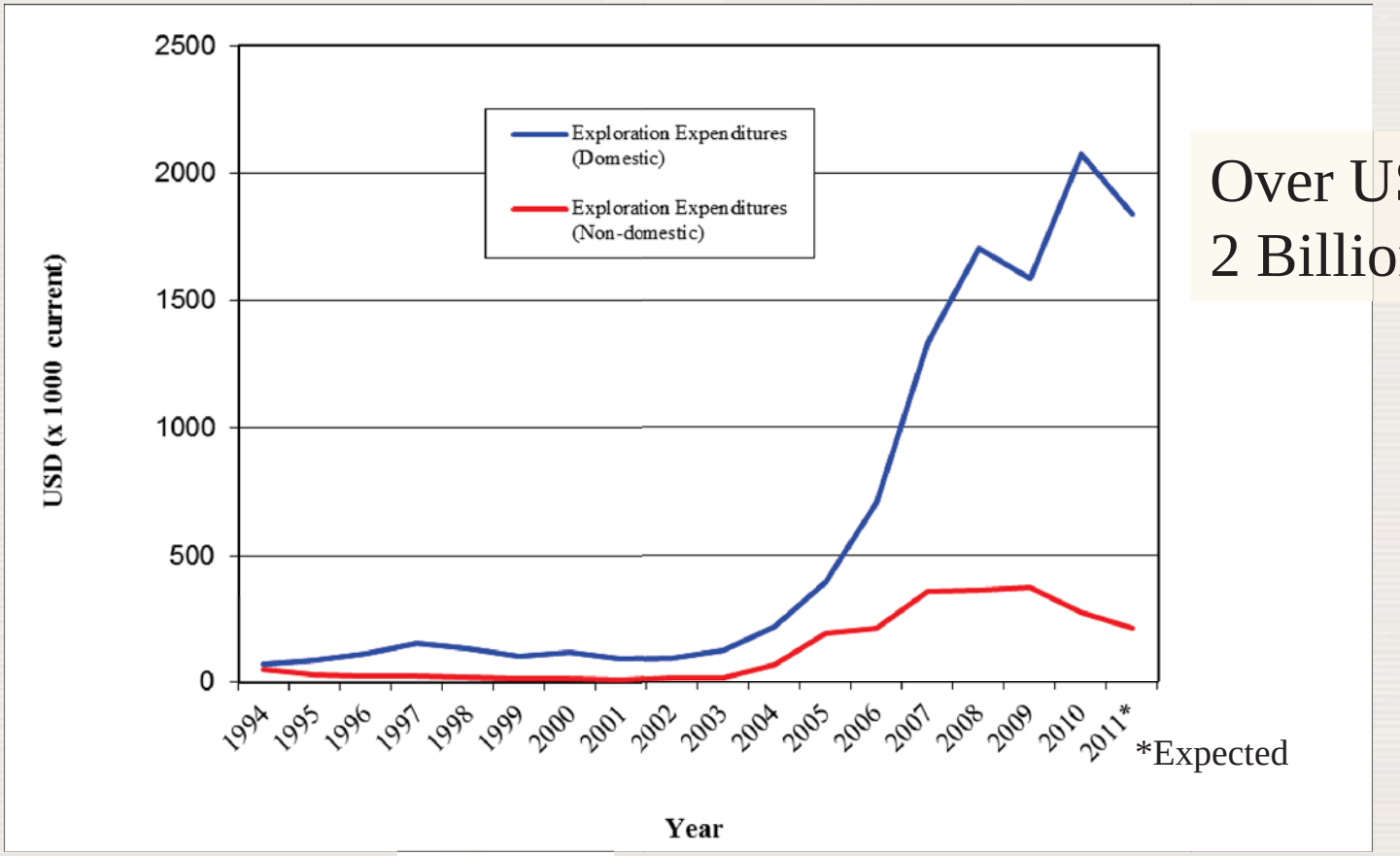


~10% increase since last edition of Red Book

Market conditions and technological development will be the main factors that determine the contribution of unconventional U resources to world production totals in the future.

Exploration and Development Expenditures

22% increase in uranium exploration and mine development expenditures between 2008 and 2010

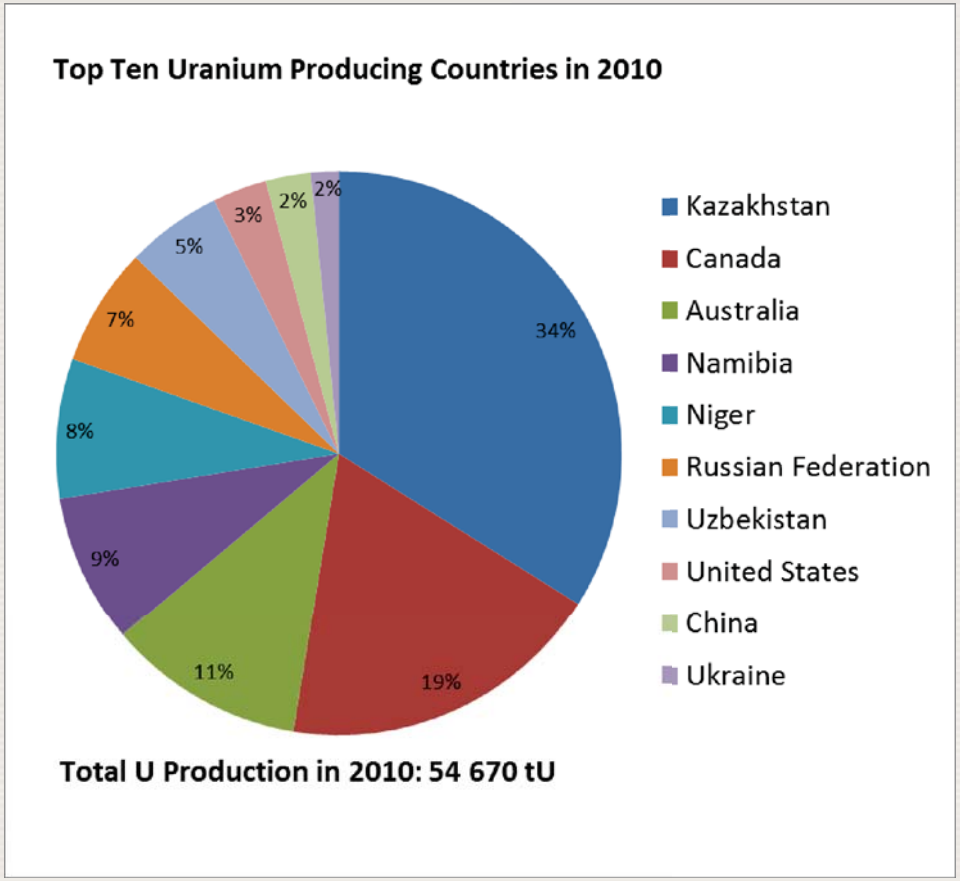


*Expected

Over USD
2 Billion in 2010

Uranium Production

Global Uranium Production increased by 25% between 2008 and 2010



- In 2010 total world uranium production was: 54,670 t U (~142 million t U_3O_8)
- Representing 85% of demand for world nuclear reactors (2010)
- 2011 forecast 57,230 t U

