

# Role of Nuclear Energy in Climate Change Strategy after the Fukushima Nuclear Accident

October 4, 2013

**Tatsujiro Suzuki**

Vice Chairman, Japan Atomic Energy Commission



*Note: The views expressed here are of my own and do not necessarily reflect those of the JAEC nor the government.*

# Summary

- Fukushima Dai-ichi nuclear power accident has become one of the worst accidents in nuclear history and **it is not completely over yet. The biggest impact is loss of public trust.** This has serious implications for not only Japan but also global nuclear energy development.
- **Impact of shale gas, improved energy efficiency and expansion of renewables** are the new trends in global energy scenes. Still, challenges for climate change remains.
- **Need all technology options** to meet climate challenge and appropriate policy mix is necessary.
- Global negotiation on climate change is facing difficulties and need **innovative approaches, such as putting carbon price,** are necessary.



# PM Abe's assuring speech on Fukushima at the International Olympic Committee

(Sept. 7, 2013)

- *" Let me assure you the situation is under control... It has never done and will never do any damage to Tokyo. There are no health-related problems until now, and nor will there be in the future."*

-From Reuter, "Abe helps secure 2020 Games for Tokyo," Sept. 7, 2013

<http://uk.reuters.com/article/2013/09/07/uk-olympics-idUKBRE9860BO20130907>



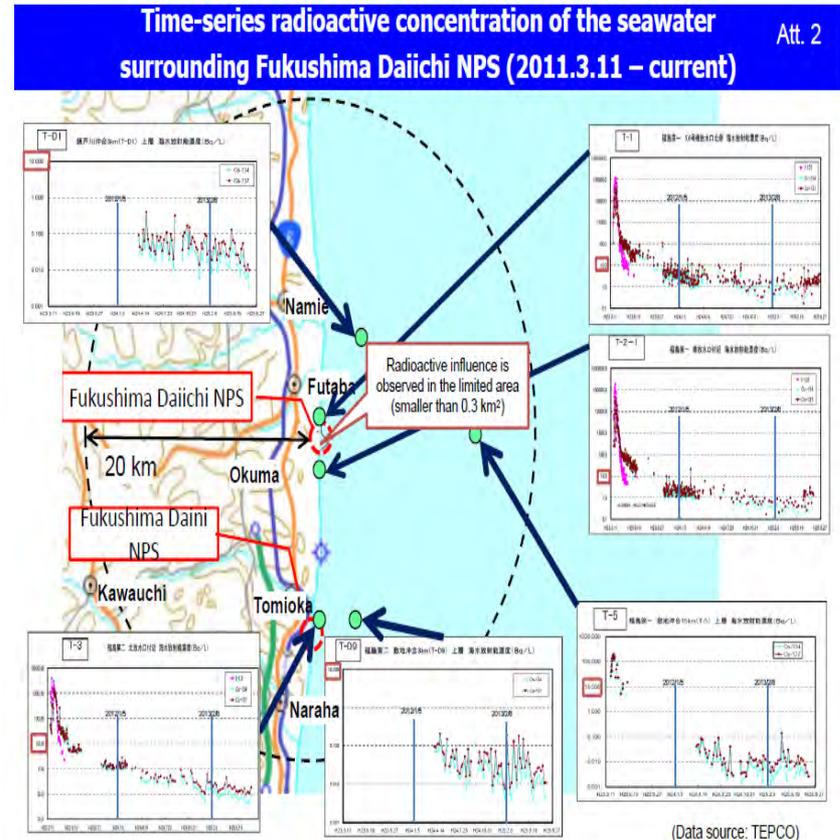
[http://www.kantei.go.jp/jp/96\\_abe/actions/201309/07ioc\\_day2.html](http://www.kantei.go.jp/jp/96_abe/actions/201309/07ioc_day2.html)

# Following up his statement...

The [technical basis](#) of his statement is as follows:

- There are 32 radiation monitoring stations and 85 radiation monitoring points along the coast of the Fukushima, Ibaraki, and Chiba prefectures. The Nuclear Regulatory Authority reports that the seawater contains 0.021 becquerel per liter or less of cesium 134 and cesium 137—far below the acceptable standard of 10 becquerel per liter.
- The contaminated water is limited to the area around the port near the Fukushima Daiichi Nuclear Power Station—an area that is no larger than 0.3 square kilometers.
- The annual radiation exposure from food and water is estimated to be lower than 0.01 millisieverts.

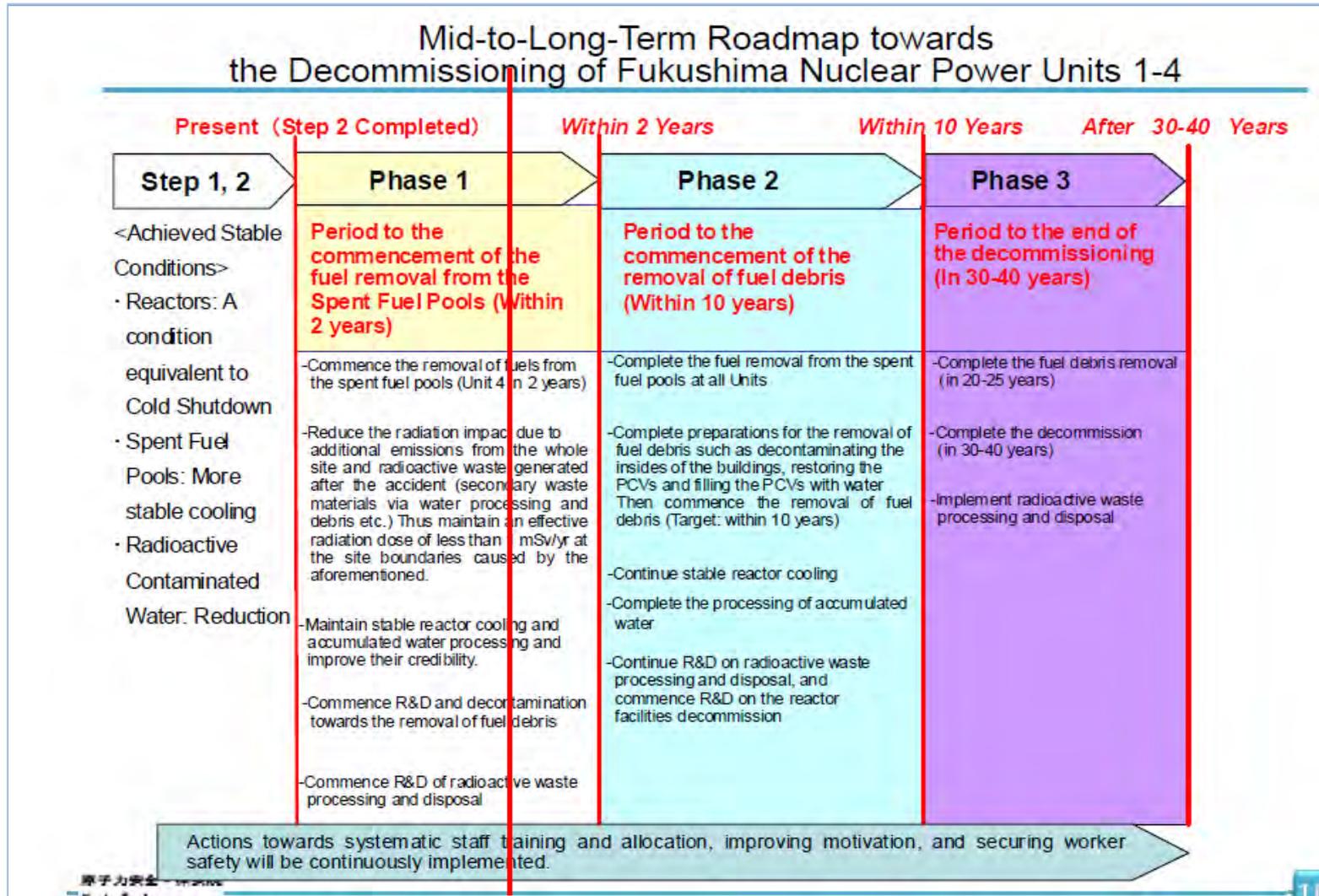
From: “Suzuki’s Fukushima updates,” The Bulletin of the Atomic Scientists, Sept. 9, 2013.  
<http://thebulletin.org/suzukis-fukushima-updates>



[http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20130904\\_01b.pdf](http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/pdf/20130904_01b.pdf)



# Mid-Long Term Roadmap for Fukushima Dai-ichi



2011/12      2013/05

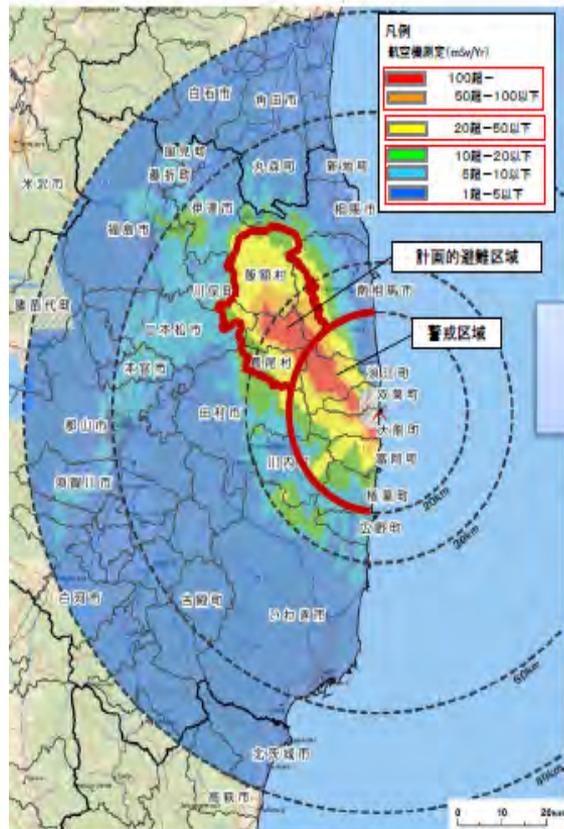
Source: M. Yasui, Nuclear and Industrial Safety Agency (NISA), March 2012,  
<http://www.nsr.go.jp/archive/nisa/english/files/en20120321.pdf>



