The Performance of TPC NPPs in 2011 and The Status for Taiwan's Stress Test upon EU's Specification

Taiwan Power Company
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Outline

1. The Performance of TPC's NPPs
2. Responses to Fukushima Accident in TPC's NPPs
-- Phase I : Assessment
-- Phase II : Stress Test
3. Summary

1. The Performance of TPC NPPs

CHINSHAN

(GE BWR-4 -- 636 MWe × 2)
Commercial in 1978, 1979

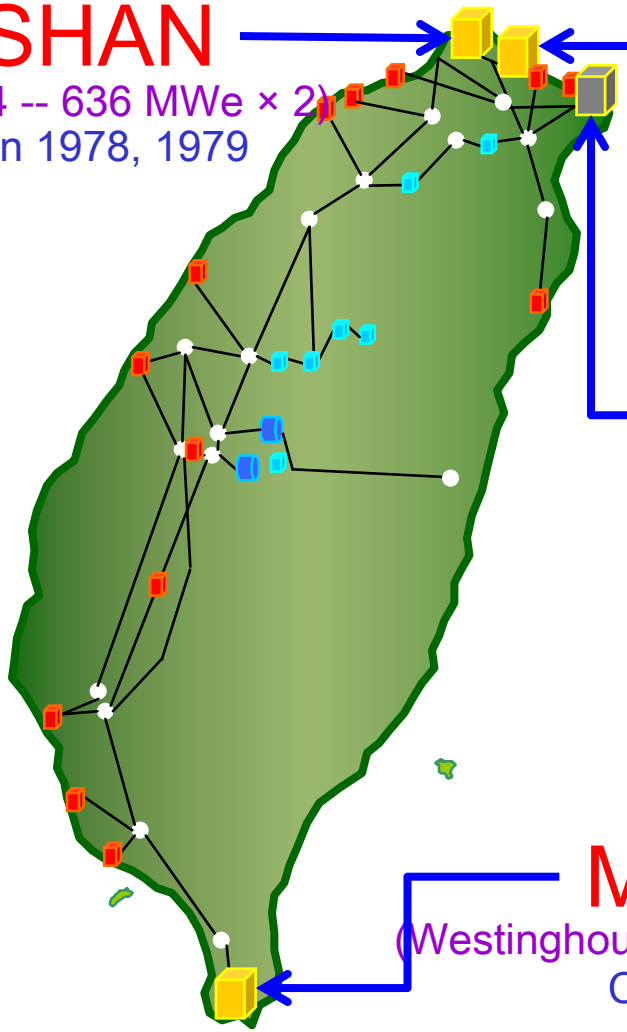
