Utilization of Nuclear Power Plants comparison with other countries -Brief Implications for Japan-

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Outline

1. **Nuclear power**

    - As a technology for GHG abatement–

2. **Load Factor**

    - What is Load Factor of NPP? –

3. **Comparison**

    - Differences in each country –

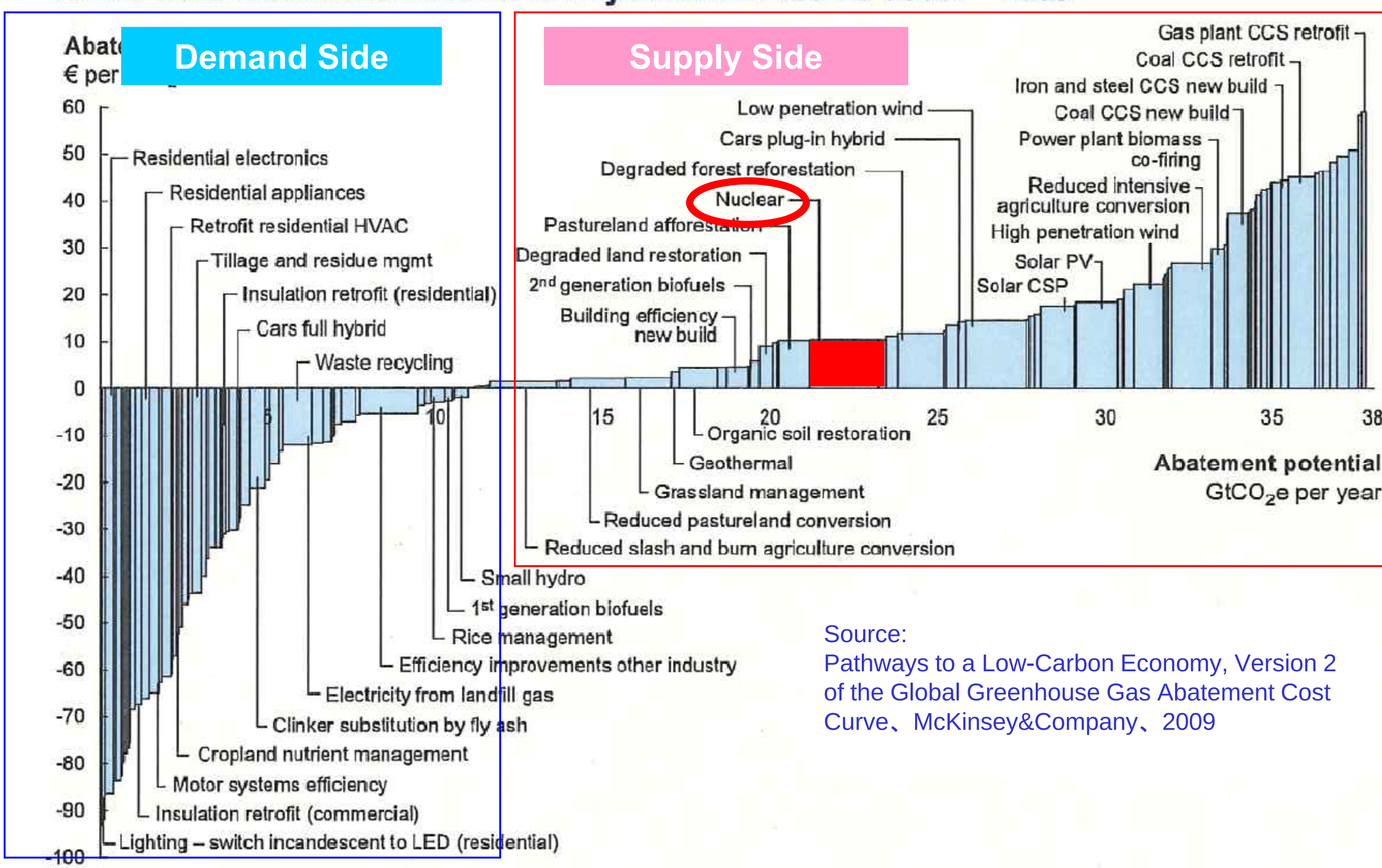
4. **Discussion**

    - What should Japan do? –

5. **Conclusion**

1. Marginal GHG abatement cost curve

Global GHG abatement cost curve beyond business-as-usual – 2030

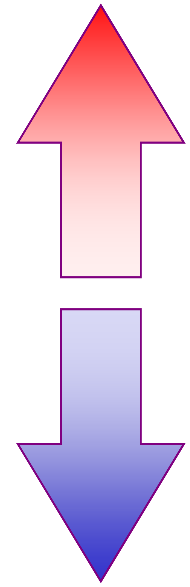