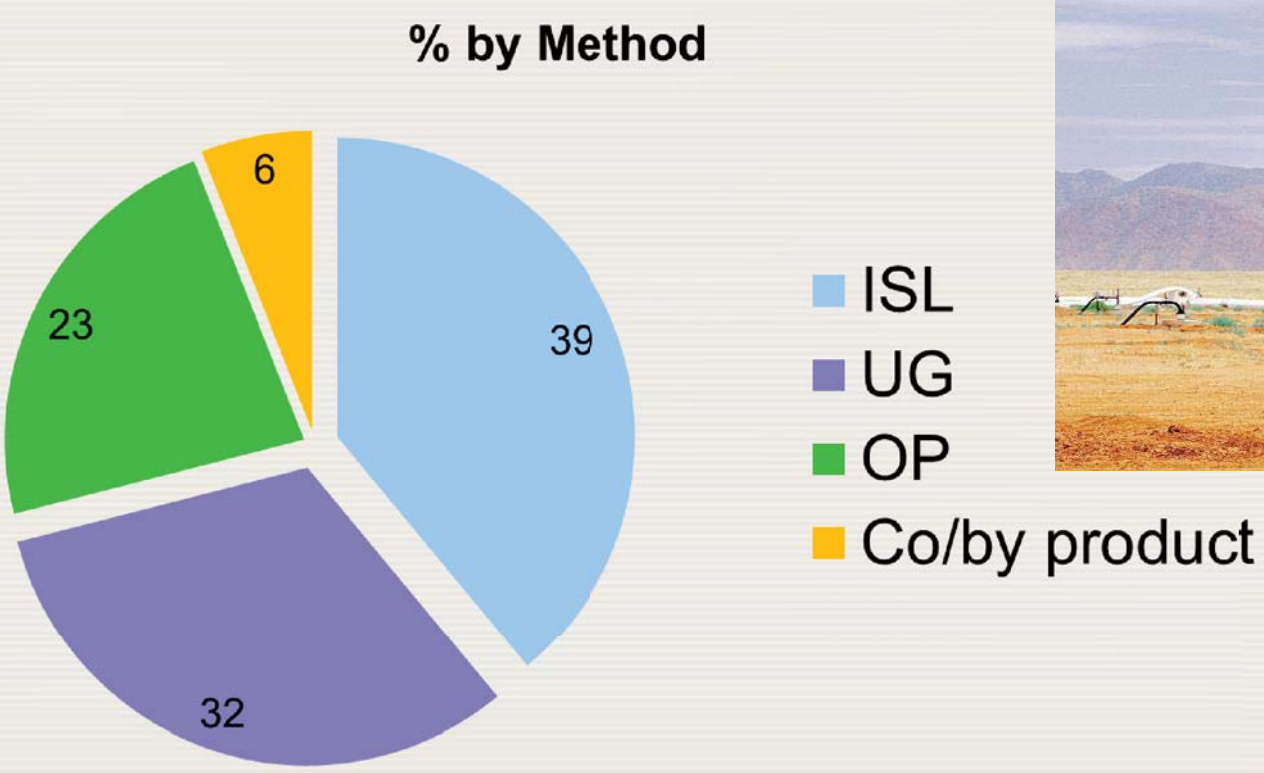
Secondary uranium sources

- military stockpiles of natural uranium
- stockpiles of enriched uranium
- reprocessed uranium from spent fuel
- mixed oxide (MOX) fuel with uranium-235 partially replaced by plutonium-239 from reprocessed spent fuel
- re-enrichment of depleted uranium tails

Uranium spot price

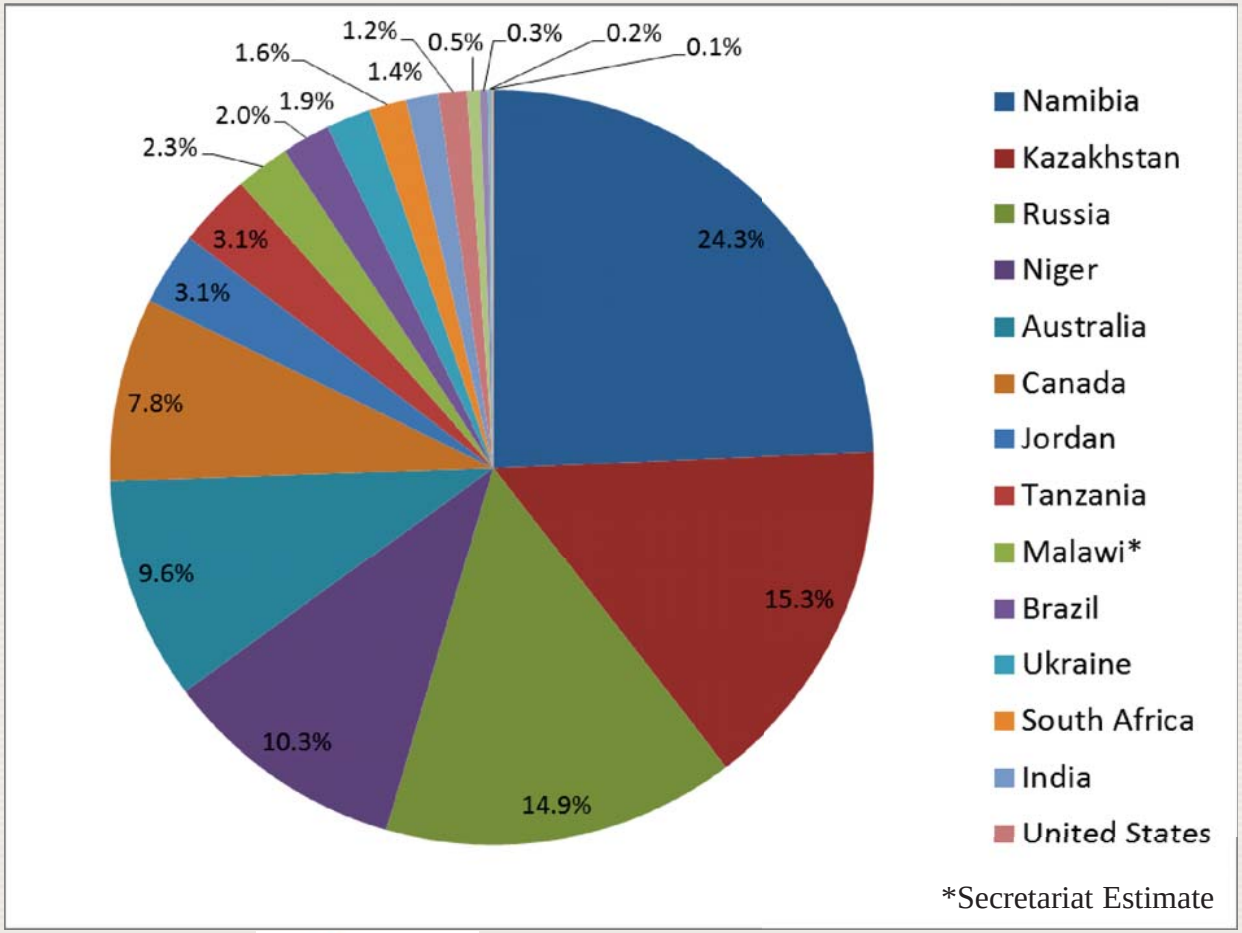
World 2010 U Production by Method

ISL surpassed UG as the main production method in 2009;
proportion of ISL in world totals are expected to continue to increase in 2011



Projected Geographical Distribution of Growth in Production Capacity to 2021

2009 to 2021: 61 430 to 63 775 tU



Uranium Production Considerations

- No mine operates at full production capability over its lifetime
- Mines take as much as 10 years to progress from resource definition to production in most jurisdictions
  - Challenging and lengthy regulatory requirements and processes
  - Infrastructure and labour issues in developing countries
  - Costs of production have increased, but market prices have declined
  - Supply chain relatively thin, some key facilities aging
  - Geopolitical risks

Years of uranium availability

Reactor/fuel cycle	Years of 2012 consumption with identified conventional resources < 260/kgU	Years of 2012 consumption with estimated undiscovered resources added	Years of 2012 consumption unconventional resources added
Current once-through fuel cycle with LWRs	104	260	375
Pure fast reactor fuel cycle with recycling	6 300 - 7 300	15 000 - 18 000	23 000 - 26 000

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Brundtland Definition

- “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”.