KUOSHENG

(GE BWR-6 -- 985 MWe × 2)
Commercial in 1981, 1983

N

LUNGMEN

(GE ABWR – 1350 MWe x 2)
under construction



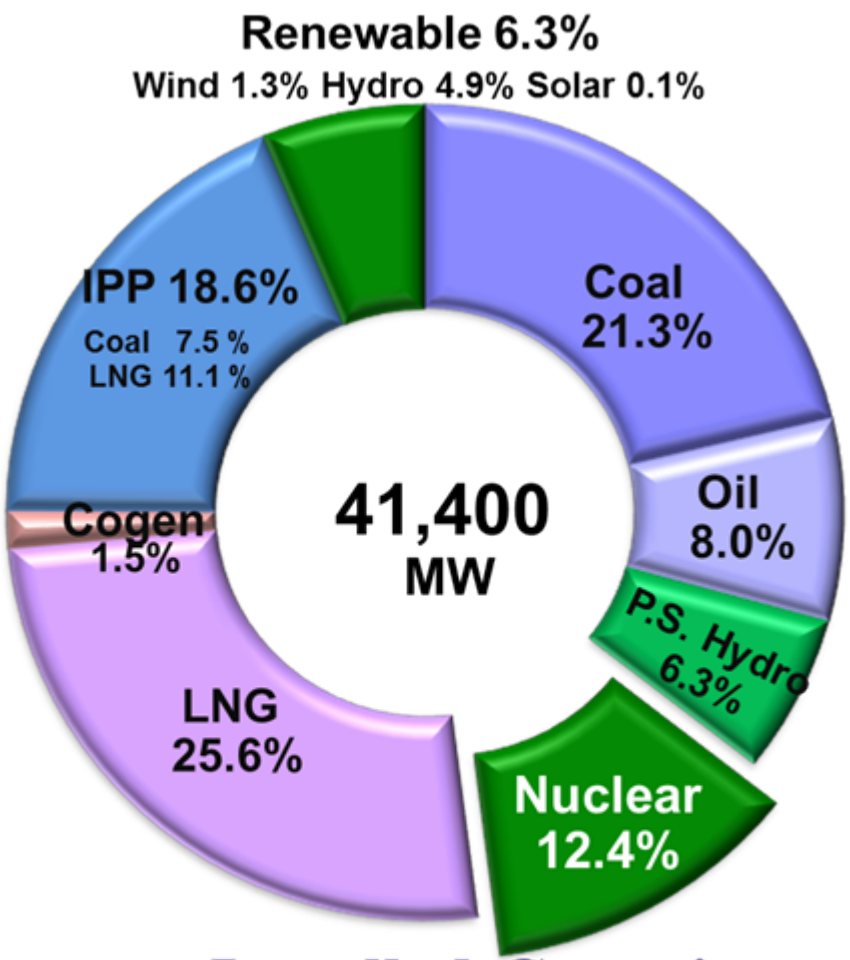
MAANSHAN

(Westinghouse PWR -- 951 MWe × 2)
Commercial in 1984, 1985

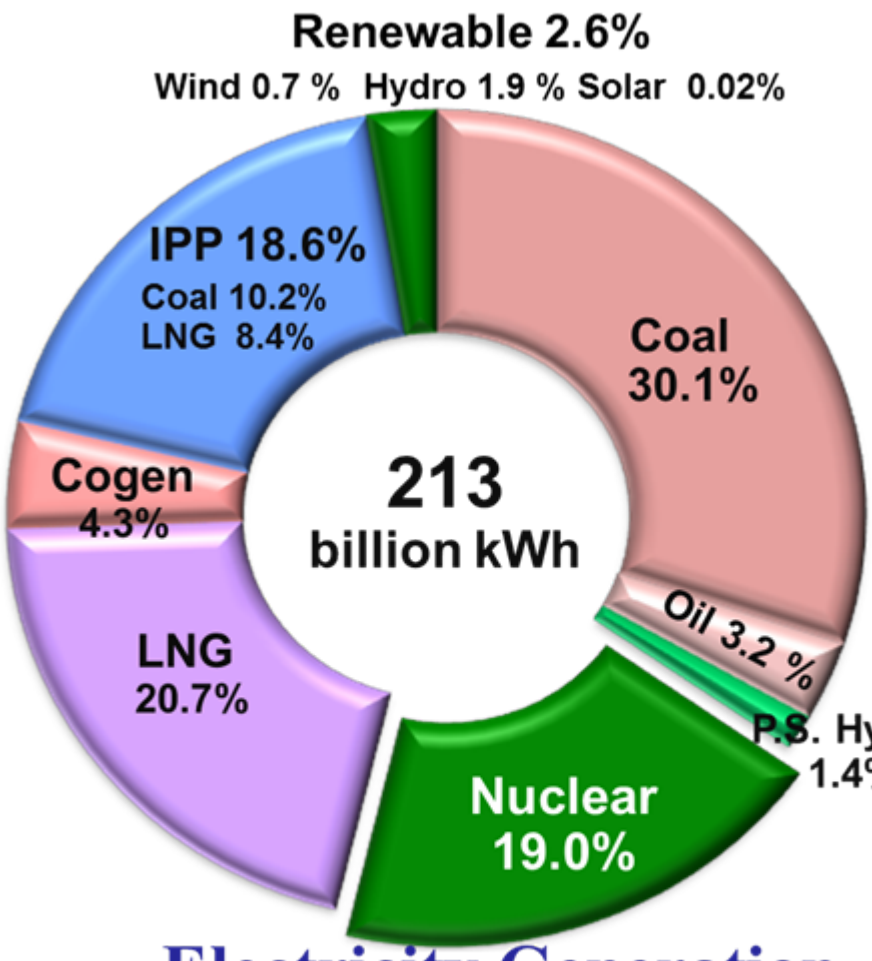
1. The Performance of TPC NPPs in 2011

- Nuclear Generation： 40.5 billion kWh
  (company's best record)
- Capacity Factor：93.06% (company's best record)
- Reactor Scram：0 (company's best record)