Note: The curve presents an estimate of the maximum potential of all technical GHG abatement measures below €60 per tCO_2e if each lever was pursued aggressively. It is not a forecast of what role different abatement measures and technologies will play.
Source: Global GHG Abatement Cost Curve v2.0

Source:
Pathways to a Low-Carbon Economy, Version 2 of the Global Greenhouse Gas Abatement Cost Curve、McKinsey&Company、2009

To reduce GHG

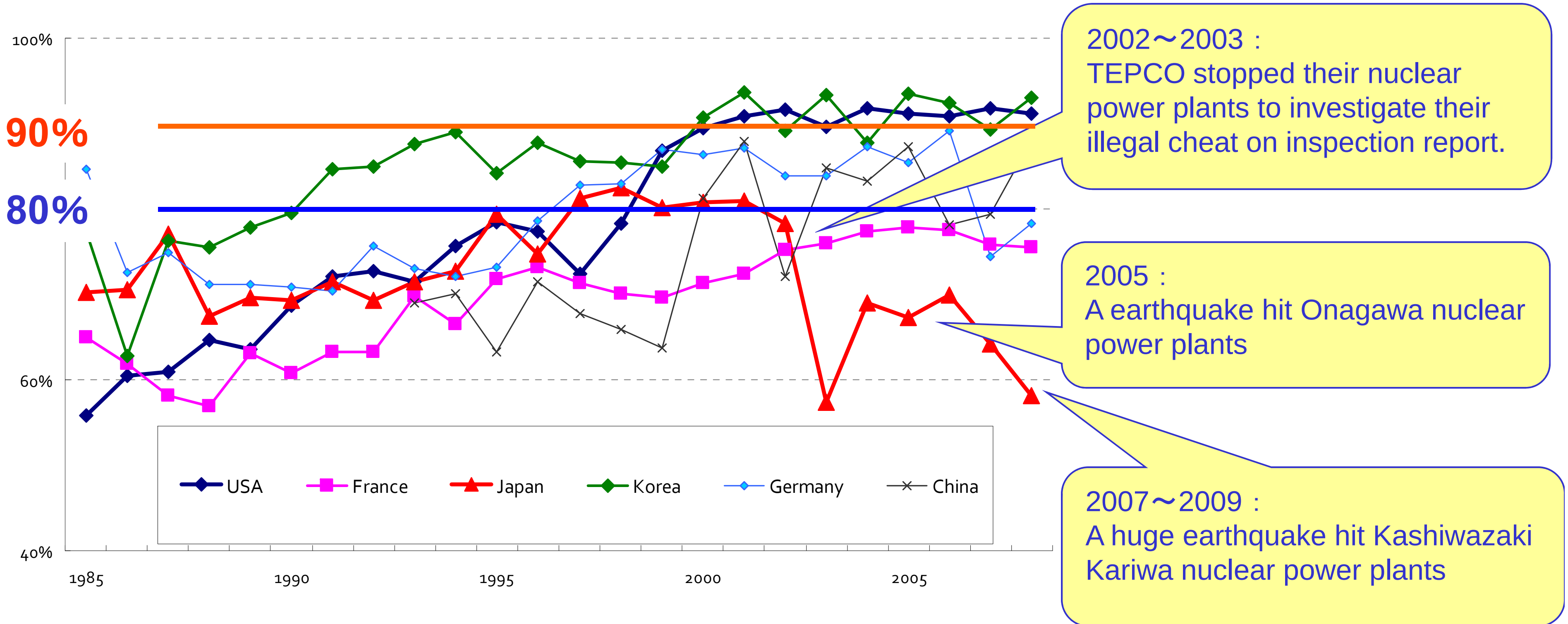
High Cost



Low Cost (Negative Cost)

- **Nuclear power is a relative low GHG abatement cost technology in supply side technologies.**
- **Nuclear power has large GHG reduction potential.**