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CSD-9: Nuclear Outcomes

Leila Mead/IISD

- exhaustive debate
- agreement to disagree on nuclear's role in sustainable development
- unanimous agreement that choice belongs to countries

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Why is Kyoto good for Nuclear?

- Without greenhouse gas (GHG) restrictions, emissions are free
- Nuclear power's avoidance of GHG emissions has no economic value
- In liberalized markets, no economic value = invisible to investors
- For progress toward GHG restrictions, Kyoto was the only game in town

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“It’s the economics”

- One size does not fit all
- New nuclear most attractive where
  - energy demand growth in rapid
  - alternative resources are scarce
  - energy supply security a priority
  - reducing air pollution and GHGs a priority
  - financing can look longer-term
  - low financial risk premium

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“It’s the economics”

Advantages

- Nuclear power plants are cheap to operate
- Stable & predictable generating costs
- Long lifetime
- Supply security
- Low external costs (only partly internalized)

But…

- High upfront capital costs can be difficult to finance
- Sensitive to interest rates
- Long lead times (planning, construction, etc)
- Long payback periods
- Regulatory/policy risks
- Market risks

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Cost components of electricity generation

- Full generating costs matter and not subsets of components
- Investment (capital) and interest charged on capital
- Fuel costs
- Fixed operations & maintenance (O&M) costs
- Variable O&M costs (including possible GHG emission charges)
  - Decommissioning and waste funds

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Existing generating plants

- Only carry fuel and variable O&M costs (“marginal generating costs”)
- Investment and fixed O&M costs are “sunk” costs
- If electricity rates are higher than the marginal costs the plant will operate (profit margin?)
- Different generation alternatives compete on the basis of marginal costs only
- Low marginal costs: Comparative advantage of nuclear power

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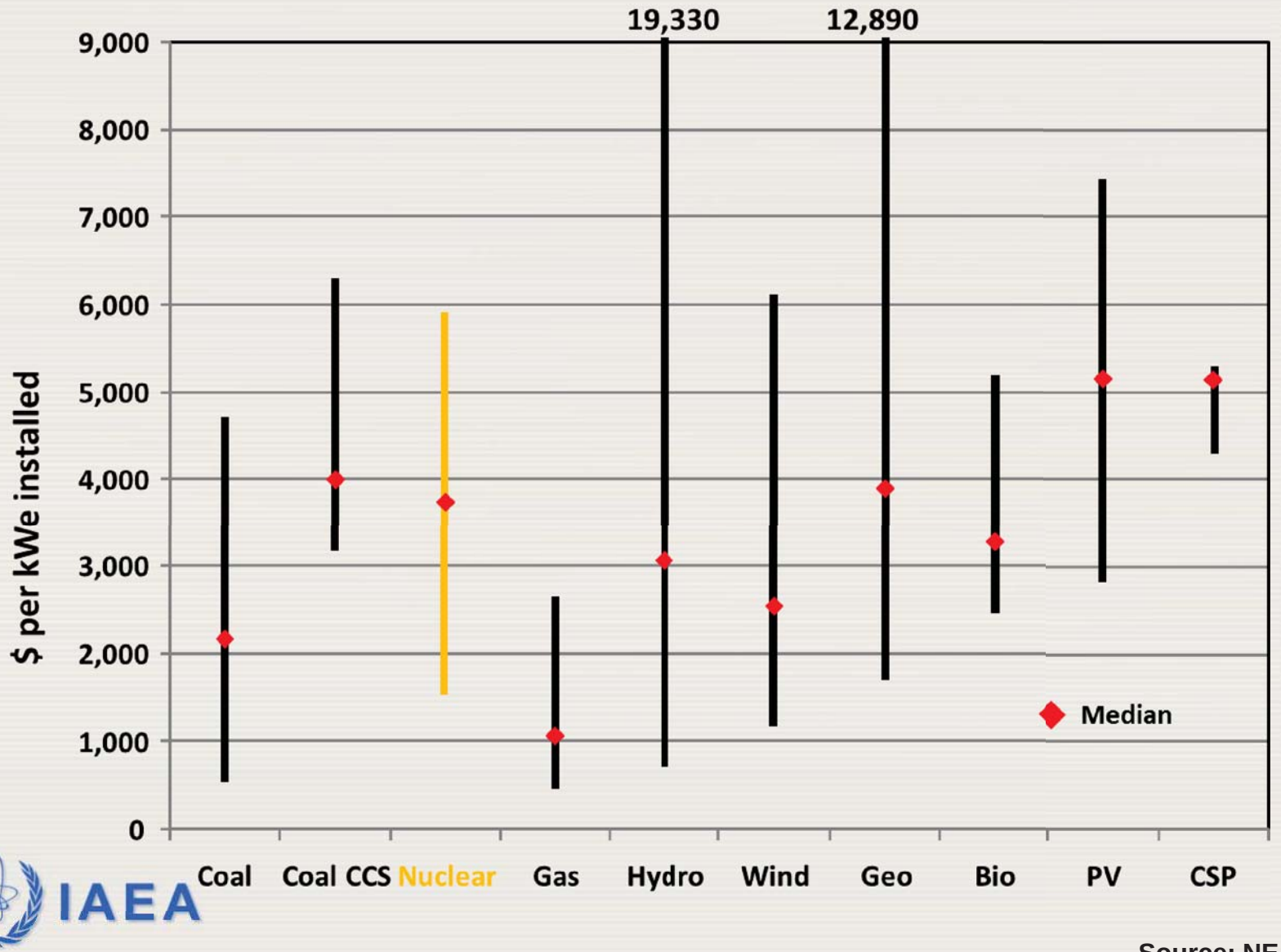
Overnight investment costs (OC) of different electricity generating technologies