1. The Performance of TPC NPPs- Capacity & Gen

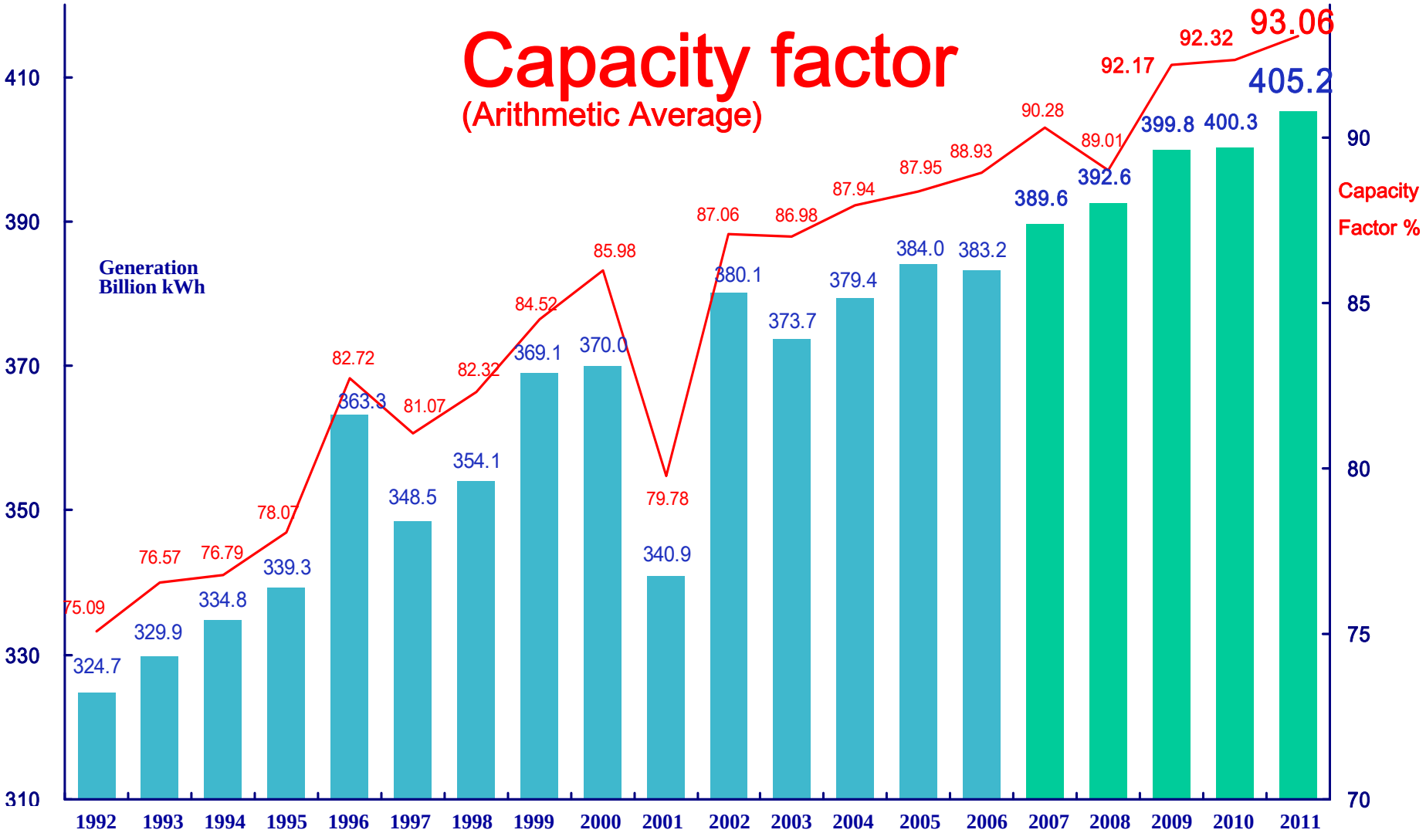


Installed Capacity In 2011

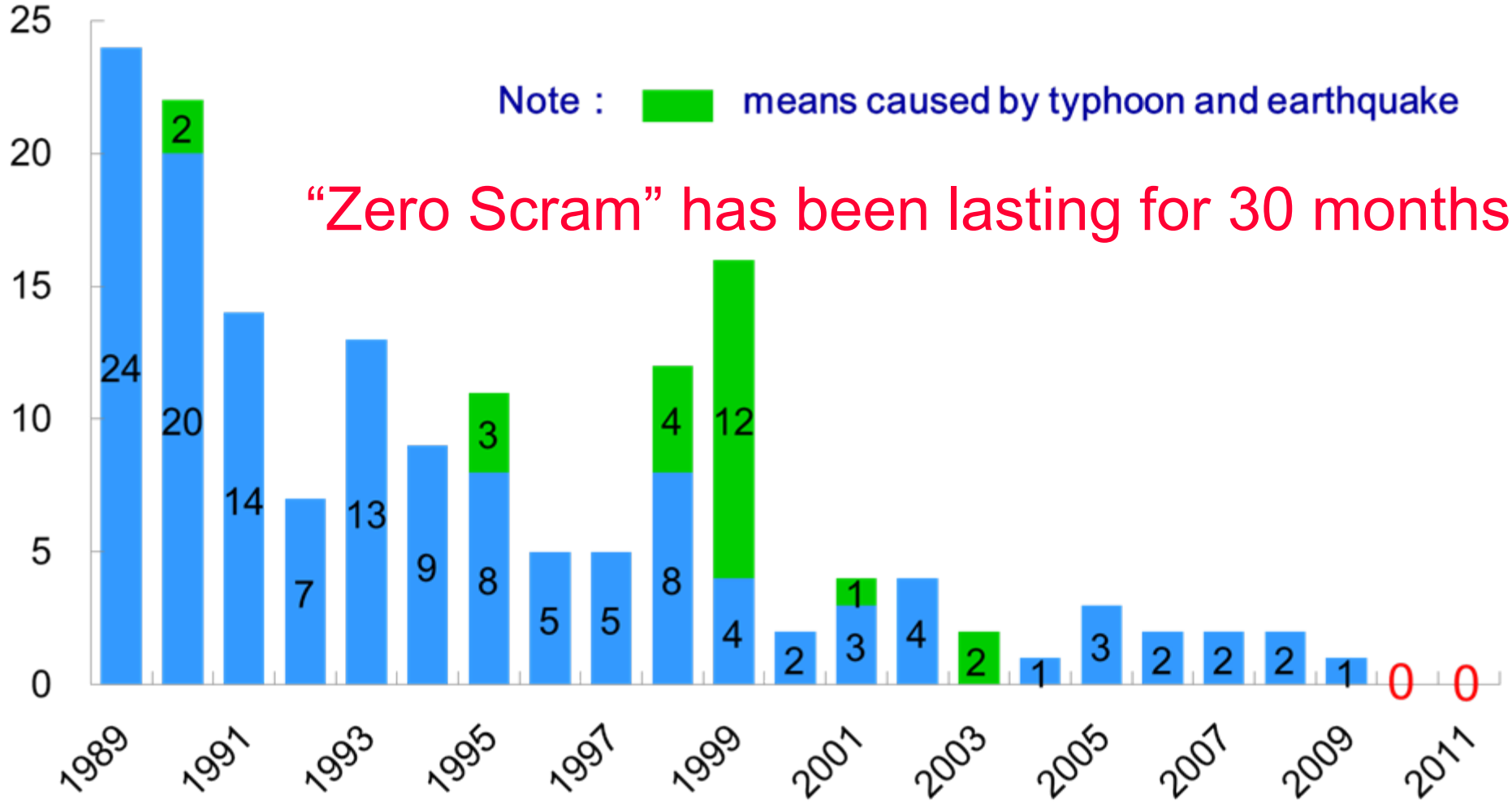


Electricity Generation In 2011

1. The Performance of TPC NPPs- Capacity factor



1. The Performance of TPC NPPs- Scram Record



2. Responses to Fukushima Accident
- Comprehensive Safety Assessments (CSA)

- *Carried out Comprehensive Safety Assessments (CSA):*

(1) In the light of the Fukushima accident, ROC President declared that "the comprehensive safety assessments in operation and construction NPPs shall be undertaken immediately" in 311 National Security Meeting.

(2) On the basis of proposals made by AEC in April 19, 2011, TPC plan out 2 Phase of CSA – Assessments and Stress Test

2. Responses to Fukushima Accident -CSA

- *Carried out Comprehensive Safety Assessments (CSA):*
- *Be divided into **two phases** – **Assessments** and **Stress Test**.*

(1) **Phase I:** Fully inspected/evaluated various aspects including site selection , design basis, maintenance and operation, accident management, and worked out response programs to reinforce the capabilities of prevention and mitigation of Beyond Design Basis Accident *.(CSA report)*

(2) **Phase II** : Identify the robustness of design and recognize cliff-edge effect and hidden weakness. Refer to EU Stress Test specification and adopt PRA methodology to recognize the cliff edge and verify the effectiveness of countermeasure developed in Phase I*.(EU's Stress Test)*