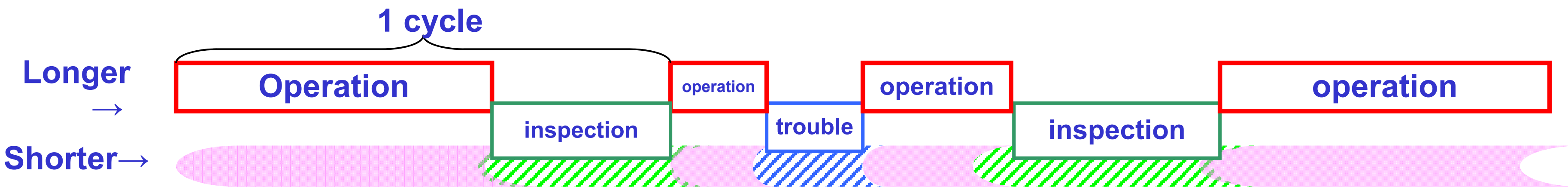
2-1 Load Factor of NPP



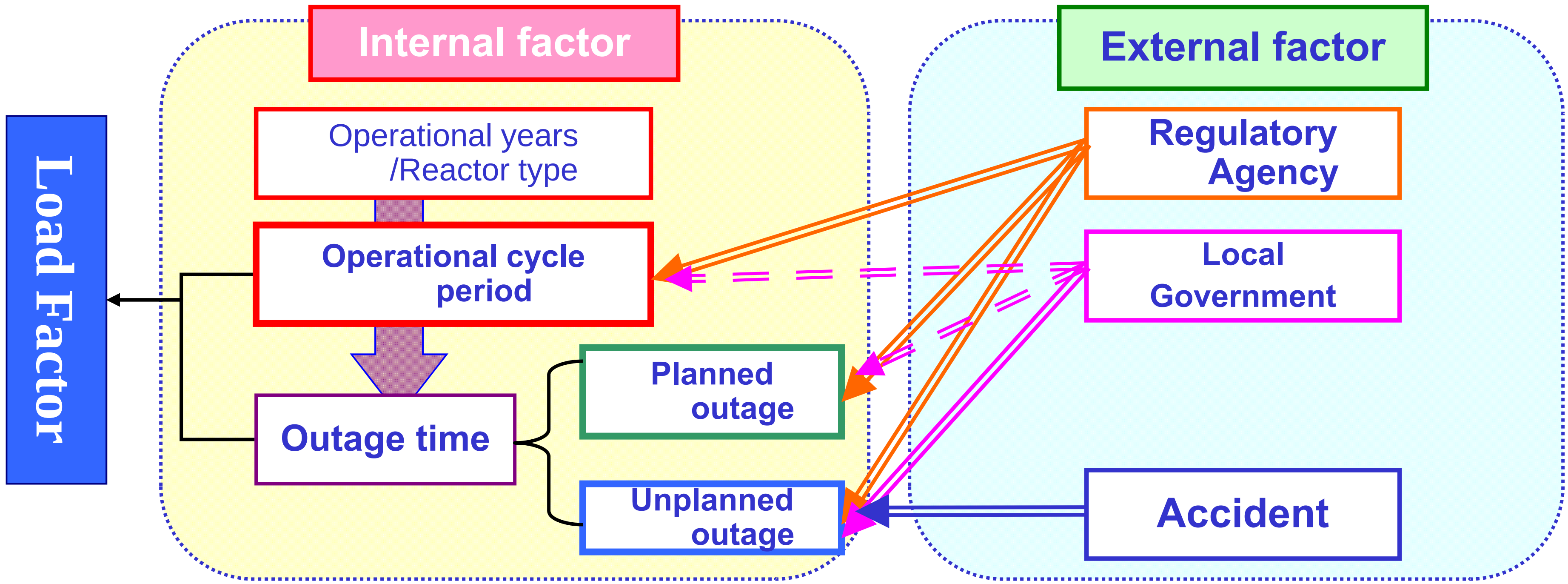
Source: IAEA, Power Reactor Information System (PRIS), the International Atomic Energy Agency, 2009

- **USA and Korea have been increasing load factor of NPP in each country, because they made many efforts to make the best use of NPP.**
- **The load factor of NPP in Japan used to be on a up trend, but it dropped in 2003. After that, some earthquakes hit NPP in 2005 and 2007.**

2-2 Analysis of “Causes of low operating performance”