# Evacuation Area Amended (March 7, 2013)

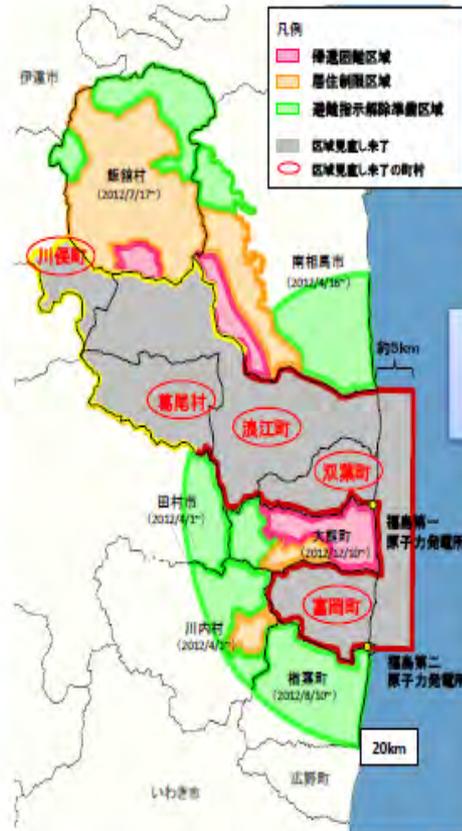
(As of April 29, 2012)

〔平成23年4月29日時点の  
線量分布〕



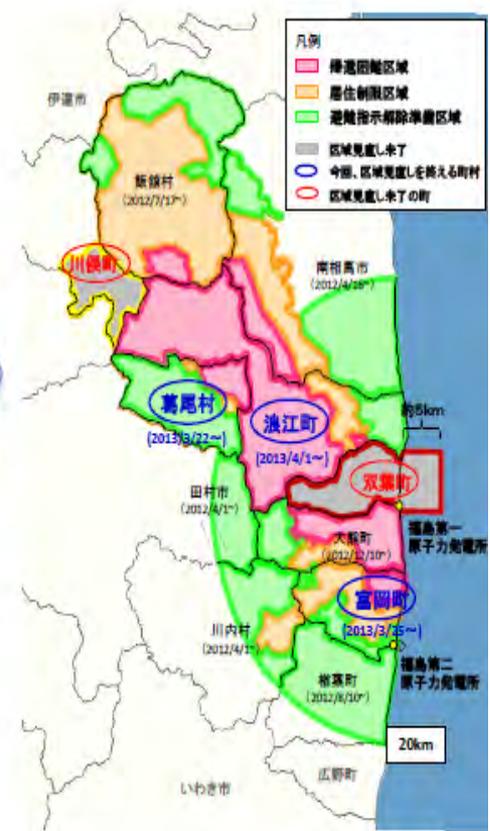
(Dec 10, 2012)

〔平成24年12月10日時点  
(今回の区域見直し前)〕



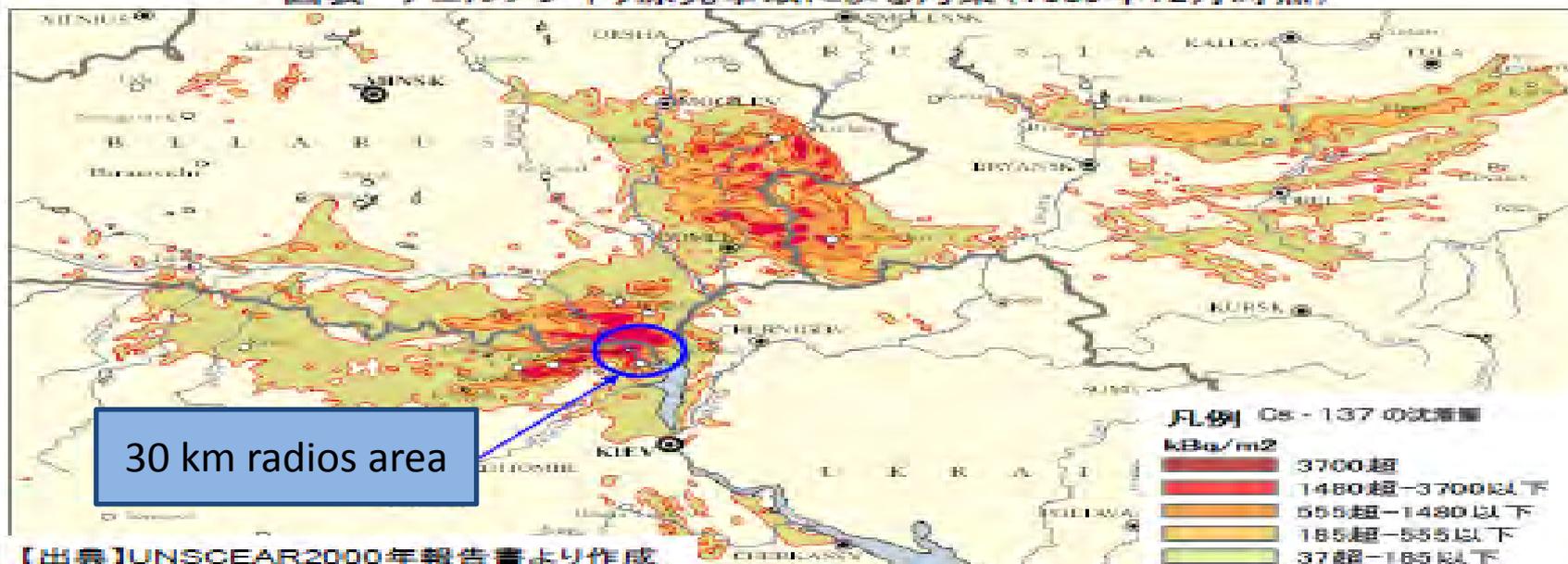
(After April 1, 2013)

〔平成25年4月1日以降  
(今回の区域見直し後)〕

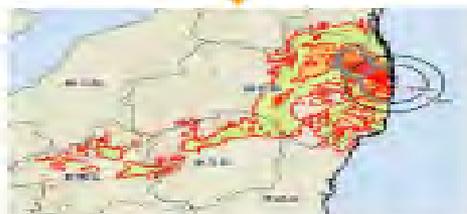


# Compared with the Chernobyl accident

図表 チェルノブイリ原発事故による汚染(1989年12月時点)



両図を同縮尺  
で記載



図表 東電福島第一  
原発事故による汚染  
(2011年11月時点)

【出典】文部科学省発表資料(2011年11月)より作成

図表 汚染地域の面積

汚染濃度 (kBq/m <sup>2</sup> )	汚染地域の面積(km <sup>2</sup> )		
	Chernobyl	Fukushima	F/C
> 1,480	3,100	200	6%
555 - 1,480	7,200	400	6%
185 - 555	18,900	1,400	7%
37 - 185	116,900	6,900	6%
合計面積	146,100	8,900	6%



# Cherry blossom in Tomioka Town

(April, 2013, 10 km from Fukushima Daiichi)



<http://www.asahi.com/special/10005/images/TKY201204190192.jpg>



<http://img.47news.jp/PN/201204/PN2012041901001125.-.-.CI0003.jpg>

# Most Important Lessons Learned from Fukushima: “Thinking Unthinkable” and “Resilience”

- *“The Investigation Committee is convinced of the **need of a paradigm shift** in the basic principles of disaster prevention programs for such a huge system, whose failure may cause enormous damage.”* - from the Interim Report by the Gov’t investigation committee (Dec. 2011)
- “**Thinking unthinkable**” is essential in preparing for the emergency and for energy security.
- “**Resilience**” beyond “defense in depth” is needed for preparing “unexpected crisis”.
  - Resilience means a capability to **respond to “unexpected crisis”** as well as to **restore safe and secure status** of the social system.