2. Responses to Fukushima Accident-CSA

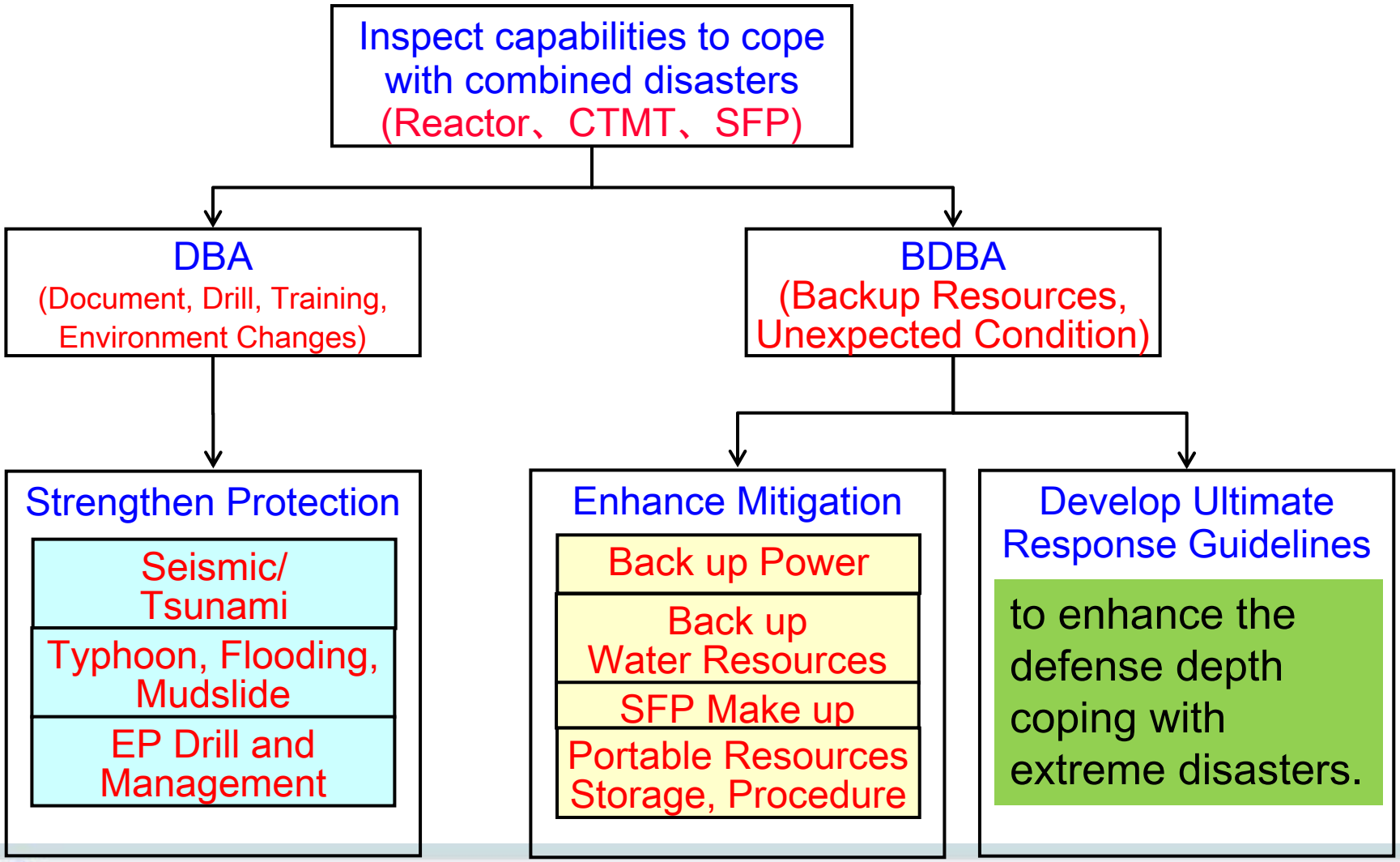
- *Carried out Comprehensive Safety Assessments (CSA):*

  - *Schedule 2-Phase of CSA*

Phase	Plan	NPPs	Schedule
1	Assessments(11 items, Seismic Review and Tsunami Review) -(CSA Report)	Plants in Operation	March ~ June , 2011 (completed)
		Lungmen	May ~ December , 2011 (completed)
2	Stress Test (refer to EU stress test spec.)-(Stress Test Report)	Plants in Operation	July , 2011~February , 2012 (completed)
		Lungmen	January ~April , 2012 (completed)

2. Response to Fukushima Accident-CSA

- *Techniques of CSA-Phase I*



2. Response to Fukushima Accident-CSA

- According to the results of CSA, 96 key improvement items for operating plants and 67 items for Lungmen site have been developed.