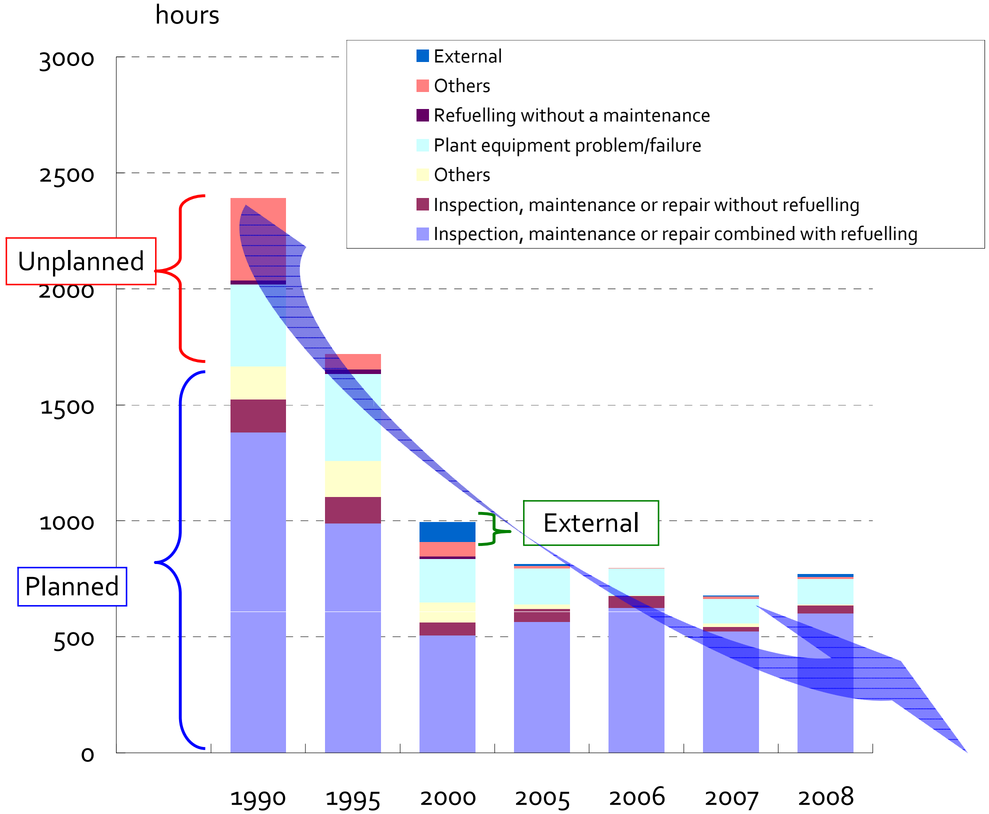


(Source: Atomic Energy Commission, Japan)



- We analyzed the following factors. **“Operational cycle period”, ”Planned outage”,“Unplanned outage”**

3-1 USA “Outage hours by causes”