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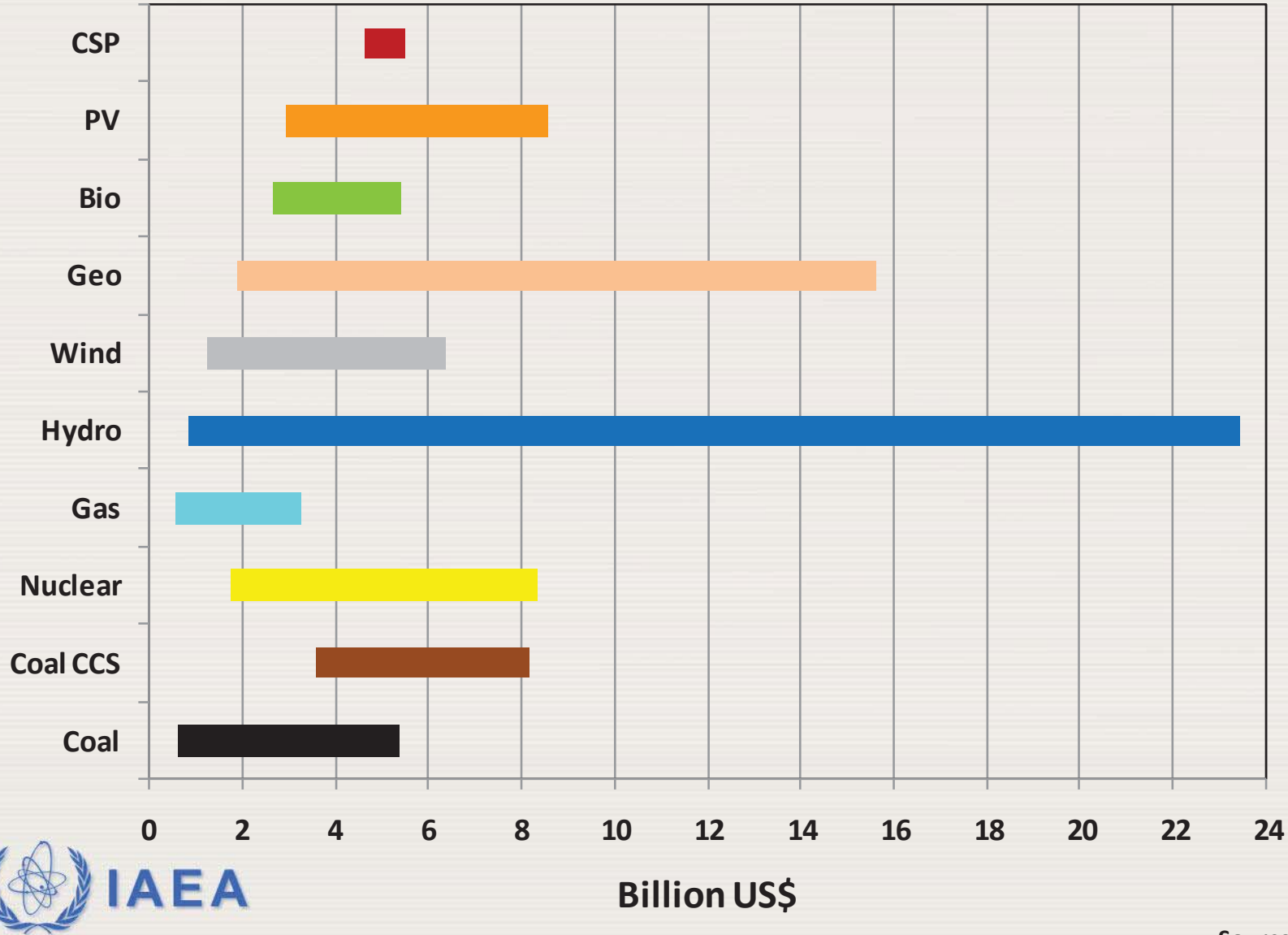
Source: NEA/IEA, 2010

Overnight costs (OC) for 1 000 MWe generating capacity



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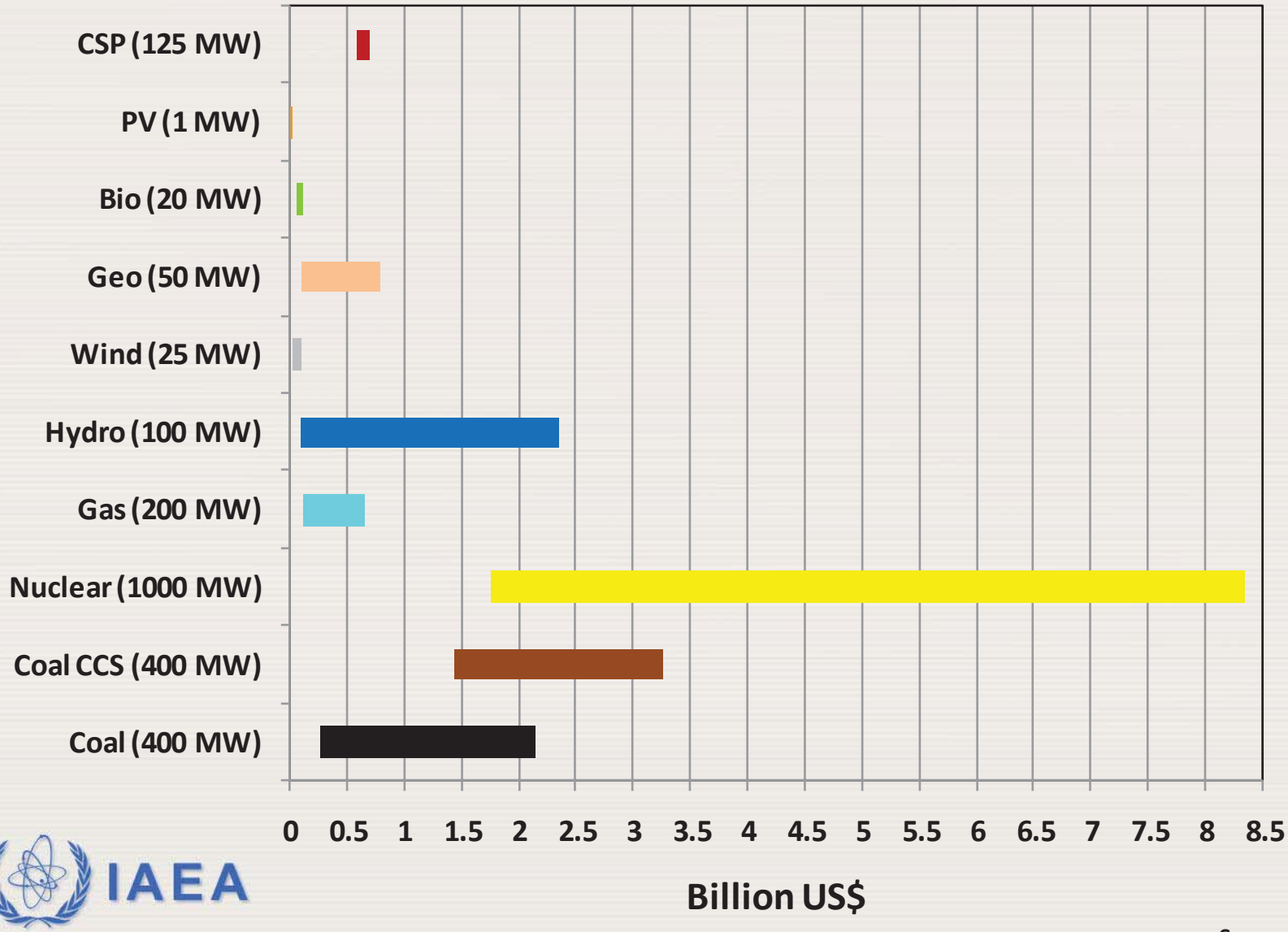
Source: NEA/IEA, 2010

Actual investments per unit (investment decision)