- Classified all items under 4 functions ：

1.Enhance earthquake-resistant capabilities

2.Enhance tsunami/flooding-protection capabilities

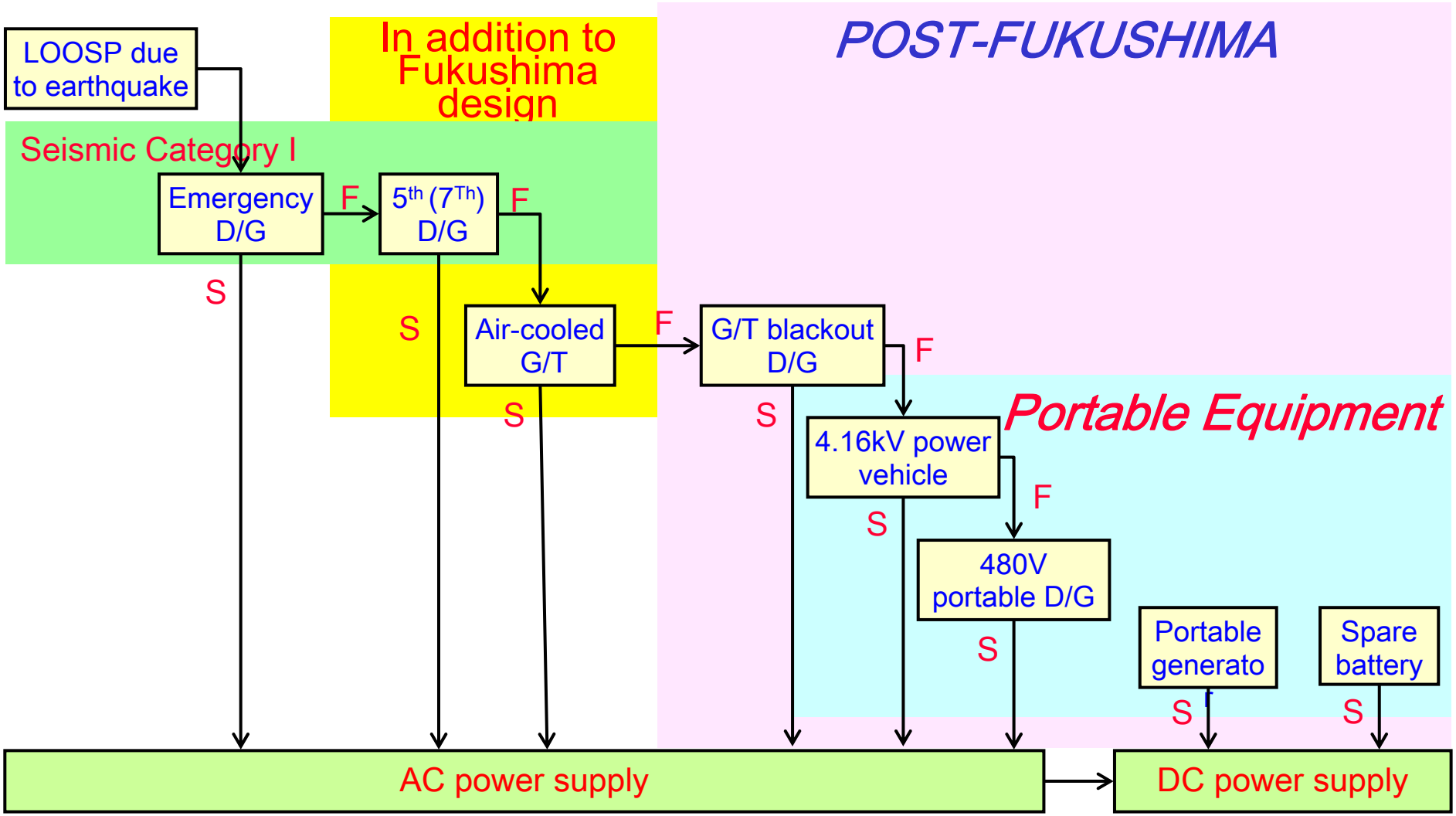
3.Enhance mitigation resources

- Backup power supply
- Water resources and injection
- Spent fuel pool cooling
- Resources preparedness

4.New authored Ultimate Response Guidelines (URG)