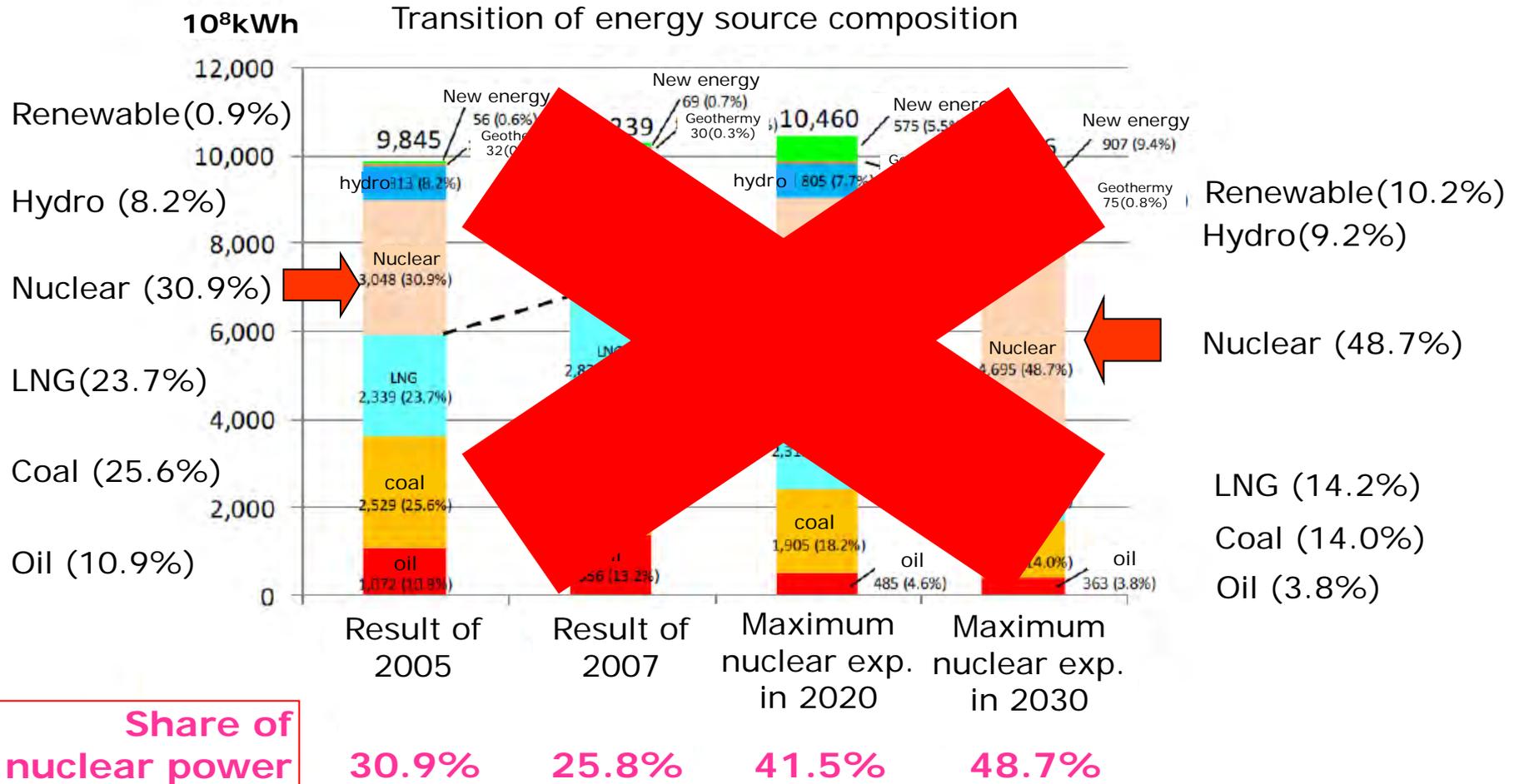


# Japan's energy policy after 3/11



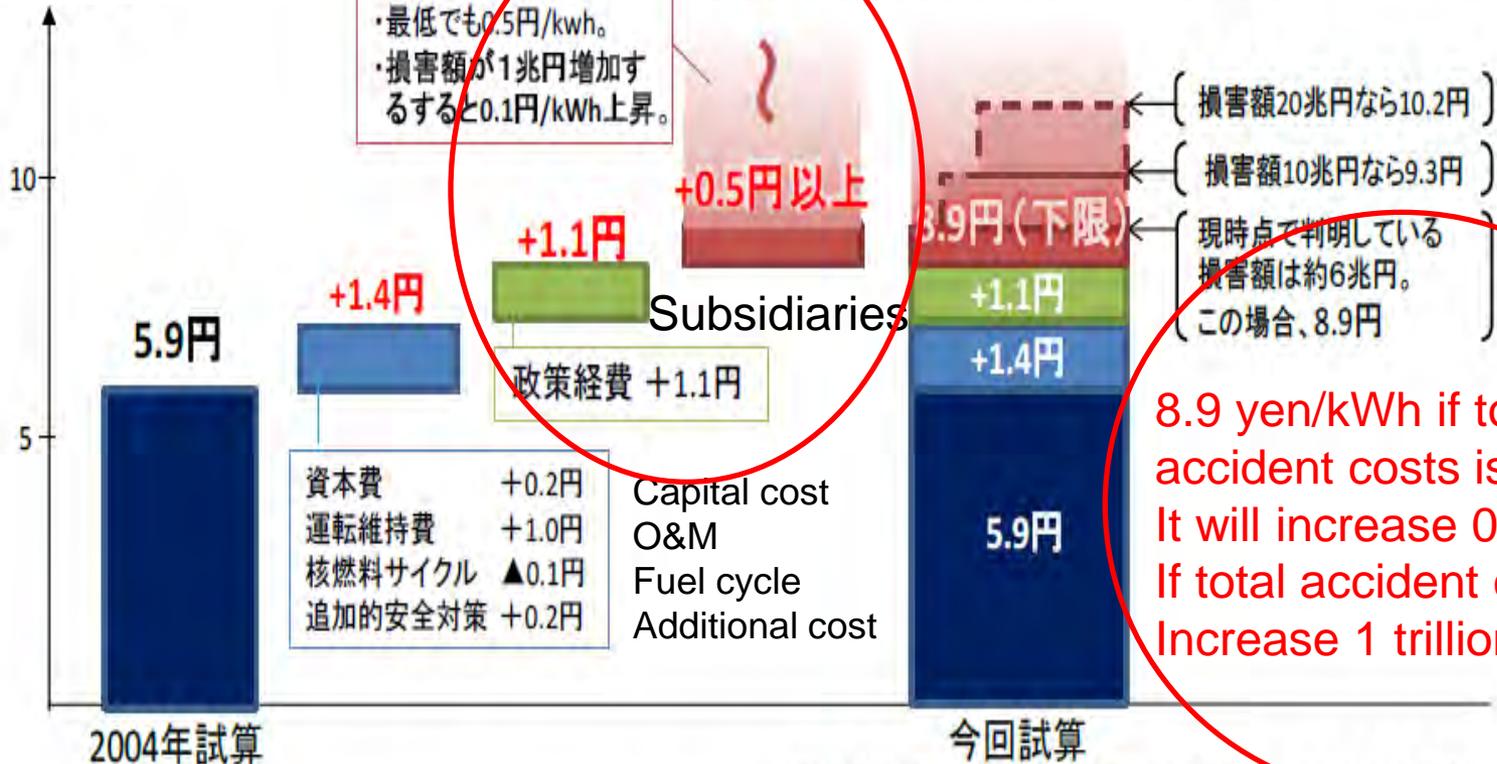
# Goal of Power Production Mix in 2030

## Before 2011/3/11



Source: Institute of Energy Economics, March 2010

Yen/kWh



Costs associated with accident

事故リスク対応費用  
 ・最低でも0.5円/kwh。  
 ・損害額が1兆円増加するすると0.1円/kWh上昇。

← ( 損害額20兆円なら10.2円 )  
 ← ( 損害額10兆円なら9.3円 )  
 ← ( 現時点で判明している損害額は約6兆円。この場合、8.9円 )

8.9 yen/kWh if total accident costs is 6 trillion yen.  
 It will increase 0.1 yen/kWh if total accident costs increase 1 trillion yen.

2004年試算  
2004

今回試算  
2011

※稼働年数40年、設備利用率70%(実績ベース)、割引率3%

(図 20) 原子力の発電コスト (2004年試算と今回試算)

Nuclear Power Generation Costs (2004, 2011)

出所:コスト等検証委員会報告書、2011年12月19日

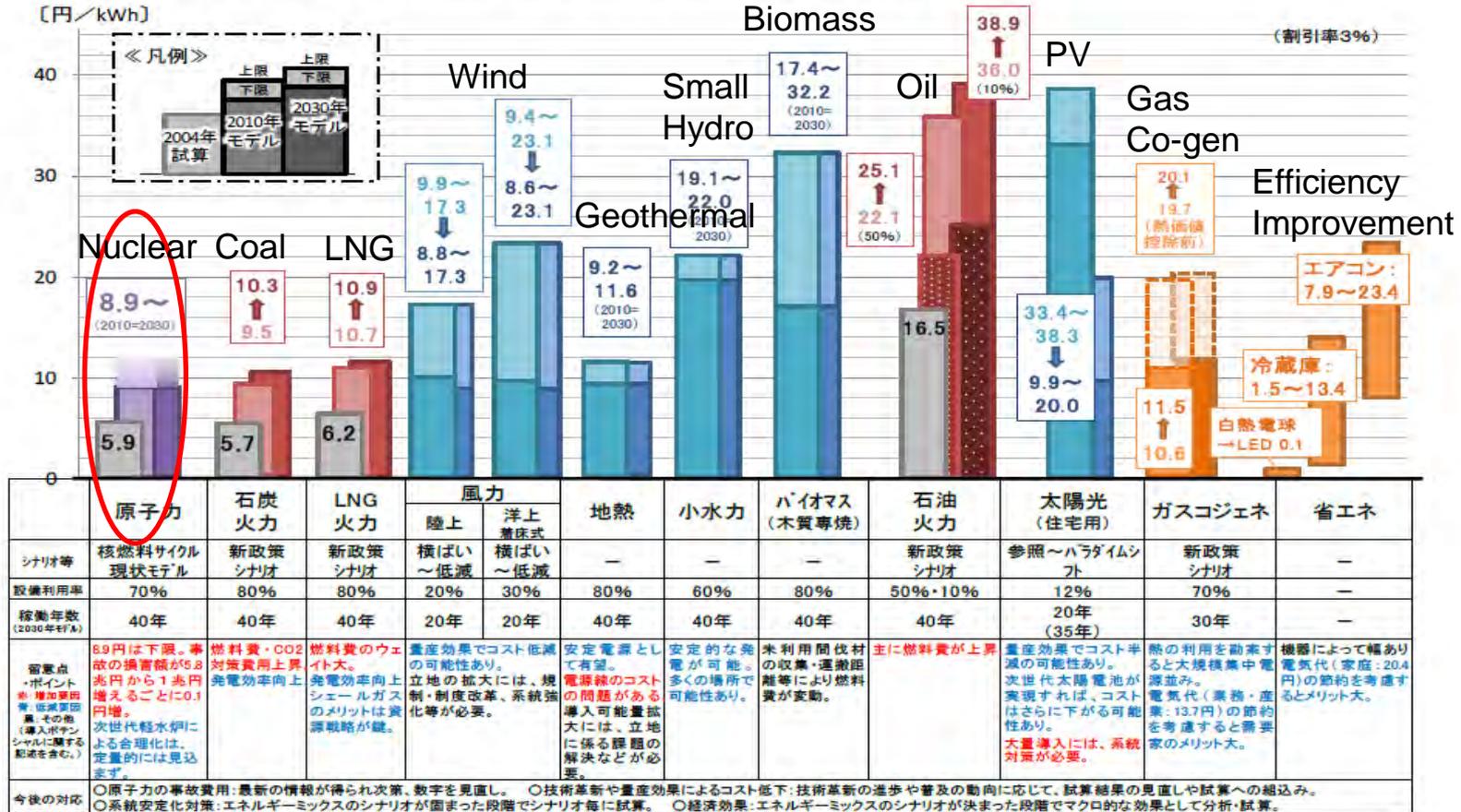
<http://www.npu.go.jp/policy/policy09/pdf/20111221/siryos3.pdf>