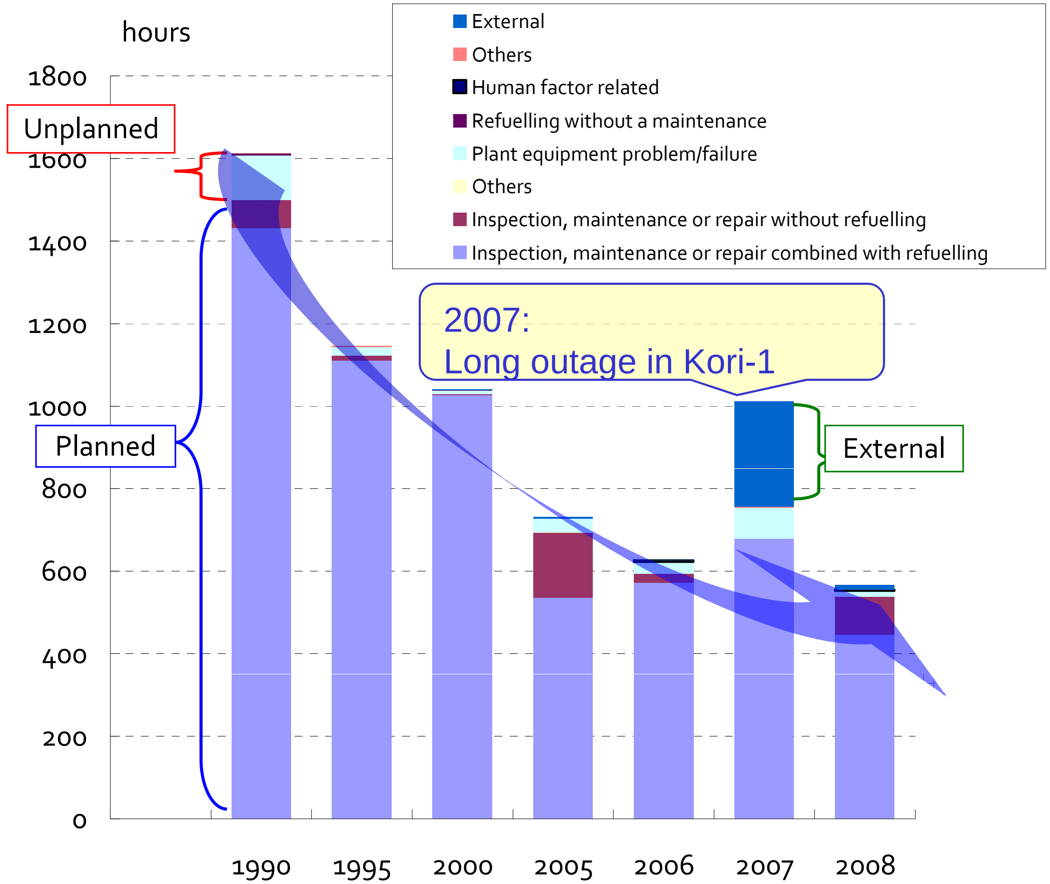


- ✧ The average outage time, both the planned and unplanned, have been decreasing.
- ✧ The frequency of events have been also decreasing.

- ✧ **Preventive maintenance during Operation (PMO)**
- ✧ **Longer cycle period have contributed to this higher performance.**

- **Periodic inspection, the longer operational cycle period and the planned outage time has been decreasing.**
- **Decreasing frequency of unplanned shutdown and the outage time in case of unplanned events**

3-2 South Korea "Outage hours by causes"

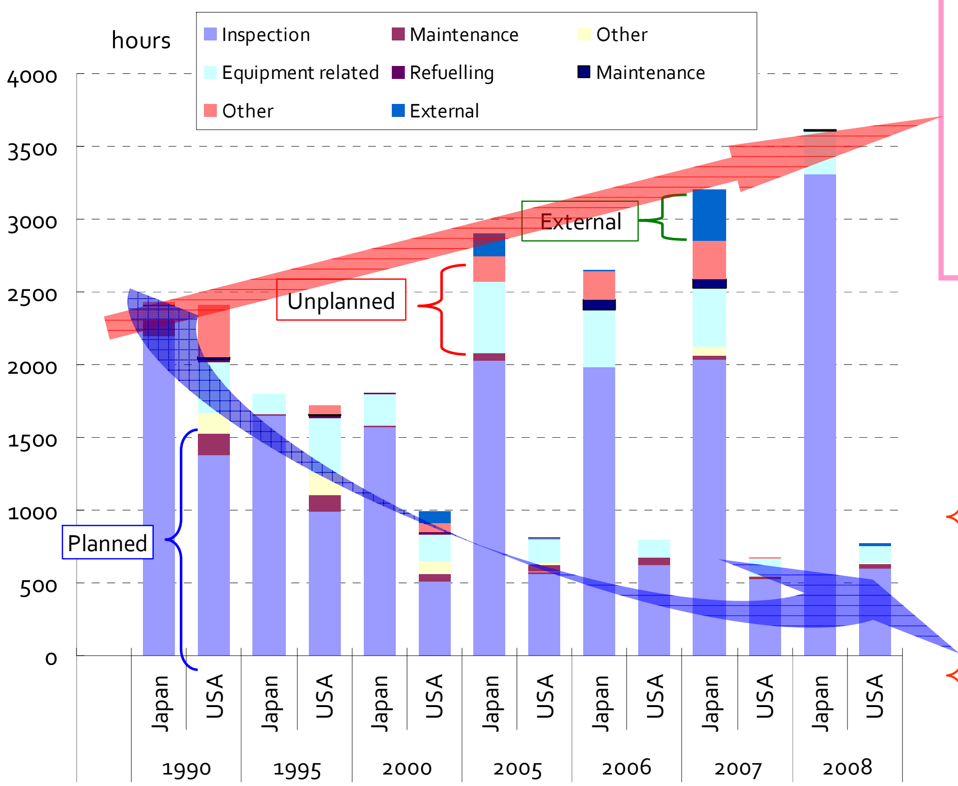


- ✧ The outage time has been decreased by half between 1990 to 2006.
- ✧ The planned outage time has been remarkably shortened as well as the unplanned outage time.