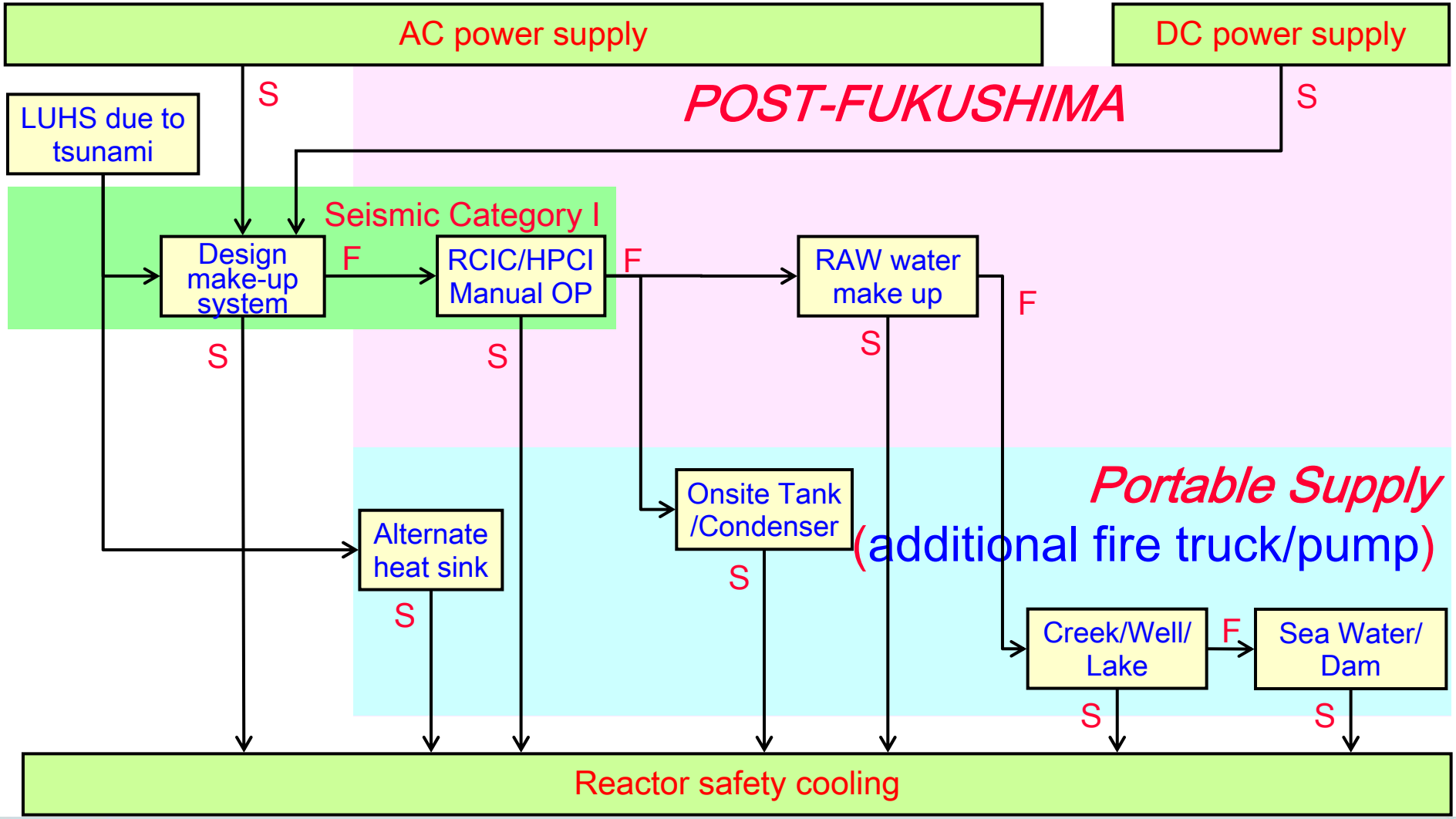
2. Response to Fukushima Accident-CSA

Enhance mitigation resources – Electric power source



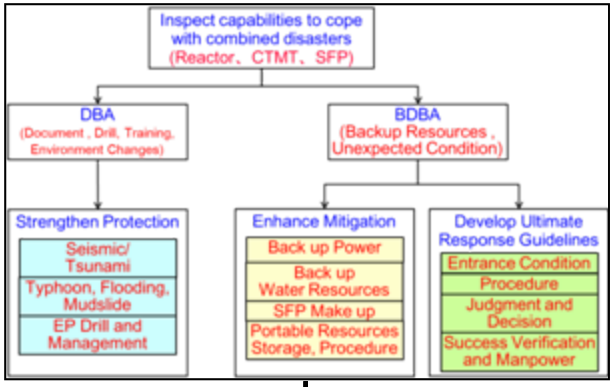
2. Response to Fukushima Accident-CSA

Enhance mitigation resources – Diversify water resources



2. Responses to Fukushima Accident-Stress Test

Techniques of CSA-Phase II



Phase I：Inspect capabilities to cope with combined disasters

PRA SSC Seismic Margin

Phase II：Stress Test (Follow EU)