# Nuclear power can be competitive, but social costs can be high...

## 【コスト試算のポイント】

- モデルプラント形式(最近7年間の稼働開始プラント、最近3年間の補助実績等を基に設定)
- CO2対策費用、原子力の事故リスク対応費用、政策経費等の社会的費用も加算。
- 2020年、2030年モデルは燃料費・CO2対策費の上昇、技術革新等による価格低減を見込んで試算。

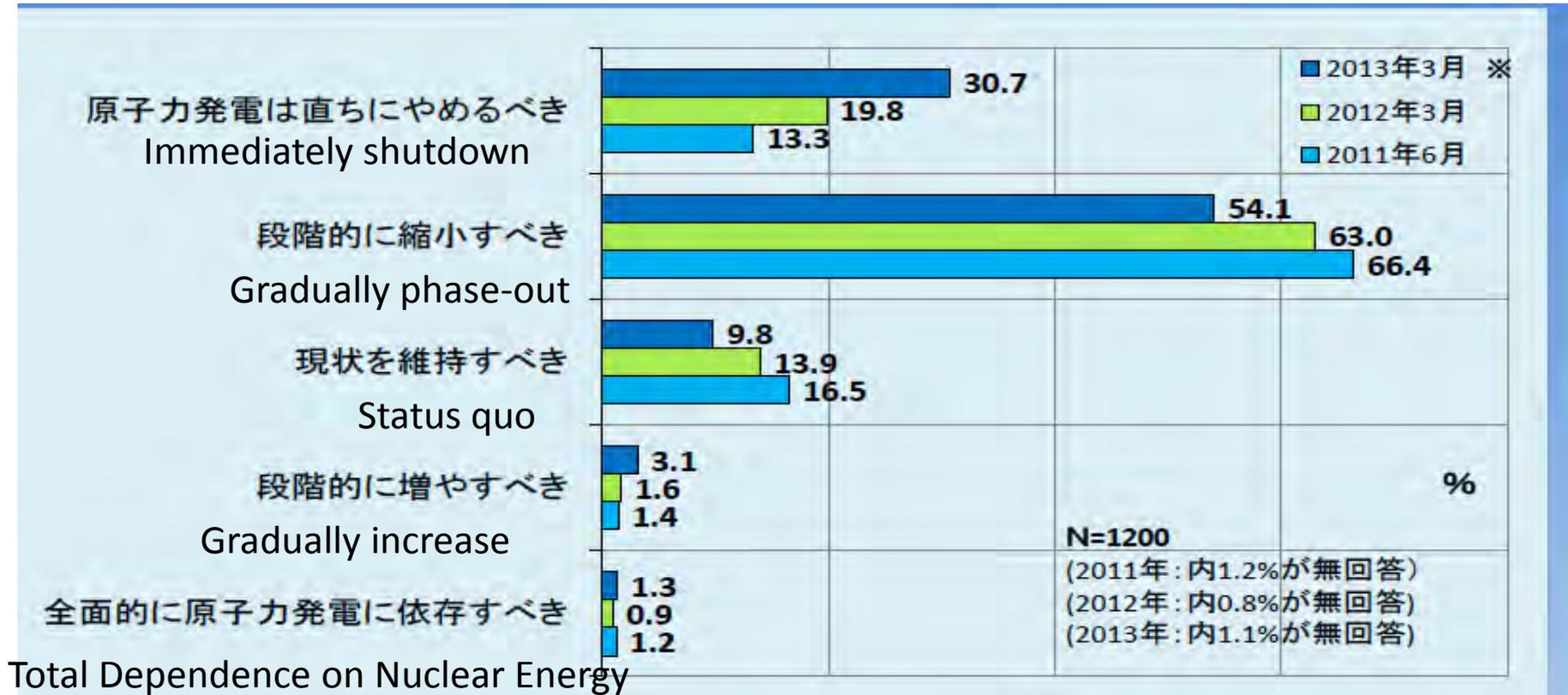


(図 36) 主な電源の発電コスト (2004年試算/2010年・2030年モデルプラント)



出所:コスト等検証委員会報告書、2011年12月19日

<http://www.npu.go.jp/policy/policy09/pdf/20111221/siry03.pdf>



What is your opinion about nuclear power in Japan?

## 日本の原子力発電はどうあるべきか

※2013年の調査では、回答項目は「再稼働を認めず、直ちにやめるべき」「再稼働を認めて段階的に縮小すべき」「再稼働を認めて現状を維持すべき」「再稼働を認めて段階的に増やすべき」であった。

Source: Prof. Hirotada Hirose, “Changes of Public Opinion about Nuclear Power,”

Presented at Japan Atomic Energy Commission, July 17, 2013

<http://www.aec.go.jp/jicst/NC/iinkai/teirei/siryo2013/siryo27/siryo2.pdf>



# Summary of New Energy and Environmental Strategy (2012/09/14) (on nuclear energy policy)

Realization of “Society not dependent on nuclear power” in earliest possible future

: Mobilize all possible policy resources to such a level as to even enable zero operation of nuclear power plants in the 2030s.

(1) 3 Principle guidelines

- Strictly apply 40-year limitation of reactor operation
- Restart the operation of nuclear power plants once the Nuclear Regulation Authority gives safety assurance
- Not to plan the new and additional construction of a nuclear power plant

(2) 5 policies to achieve society without dependent on nuclear power (later)

(3) Review and constantly re-examine the path towards realization of a society not dependent on nuclear power

Source: The Energy and Environment Council, “Innovative Strategy for Energy and Environment,” September 14, 2012. [http://www.cas.go.jp/jp/seisaku/npu/policy09/pdf/20120914/20120914\\_1.pdf](http://www.cas.go.jp/jp/seisaku/npu/policy09/pdf/20120914/20120914_1.pdf)



# PM Abe's Statement at Diet on Energy Policy (2013/02/28)

- Reflecting on the accident at Tokyo Electric Power Company's Fukushima Daiichi Nuclear Power Station, under the Nuclear Regulation Authority, **we will foster a new culture of safety that will uncompromisingly enhance the degree of safety.** After doing so **we will restart nuclear power plants where safety has been confirmed.**
- **We will promote the introduction of energy conservation and renewable energies to the greatest possible extent to reduce our degree of dependency on nuclear power as much as possible.** At the same time, we will begin a **fundamental reform of the electric system.**

[http://www.kantei.go.jp/foreign/96\\_abe/statement/201302/28siseuhousin\\_e.html](http://www.kantei.go.jp/foreign/96_abe/statement/201302/28siseuhousin_e.html)



# Impact on Global Nuclear Energy Development

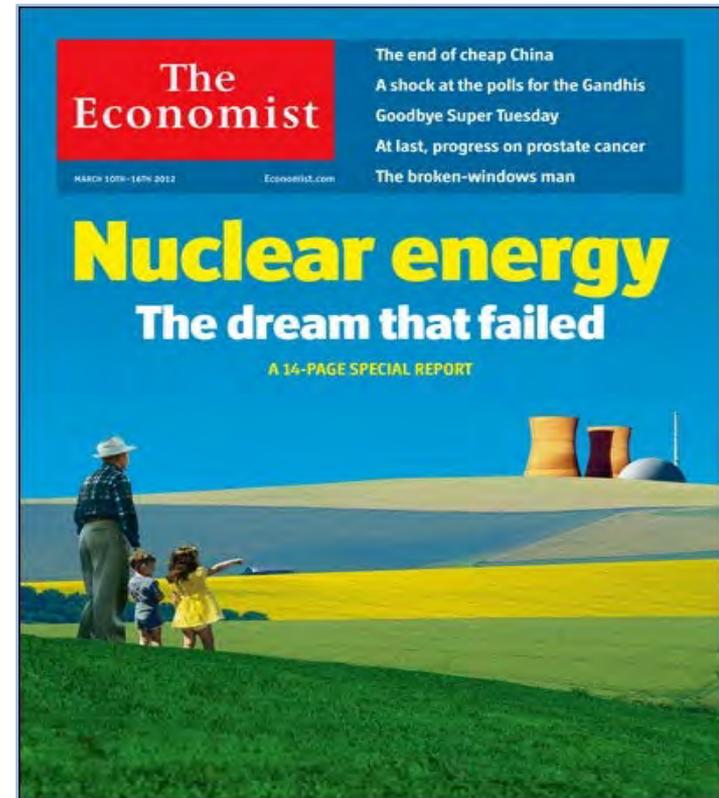


# From “Nuclear Renaissance” to “Failed Dream”? by “The Economist”



*“A nuclear revival is welcome so long as the industry does not repeat its old mistakes”*

*-- The Economist, September 8, 2007*

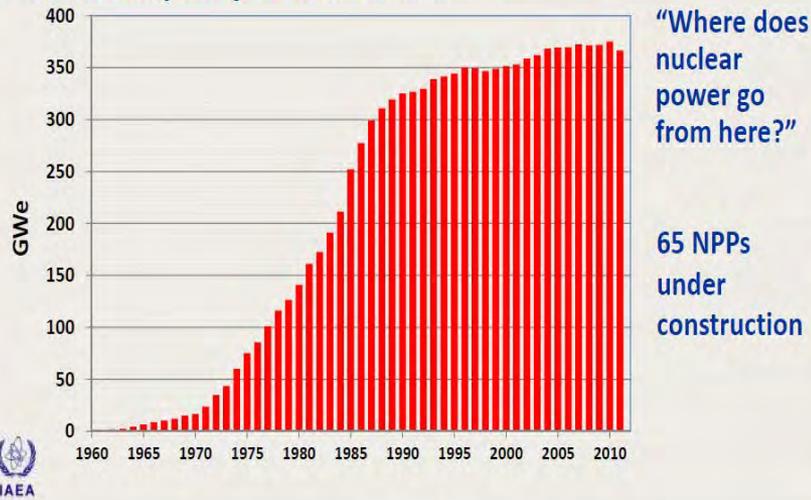


*“For nuclear to play a greater role, either it must get cheaper or other ways of generating electricity must get more expensive.”– The Economist, March 10, 2012*