- ✧ **Having target, "One cycle trouble free"**
- ✧ **Standard template for periodic inspection**

- ☐ **Many lessons learned since the introduction of nuclear power,**
- ☐ **Various methods to shorten the outage period for maintenance, and efforts to enhance the reliability**

3-3 Comparison with Japan and USA



- ✧ The planned outage time has extended since 2000.
- ✧ Unplanned outage time has also been longer.
- ✧ Total outage time is three times as long as that of USA.

- ✧ **Renewal of inspectional regulation in 2003 extended planned outage time.**
- ✧ **In addition, outage time was much longer due to earthquake in 2007.**

- ☐ **We must clarify the causes of long outage and actions to shorten outage time into three parts.**
- ☐ **"Periodic inspection time", "Unplanned outage time" and "Operational cycle period"**

3-4 Results of comparison -causes and actions-

○Periodic inspection time

– Causes : Long inspection and many check points.
– Action : Rationalization check points and work procedure

○Unplanned outage time

– Causes : Many steps toward restart (=> next slide)
– Action : Simplification of restart process

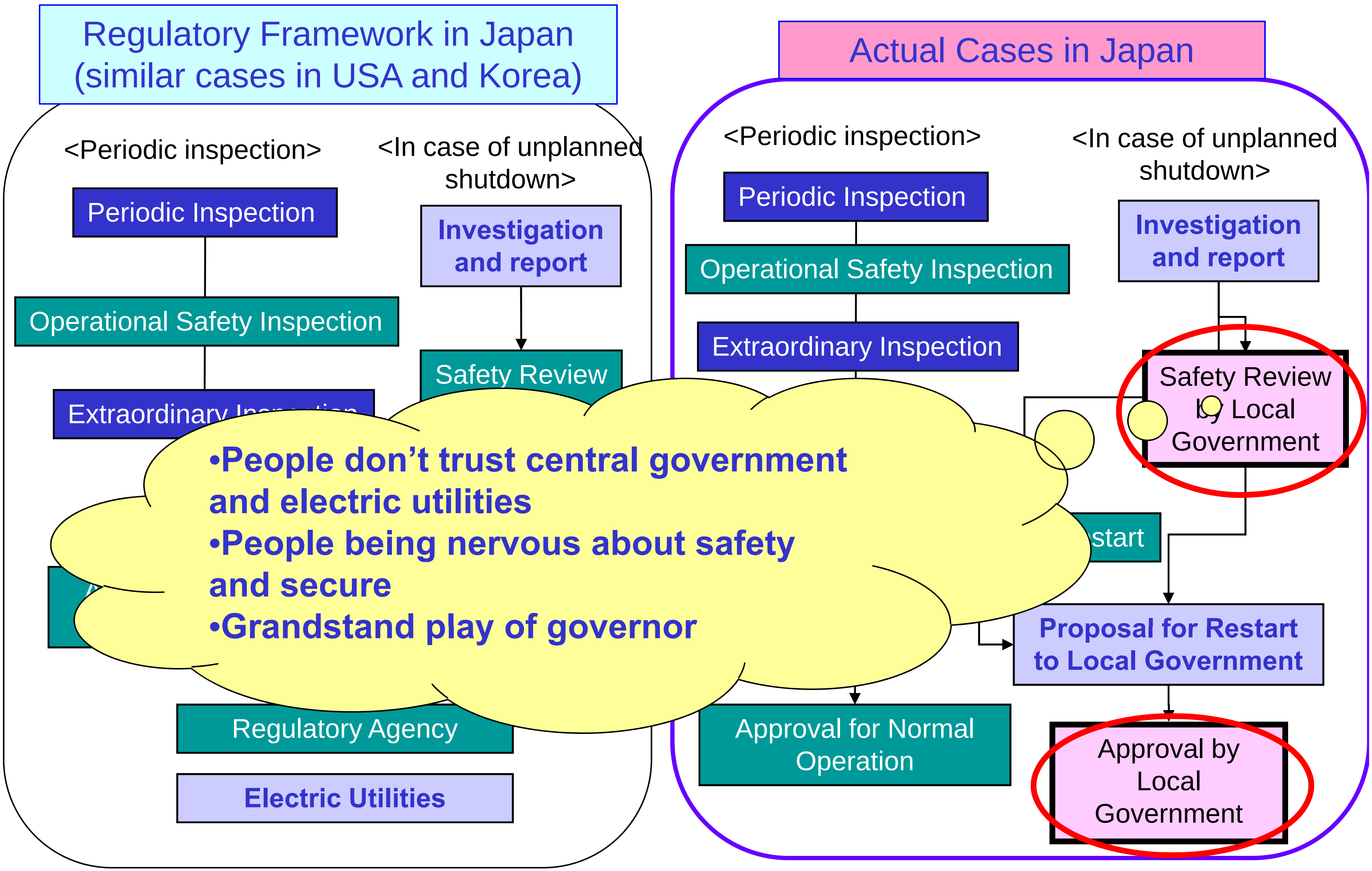
○Operational cycle period

– Causes : Shorter cycle period than other advanced countries'
– Action : Extension of cycle period

We need

Many countermeasures to shorten outage time and improve load factor from both technical and political aspects.

3-5 Procedure for Restarting after Planned / Unplanned Shutdown