Building Openings and Equipment Elevation

PRA Seismic Event Tree

PRA Tsunami Event Tree

+

+

General data about site/plant

Earthquake (Including DBE+DBF)

Flooding (Including Tsunami)

Extreme natural hazards

Loss of electrical power and loss of ultimate heat sink

Severe accident management

2. Responses to Fukushima Accident-Stress Test

◆ Phase II : Stress Test

The Action to Verify the Safety Margin Against Natural Hazards

(1) According to EU Stress Test Specification, Implementing Stress Test in TPC NPPs to inspect defense in depth and safety margins and identify Cliff-edge Effect and effectiveness of countermeasures developed in CSA-Phase I.

(2) Initiating events

- Earthquake
- Flooding

(3) Consequence of loss of safety functions from any initiating event conceivable at the plant site

- Loss of electrical power, including station black out (SBO)
- Loss of the ultimate heat sink (UHS)
- Combination of both

2. Responses to Fukushima Accident-Stress Test

◆ Phase II : Stress Test

(4) Severe accident management issues

- Means to protect from and to manage loss of core cooling function
- Means to protect from and to manage loss of cooling function in SPF
- Means to protect from and to manage loss of containment integrity

(5) Assessment of Safety Margins

- Specify the event tree leading to significant damage to fuel based on findings from probabilistic risk assessments (PSA)
- Identify scenarios leading to significant damage to fuel, using results of assessment of safety margins in structures, systems and components as input conditions to decide the path the event tree deterministically
- Specify the Cliff Edge in the identified scenarios

Event Tress

2. Responses to Fukushima Accident-Stress Test

◆ Phase II : Stress Test

(6) Cliff Edge

To evaluate cliff edge effect to know potential week points of nuclear power plants, and confirm effectiveness of countermeasures preventing a severe accident in light of defense in depth approach

(7) Progress

- NPPs in Operation：Completed in February, 2012.
- Lungmen：Completed in April, 2012.

Result – Identifying Cliff-edge Effect and confirming effectiveness of countermeasures developed in CSA-Phase I.

Initiation Event: : Earthquake

Plant	Design Basis	Cliff-edge as original design
CS	0.3g	1.05g (core support structure)
KS	0.4g	0.77g (RCIC DC Switchgear)
MS	0.4g	1.48g (DC Bus Switchgear)

Initiation Event: : Tsunami

Plant	Design Basis	Cliff-edge as original design	Cliff-edge with countermeasure
CS	10.73 run up(m)	11.2 m (RCIC)	12.20 m (installation gate with 1 meter height is under consideration)
KS	10.28 run up(m)	12.30 m (RCIC)	13.30 m (installation gate with 1 meter height is under consideration)
MS	12.03 run up(m)	15 m (DC Bus)	16.0 m (installation gate with 1 meter height is under consideration)

Initiation Event: : Station black out

Plant	Design Basis	Cliff-edge as original design	Countermeasure for Cliff-edge
CS	8 hours	24 hours (isolate non-vital DC load)	With portable D/G
KS	8 hours	24 hours (isolate non-vital DC load)	With portable
MS	8 hours	8 hours (isolate non-vital DC load)	With portable D/G

Initiation Event: : Loss of ultimate heat sink

Plant	Design Basis	Cliff-edge as original design	Countermeasure for Cliff-edge
CS	8 hours	40 hours (CST storage capacity)	With fresh water from reservoir(There is no limitation for water supplying from creek or sea)
KS	8 hours	24 hours (CST storage capacity)	With fresh water from reservoir(There is no limitation for water supplying from creek or sea)
MS	8 hours	40 hours (CST storage capacity)	With fresh water from reservoir(There is no limitation for water supplying from creek or sea)

3. Summary

1. Taipower NPPs' performance keep hitting the new record high.

2. Action items after 311 earthquake include:

- Launch comprehensive safety assessments.
- Multiplied and diversified emergency power and water suppliers.
- Newly authored "Ultimate Response Guidelines" against Beyond Design Basis Accident.

3.Refer to European practices; impose "Stress Test" on NPP and identify Cliff-edge Effect and effectiveness of countermeasures developed in CSA-Phase I.

Thank you for your attention

Lungmen NPP Seismic Event Tree