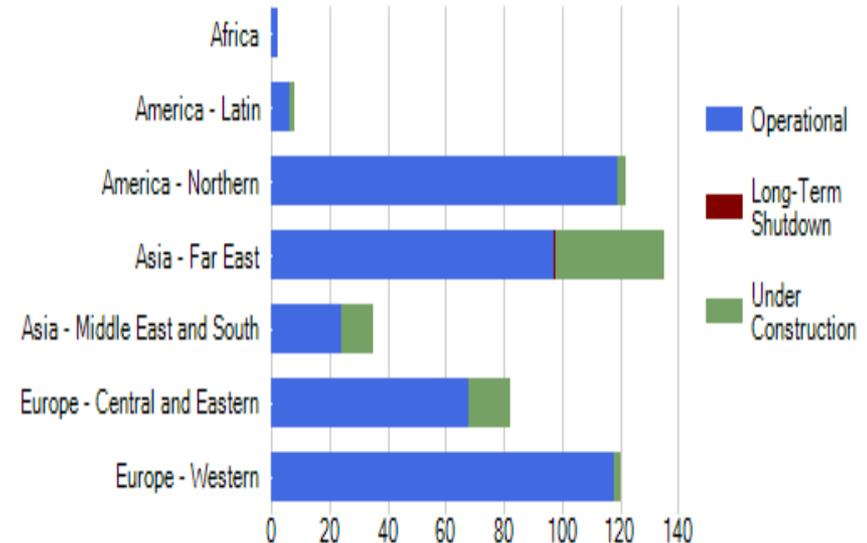
# Global Nuclear Power Development Current Status (IAEA)

## Nuclear power today

On 21 November 2011, 443 nuclear power plants (NPPs) operated in 30 countries worldwide, with a total installed capacity of 366.6 GWe.



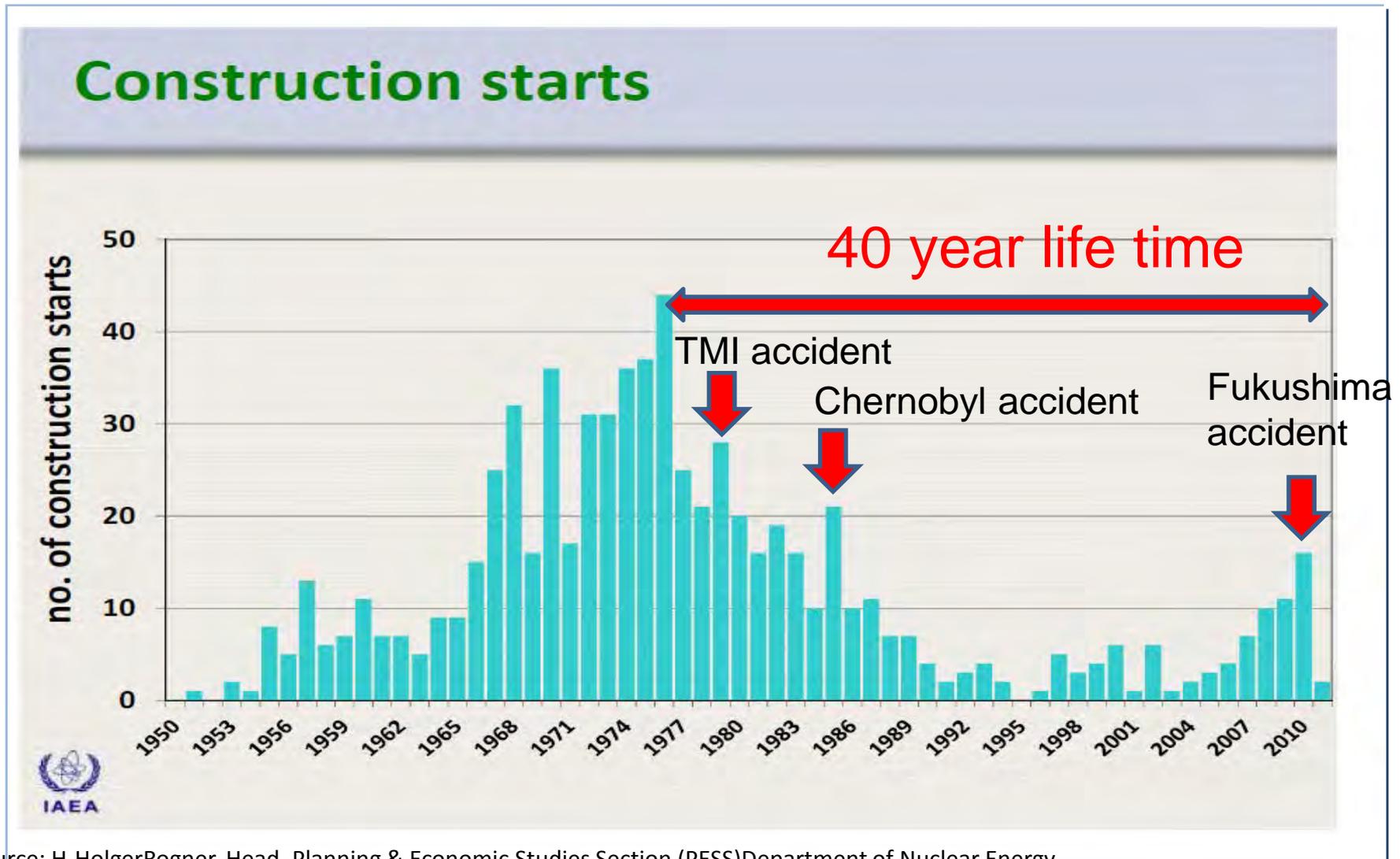
## Total Number of Reactors



Source: H-HolgerRogner, Head, Planning & Economic Studies Section (PESS)Department of Nuclear Energy, International Atomic Energy Agency, “Energy, Electricity and Nuclear Power Estimates for the Period up to 2030,” November 2011.

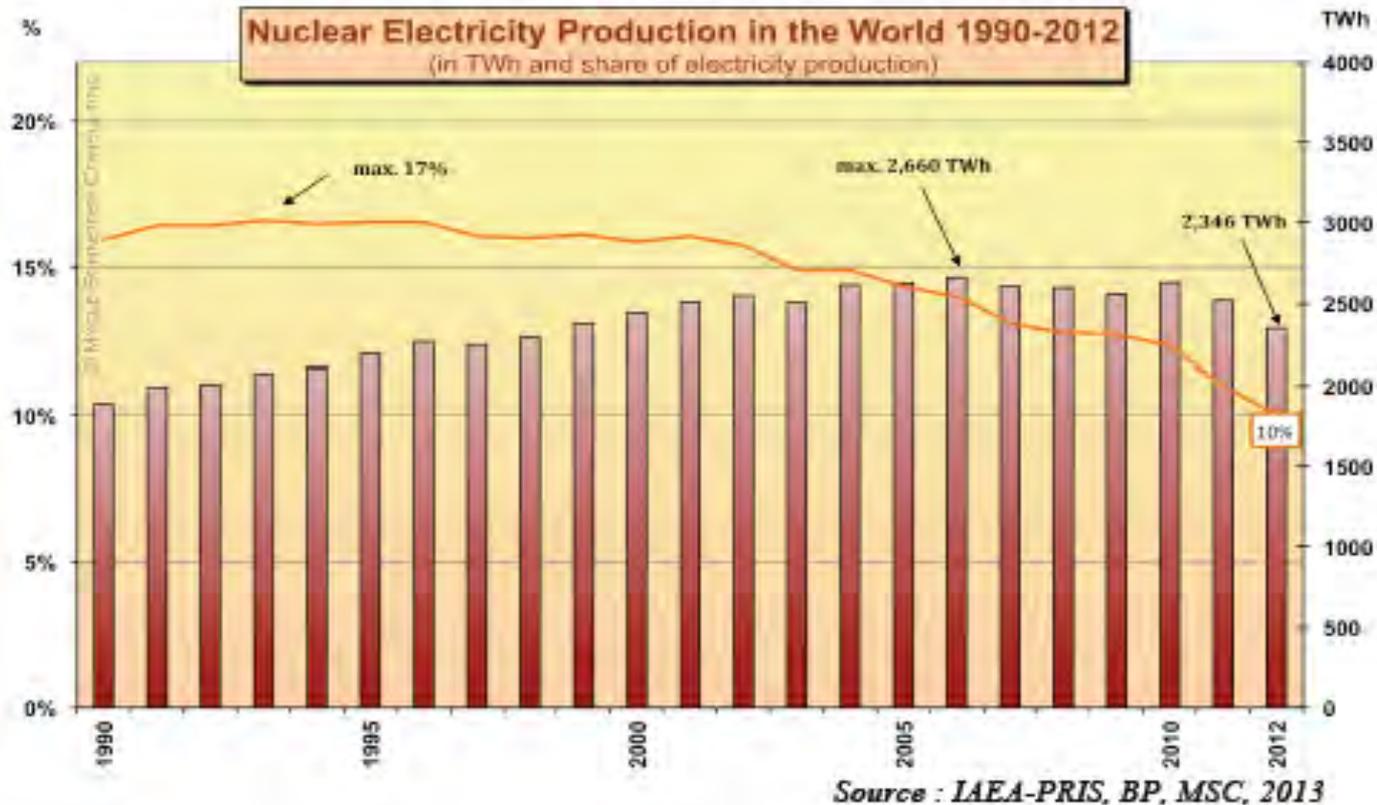
As of July 31, 2013, 434 nuclear power plants (370.5 GWe) are operating and 69 units are under construction, one unit in long term shutdown. <http://www.iaea.org/pris/>

# Global Nuclear Power Plant Construction (IAEA) : Replacement of old reactors are coming....



# Global Nuclear power production is in decline

Figure 1: Nuclear Electricity Generation in the World



# Asia: No major policy changes, still committed to nuclear power

**Bangladesh:** There is **no change** in plans to promote nuclear policy. Bangladesh signs with agreement between Russia about the construction of Rooppur NPP in November 2011.