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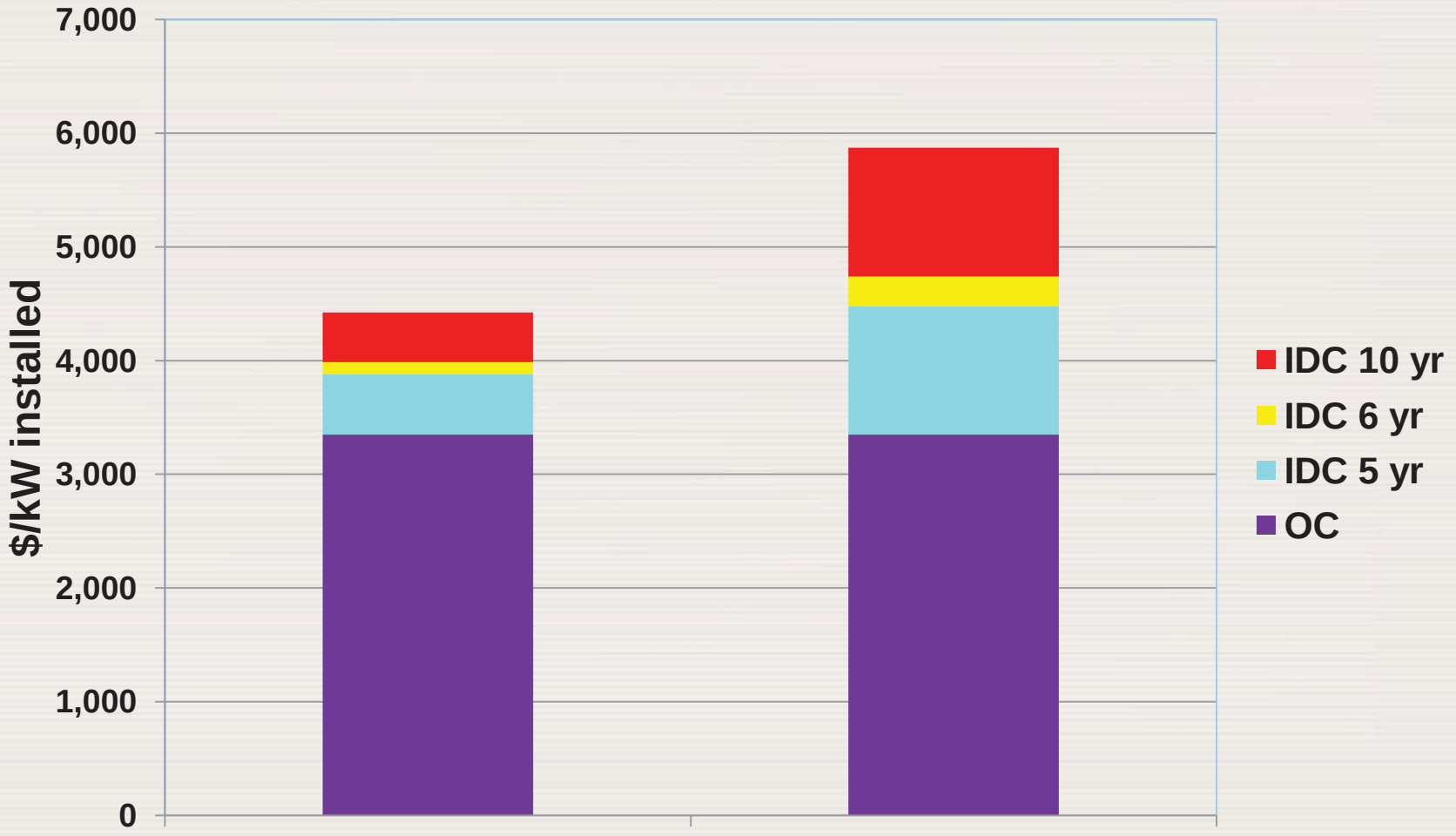
Source: NEA/IEA, 2010

The impact of interest rates and plant construction time



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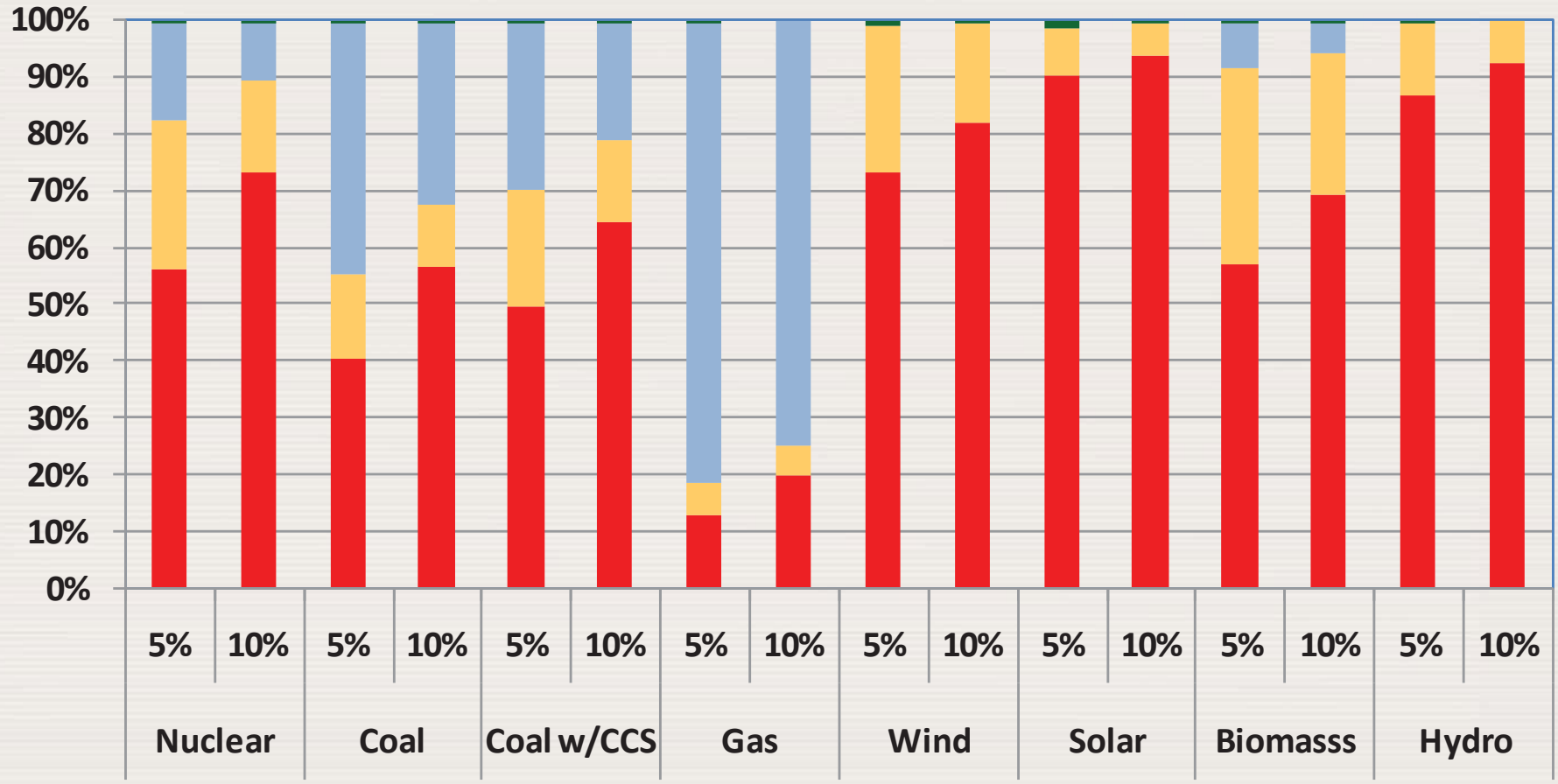
WACC = Weighted average cost of capital