4. Discussion

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Technological

Challenges

- Cut extra check points in periodic inspection
- Shorten working time
- Keep safety in extended continuous operation cycle

Countermeasures

- Advanced risk analysis
- Best practice along with standard template
- Analysis of fuel property in long continuous operation

Institutional

Challenges

- Cut extra check points in periodic inspection
- Rationalize restart procedure
- Keep transparency of decision making process

Countermeasures

- Advanced risk analysis
- Unification of regulatory agency
- Closer communication

Considering the safety of NPP,

we must review each process and regulation from the point view of the international standard and rationalization.

5. Conclusions

- **Comparison with the other countries – US and South Korea etc**
  - Load factor in many countries have improved.
  - We need any countermeasures in Japan.

- **Steady and concrete actions would be required**
  - We must learn from good examples of other countries and consider :
  - "Shortening the outage time based on the rational analysis", "Extension of operational cycle period"

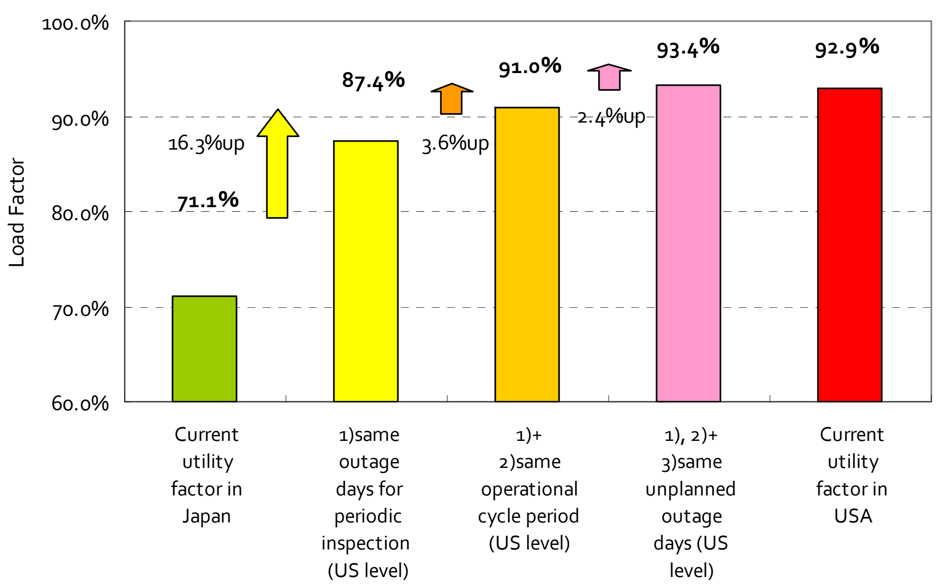
- **Public acceptance**
  - Consider the difference of public attitude toward the safety and security of nuclear energy.
  - The load factor will not reach the technically achievable level unless considering public understanding and social aspect of nuclear energy.