**China:** Important role of nuclear power in China **is not changed**. China has temporarily stopped the authorization of new projects after the accident, but the construction of NPP has restarted now.

**India:** Domestic energy demand is increasing, and nuclear power is considered to be an important option as a clean energy source (**no change**). Construction of new NPPs are progressing according to the existing plan.

**Indonesia:** 49.5% of the population is **in favor (35.5% opposition)** for against nation's nuclear policy. Nuclear power is considered as one of the main power source to support energy security.

**Kazakhstan:** There is **no change** in plans to promote nuclear power. many people are aware that there is no other option to incorporate nuclear power for the realization of nation's policy.

**South Korea:** There is **no change** in nuclear policy. Based on the "4th Comprehensive Nuclear Energy Promotion Plan", South Korea continues to build NPPs in six locations from 2012 to 2017.

**Malaysia:** There is **no change** in plans to begin the operation of Malaysia's first nuclear reactor in 2021.

**Vietnam:** There is **no change** in plans to promote nuclear power. Vietnam plans to build high safety NPPs learned from Fukushima accident with Japan and Russia in cooperation.

**Taiwan:** Announced an energy policy to **reduce the dependence** on nuclear power.

**Thailand:** **Decided the postponement** of the plan to build five NPPs for 3 years.



# Estimates of Nuclear Electrical Generating Capacity :

## Comparison of estimates in 2012 and 2011

	Actual in 2011	Estimates for 2030		Estimates for 2050	
		Estimated in 2011	Estimated in 2012	Estimated in 2011	Estimated in 2012
<b><u>World Total</u></b>					
Nucl. Capacity (GWe)	368.8		-9%		-16%
Low Estimate		501	456	560	469
High Estimate		746	740	1228	1137
Share (%)	7.1		-1%		-7%
Low Estimate		5.2	4.7	2.7	2.3
High Estimate		6.2	6.2	6.0	5.7
<b><u>Far East</u></b>					
Nucl. Capacity (GWe)	79.8		-15%		-13%
Low Estimate		180	153	220	191
High Estimate		255	274	450	417
Share (%)	5.0		+7%		-7%
Low Estimate		6.4	5.5	4.2	3.7
High Estimate		7.5	8.2	8.6	8.1

Source: International Atomic Energy Agency, "Energy, Electricity and Nuclear Power Estimates for the Period up to 2050," 2011 Edition [http://www-pub.iaea.org/MTCD/Publications/PDF/RDS1\\_31.pdf](http://www-pub.iaea.org/MTCD/Publications/PDF/RDS1_31.pdf)  
 2012 Edition [http://www-pub.iaea.org/MTCD/Publications/PDF/IAEA-RDS-1-32\\_web.pdf](http://www-pub.iaea.org/MTCD/Publications/PDF/IAEA-RDS-1-32_web.pdf)



# Energy Technology Strategy for Sustainable Future

From International Energy Agency  
“Energy Technology Perspective  
2012”

<http://www.iea.org/etp/etp2012/presentations/>



# ETP 2012 – Choice of 3 Futures

## 2DS

a vision of a **sustainable** energy system of reduced Greenhouse Gas (GHG) and CO<sub>2</sub> emissions

The 2° C Scenario

## 4DS

reflecting pledges by countries to cut emissions and boost energy efficiency

The 4° C Scenario

## 6DS

where the world is now heading with potentially **devastating** results

The 6° C Scenario

# Sustainable future still in reach

Is a clean energy transition urgent?

**YES ✓**

Are we on track to reach a clean energy future?

**NO ✗**

Can we get on track?

**YES ✓**

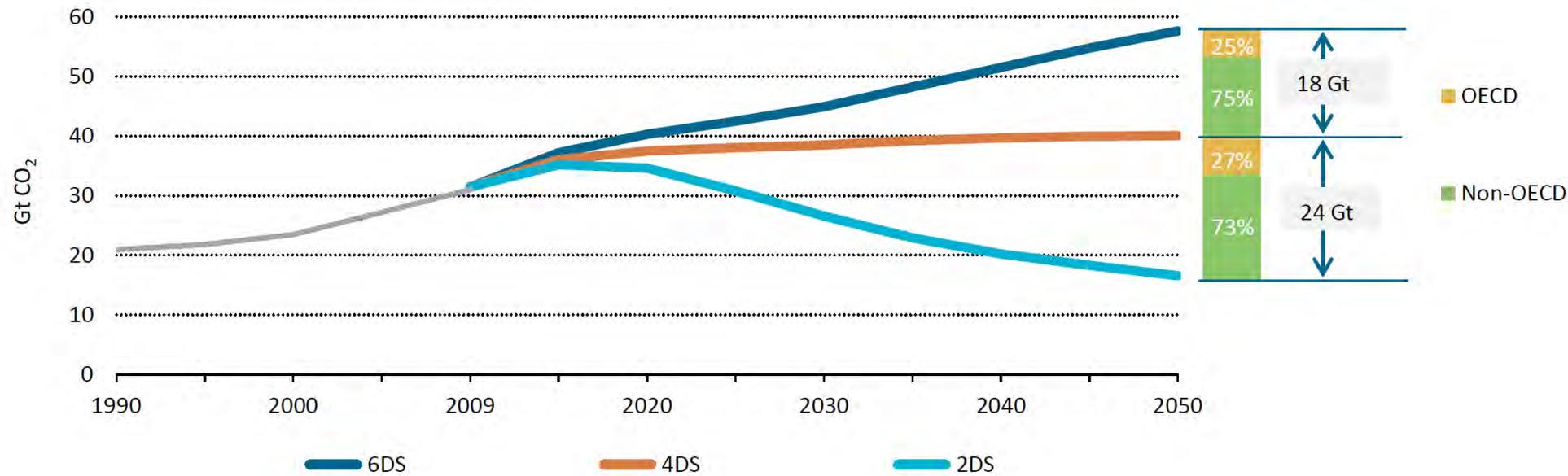
# Recommendations to Governments

1. Create an investment climate of confidence in clean energy

2. Unlock the incredible potential of energy efficiency – “the hidden” fuel of the future

3. Accelerate innovation and public research, development and demonstration (RD&D)

# Choosing the future energy system

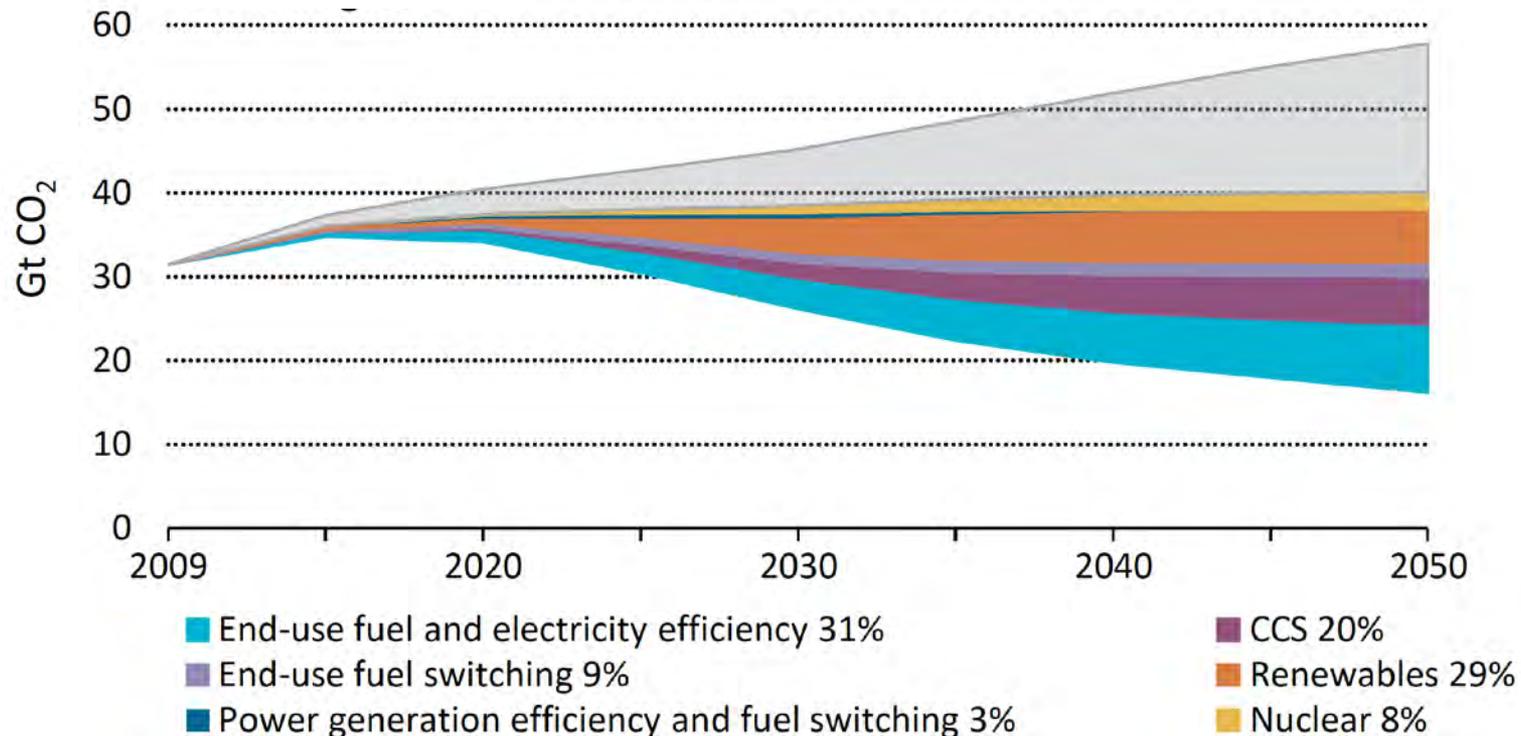


*To achieve the 2DS, energy-related CO<sub>2</sub> emissions must be halved until 2050.*