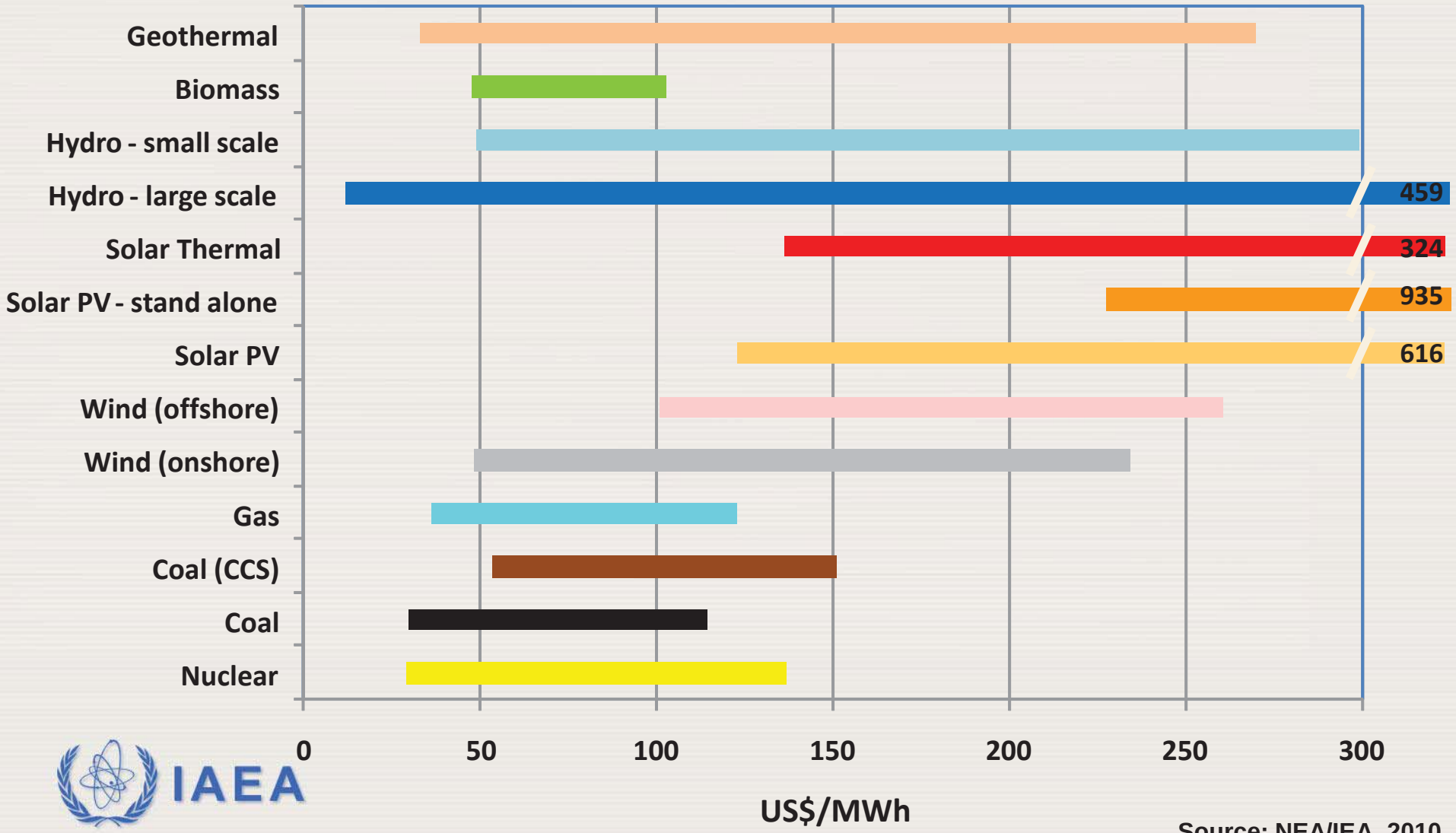
Generating cost structure (including IDC)



*Fuel costs for nuclear comprise the costs of the full nuclear fuel cycle including spent fuel reprocessing or disposal.