2-3(2) Analysis of the difference between USA and Japan

- There are 3 different indices in the USA and in Japan: Periodic inspection period, Operational Cycle Period, and the outage days per unplanned shutdown.

	Cycle Period (A)	Periodic Inspection Period (B)	Outage days per unplanned shutdown (C)	Unplanned shutdown per year
US	570	38	4.7	1.2
Japan	390	140	34	0.54

- If Japan could achieve the same levels in these 3 indices, over 90% of the CF would be attained.



Source: the 22nd Nuclear Energy Committee, March 2010, METI

2-2(2) South Korea "Action"

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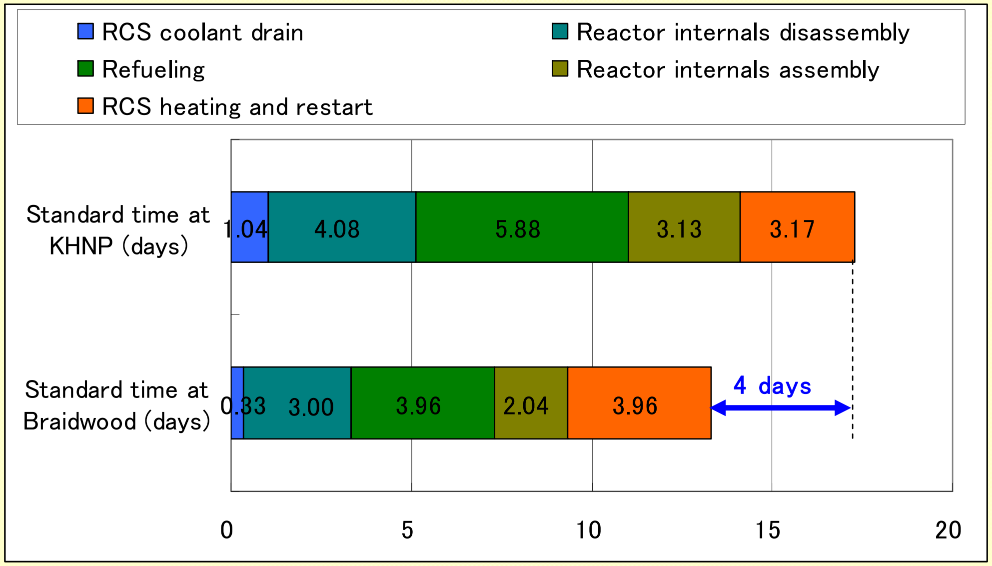
- **Policy for the action to improve load factor**
  – **"Upgrading technology of maintenance and operation", Refining instruments", "Development of managing process"**

Tangible actions

- Using "Standard template" that can show working hours in each process
- Optimization of long term periodic inspection by decade
- Ambitious target in 2014 "Load factor : 94%, Outage : 0.2 times/plant"

Analysis of outage time and working hours using a standard template



Source: JAIF HP

- **S. Korea analyzed some model cases in USA, made comparison to those of themselves and took some findings and implications to be adapted to their operation and maintenance work planning.**

2-3　日本の今後の取組みに対する示唆

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○定期検査期間の短縮

- 韓国のテンプレート分析のように**作業項目の工程表をつき合わせ、**分析していく事が必要
- 各定検工程の短縮のための**運転中予防保全活動（PMO）の検討**などが期待される

○計画外停止期間の短縮

- 計画外停止からの**早期復帰も技術的には不可能ではない**と推測される
- 安全性に問題ない事を確認後、**まず発電所を立ち上げて**、その後再発防止のために根本的な原因を詳細に究明していくという姿勢学ぶべき点がある
- **復帰に関する技術的作業の効率化**を進めていくことが重要である

○運転サイクル期間の延長

- 2010年4月から規制上は最長で24ヶ月までの運転が可能となっており、これが**適用される範囲が拡大**していくことが期待される
- 数回の運転サイクルを想定した上で、高経年化対策等の作業を織り込み、国全体の運転サイクル、保全計画をマネジメントしていくことで、技術者や作業員のマンパワーの配分を国全体で把握し、より効率的に**限られた資源の最適配分**を図ることも重要

各種対策の実施にあたっては、安全性に十分配慮しつつ、必要なところは国際的・合理的観点から規制の見直しを進めることが必要