# A portfolio of technologies is needed

## Technology contributions to reaching the 2DS vs 4DS

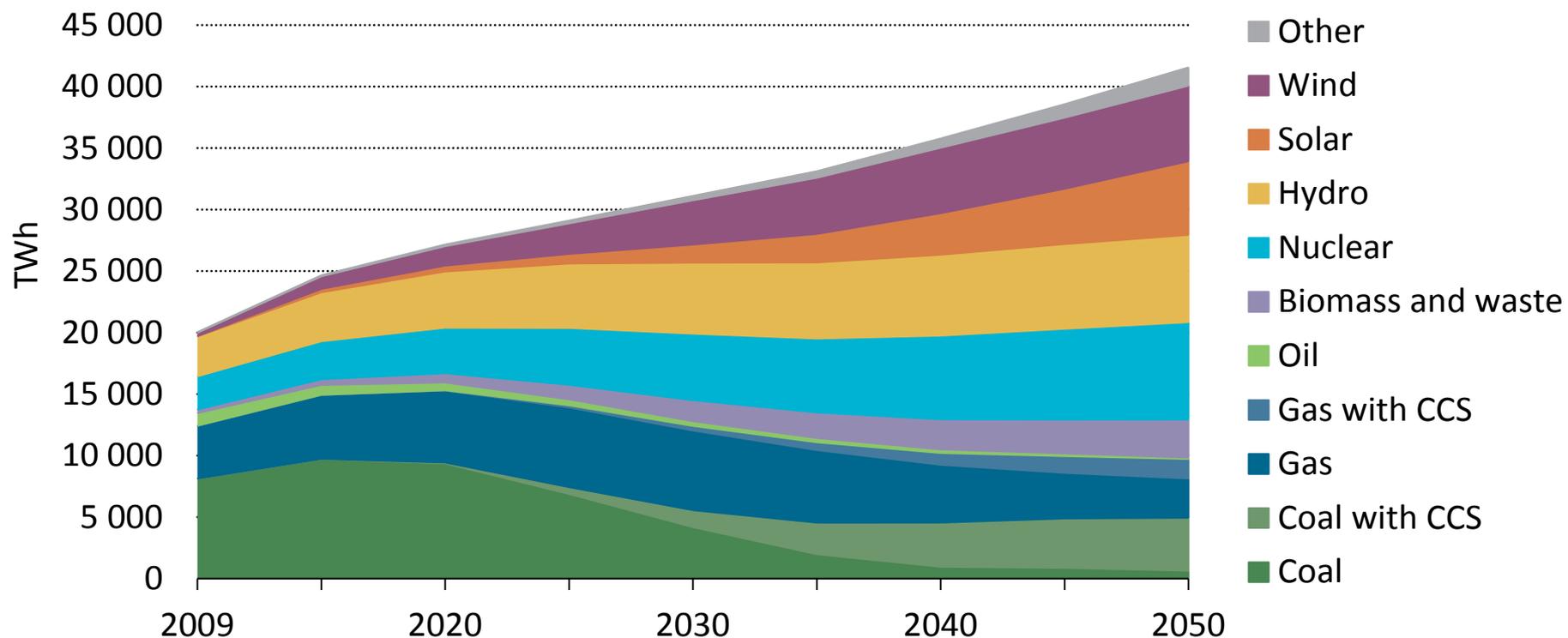


*Energy efficiency is the hidden fuel that increases energy security and mitigates climate change.*



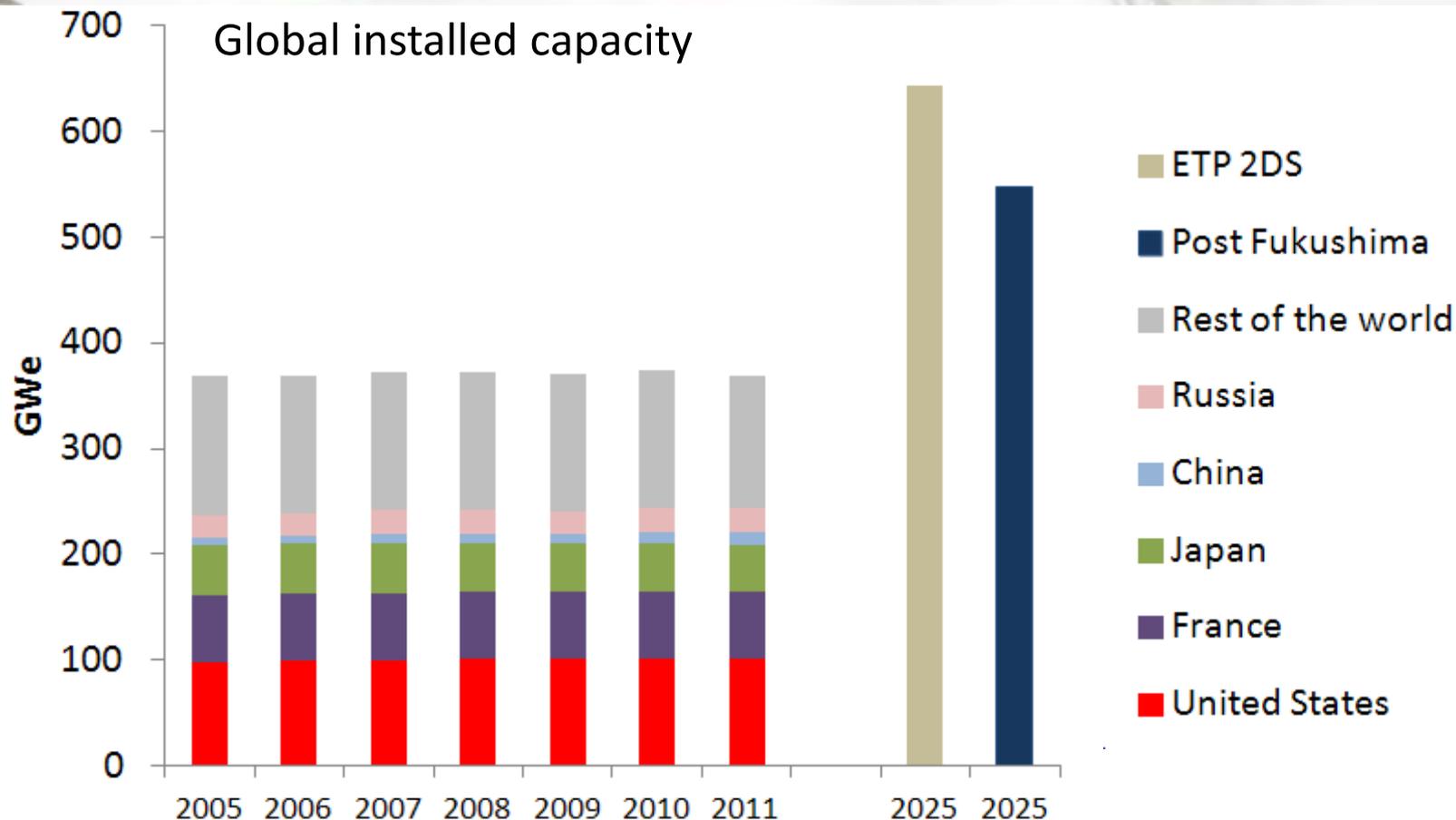
# Low-carbon electricity: a clean core

## Global electricity generation in the 2DS



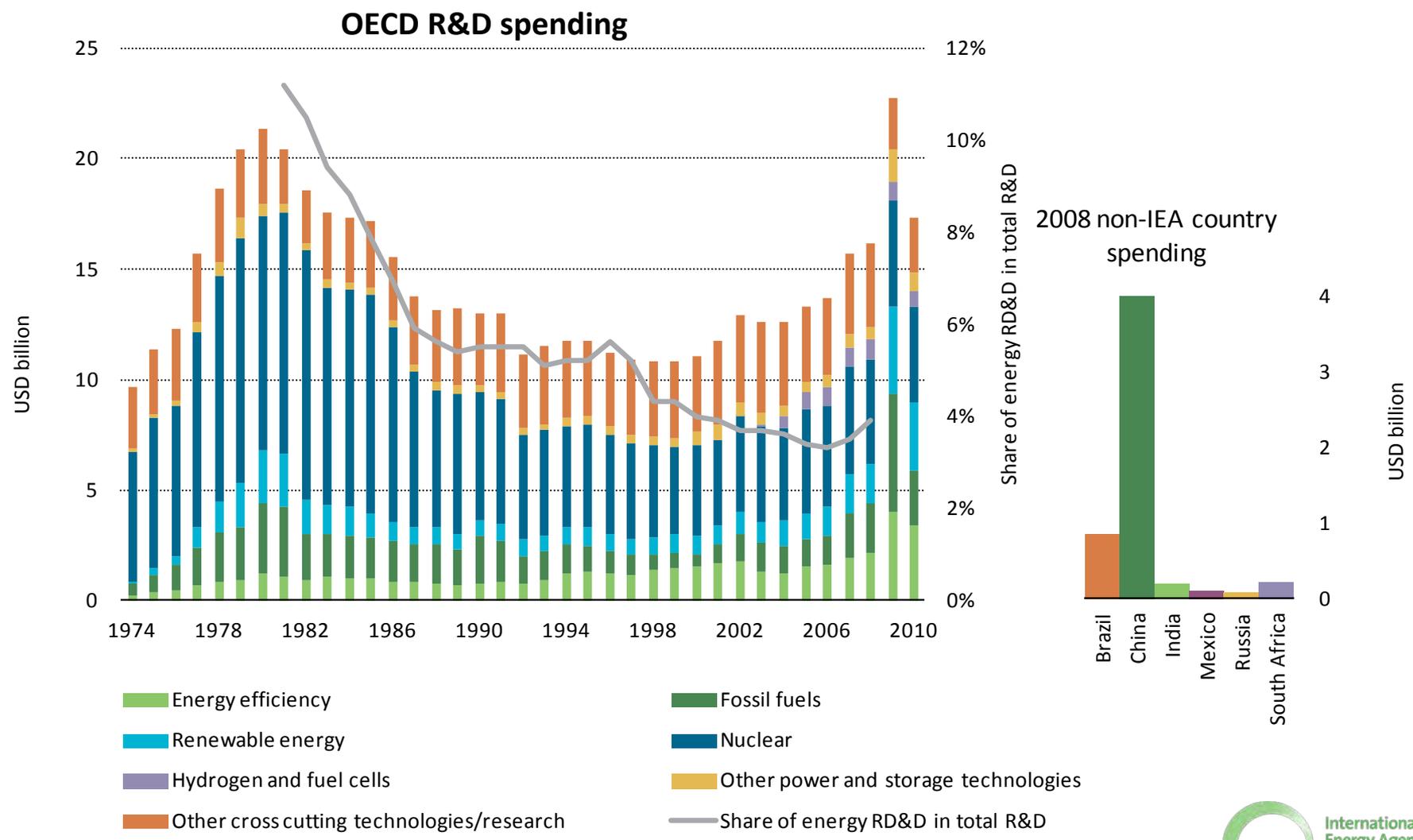
*Renewables will generate more than half the world's electricity in 2050 in the 2DS*