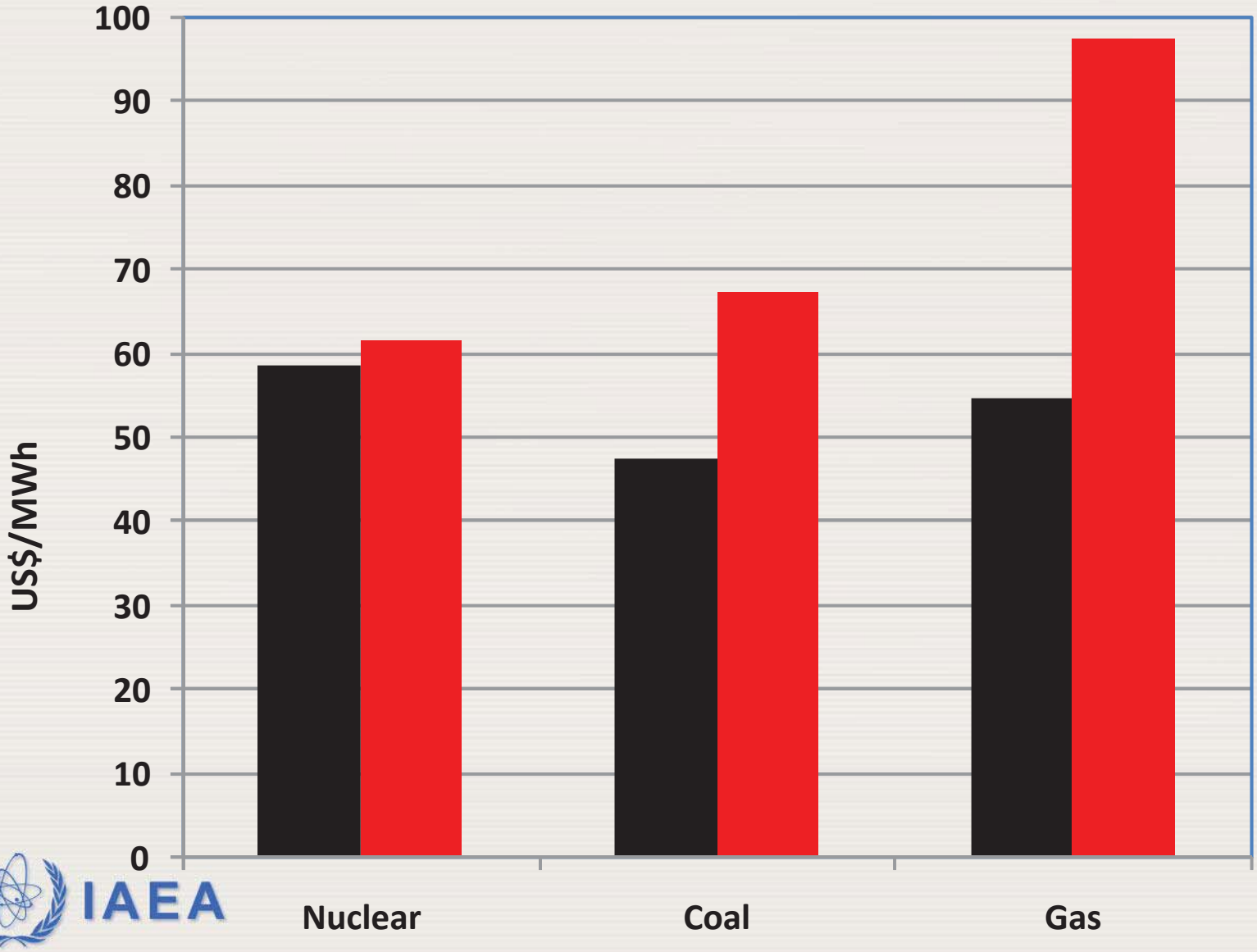
Source: NEA/IEA, 2010

Range of levelized generating costs of new electricity generating capacities

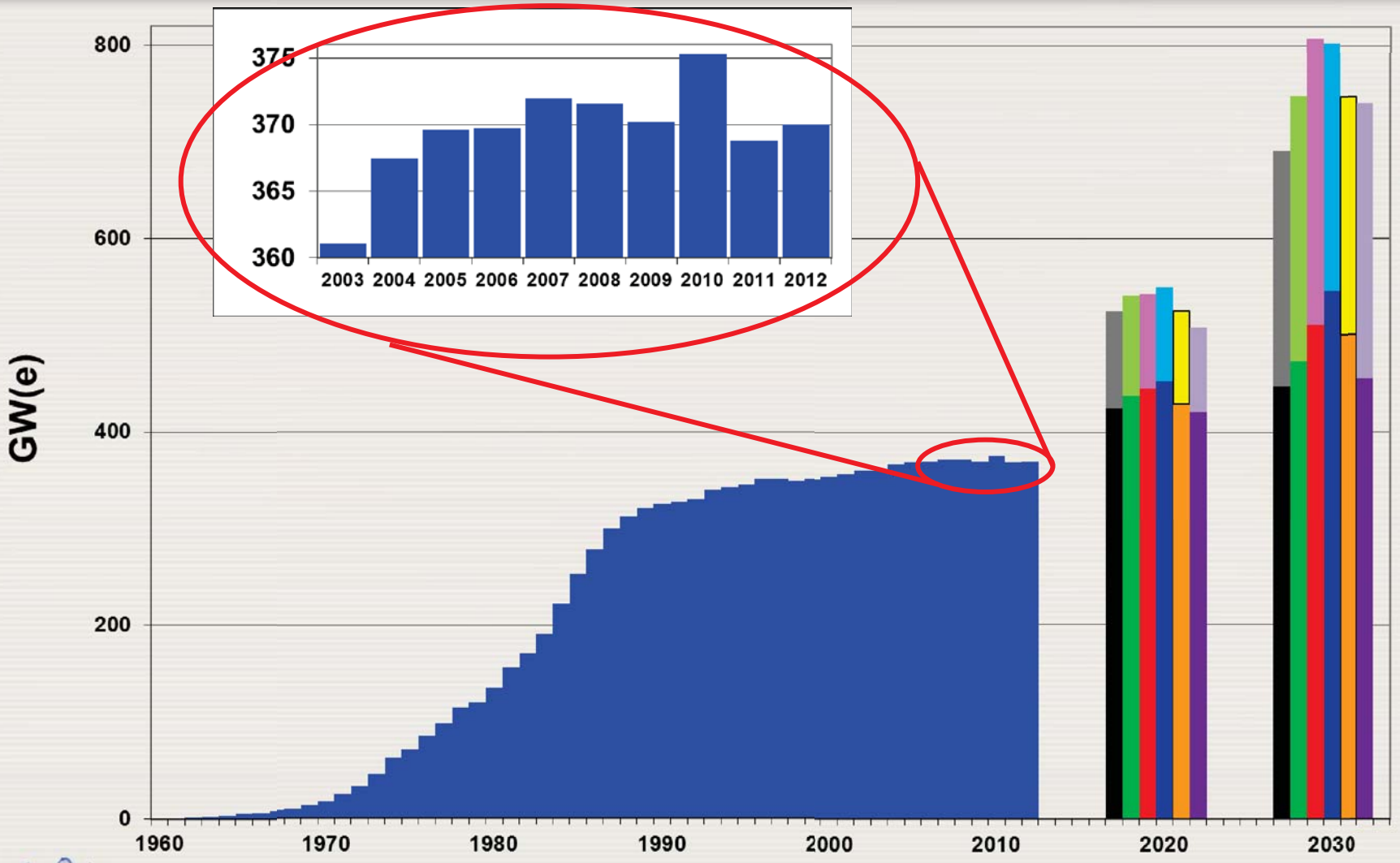


Source: NEA/IEA, 2010

Impact of a doubling of resource prices on generating costs



Global installed nuclear power capacity



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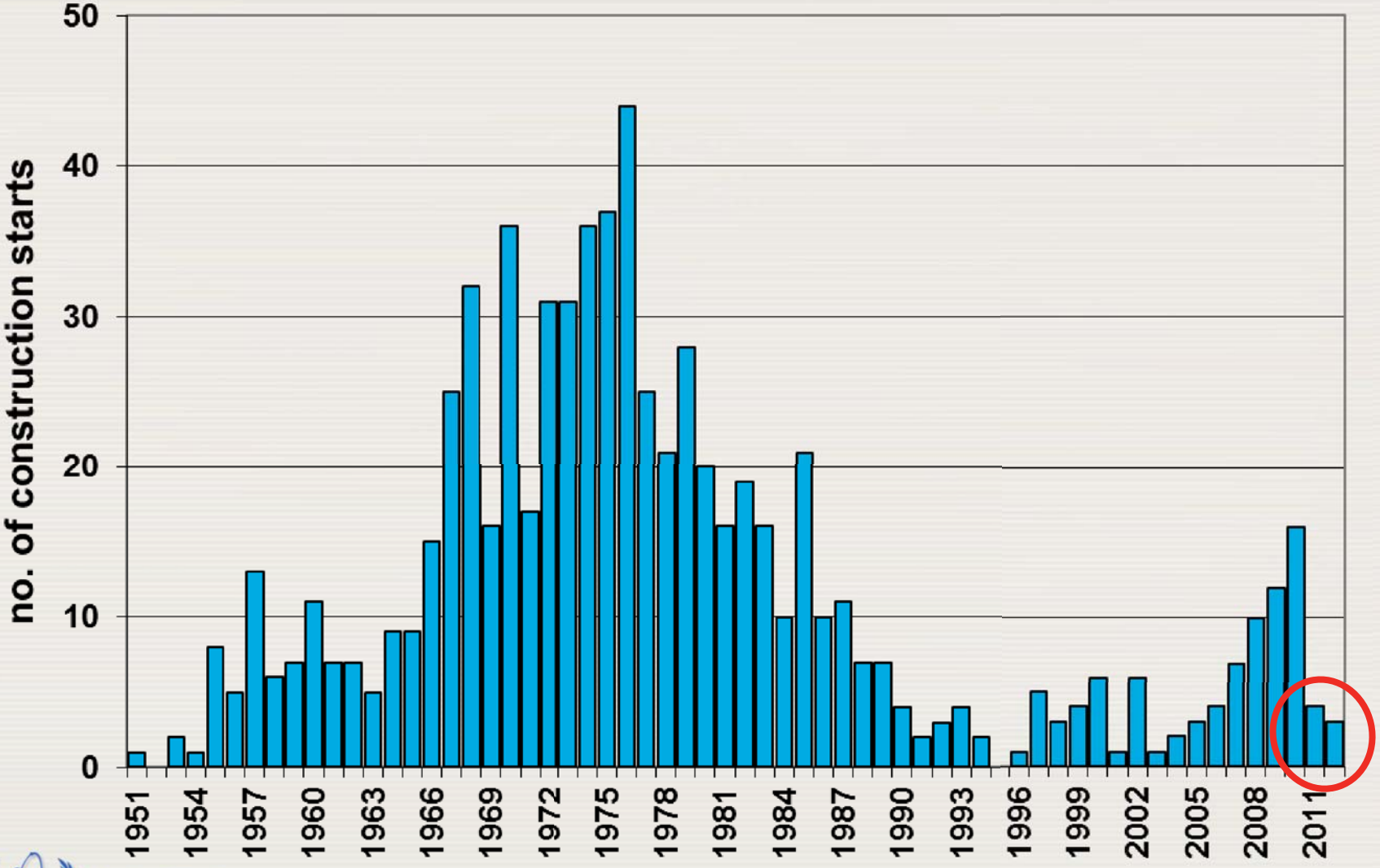
New construction starts