## Power generation; Nuclear

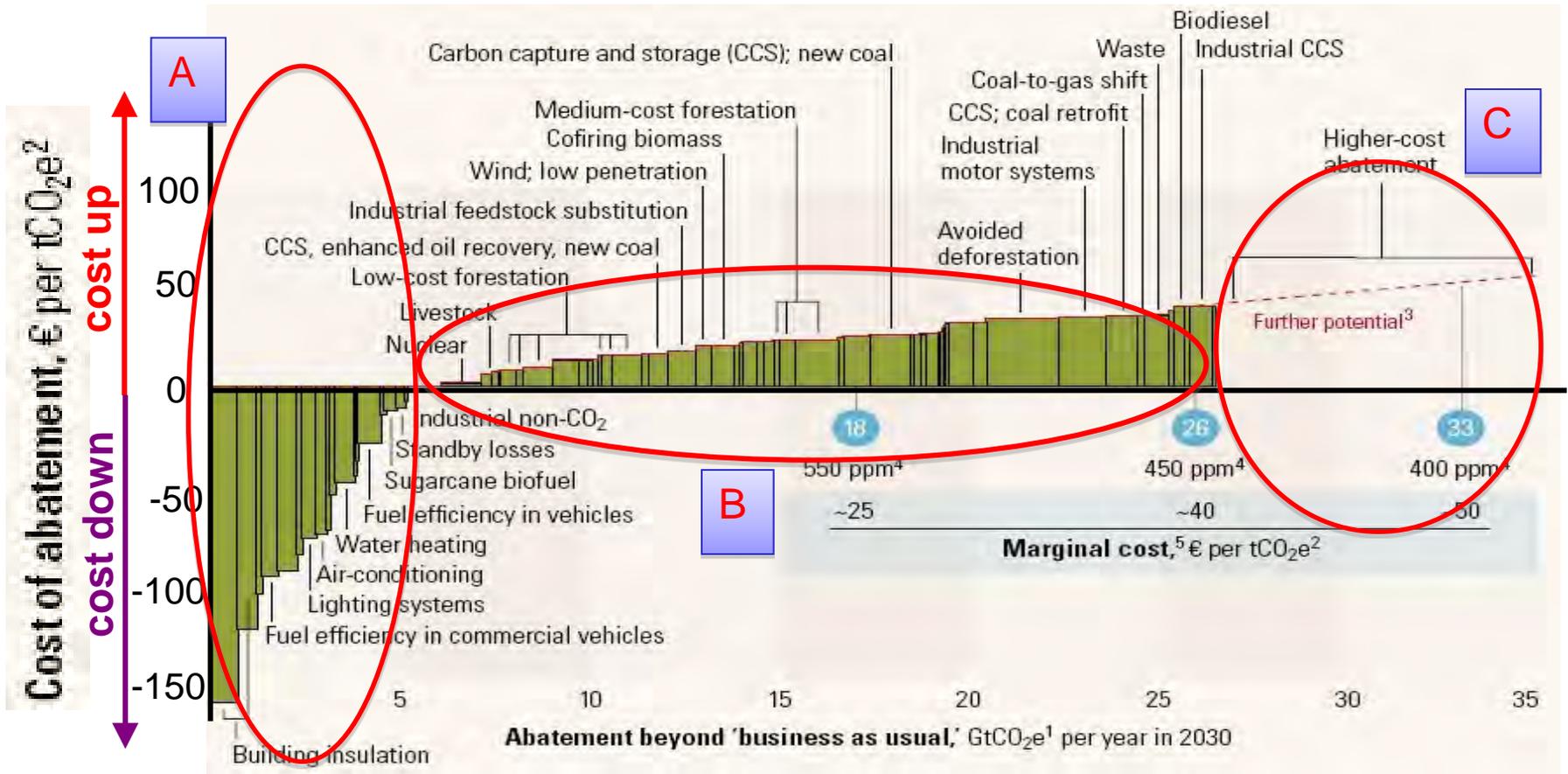


*Without further action, nuclear deployment in 2025 will be below levels in the 2DS, although a majority of key countries remain committed to nuclear.*

# Energy RD&D has slipped in priority



# How much can we reduce GHGs and how much do they cost? (Global, 2007)

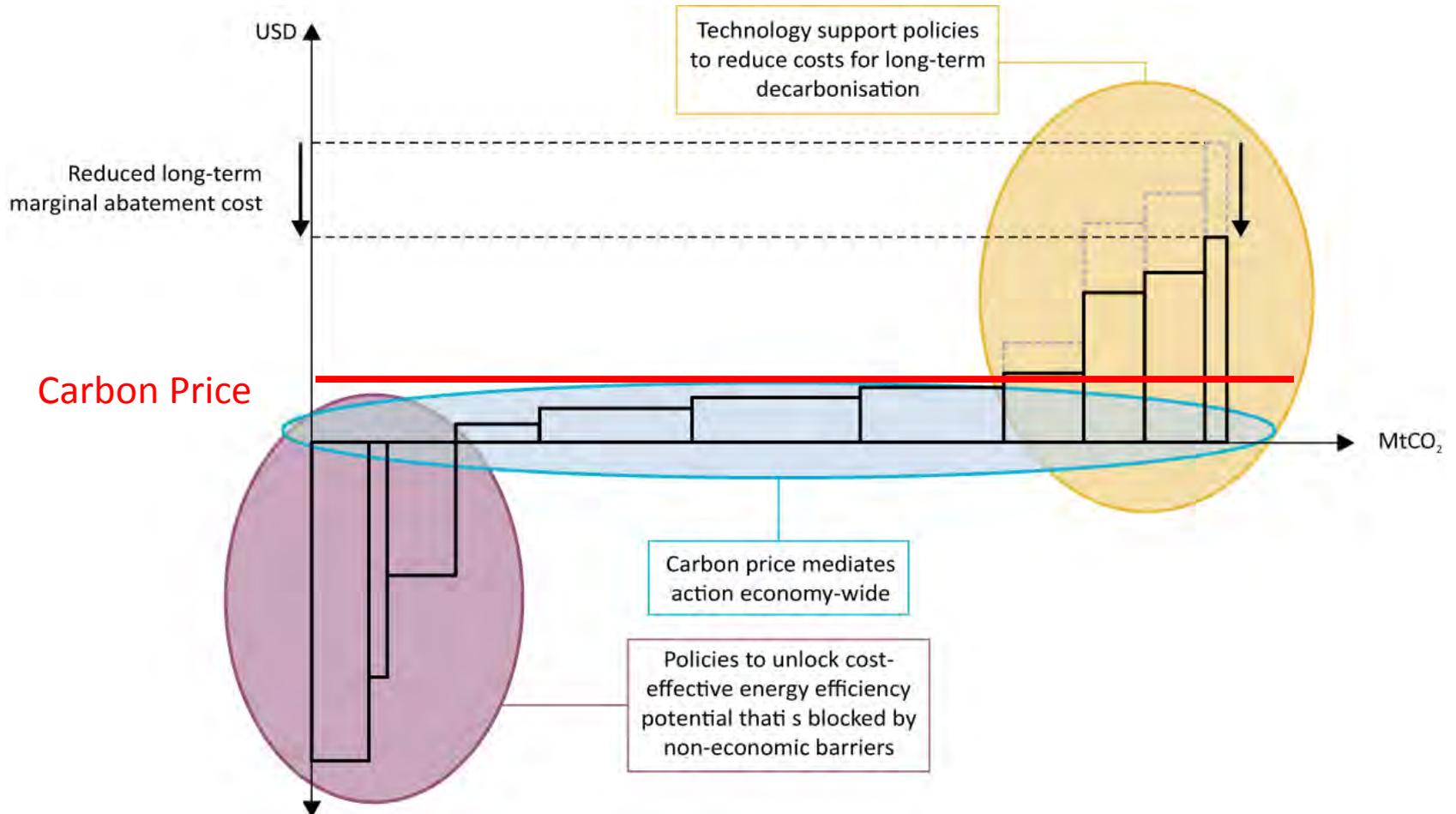


## Global cost curve for Greenhouse Gas Abatement

source: "A Cost Curve for Greenhouse Gas Reduction", The McKinsey Quarterly, 2007 No. 1



# The core policy mix



*Carbon price, energy efficiency policy and technology support are the backbone of a least-cost package to achieve 2DS.*