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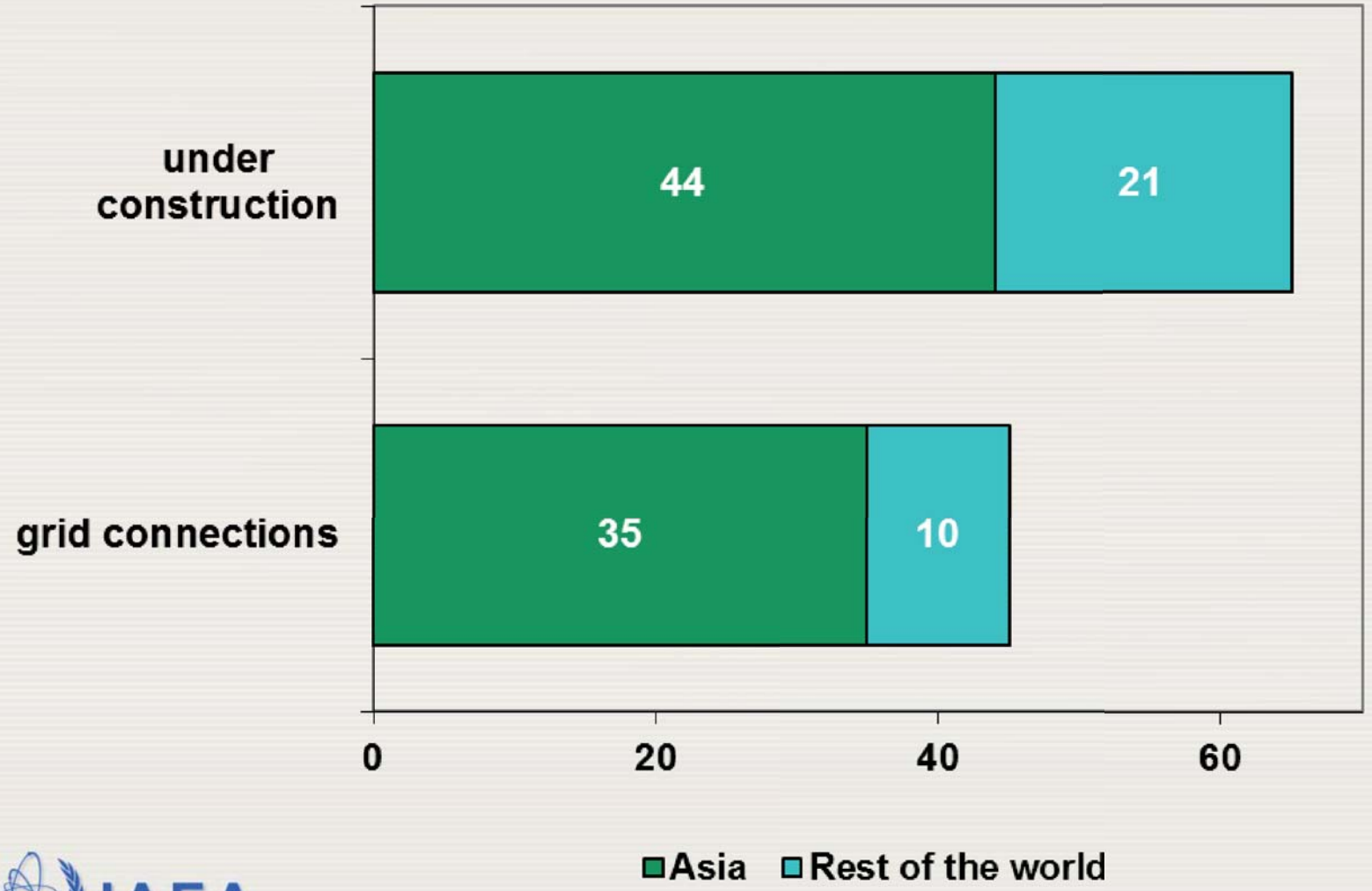
Expansion centred in Asia (end of 2011)



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Objectives of Rio+20

- To renew political commitment
- To take stock of accomplishments, identify gaps, and to address new and emerging challenges
- To increase commitments by the international community to move the sustainable development agenda forward, through achieving internationally agreed development goals, including the Millennium Development Goals (MDGs)

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The Future We Want

- The Rio+20 outcome document is a basis to accelerate progress towards sustainable development
- Result of several years of intense negotiation until the 11th hour in Rio+20
- A balance among expectations of 193 MSs
- Some consider it a major achievement
- Still it reflects the least-common denominator

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Green economy

- **Lacks a clear definition – but used as panacea for all the world's problems**
- The implementation paradigm for SD
- Markets and non-market approaches
- Supposed to enhance the welfare of all disadvantaged
- Close the technology gap between N & S
- 3Rs
- Avoids discrimination
- Path forward: No one size fits all

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IFSD

- Intergovernmental high level political forum
- GA to negotiate high level forum's format and organizational aspects - first high level forum at the beginning of the 68th session of the GA
- Strengthen the role of UNEP

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Energy

- #4 among agreed themes after poverty, food and water
- Access and affordability
- Sustainable energy = appropriate mix through increased renewables and other low-emission options, efficiency, advanced energy technologies including cleaner fossil fuels, and sustainable use of traditional energy resources

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Sustainable development goals

- For beyond 2015
- Working group prior to 2012 GA
  - 30 members nominated by regional groups
- Proposal due to 2013 GA

Means of implementation

- Finance
- Technology
- Capacity building
- Trade
- Commitments at Rio
  - More than $500 billion mobilized with over 700 commitments made by businesses, governments, civil society and multilateral development banks
  - More than 100 related to the UN SG's initiative Sustainable Energy for All

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Headlines / punch lines

- Nuclear age won't end because of uranium
- 'Sustainable development' good for finding joint gains, but don't over-extend
- Kyoto limits internalize low emissions benefit
- "It's the economics"; one size does not fit all
- Growth still projected post-Fukushima, but delayed
- CSD-9 formula in place; but watch SDGs

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