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# Outlook and Challenges for Nuclear Power Generation in 2019

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# Points of the report

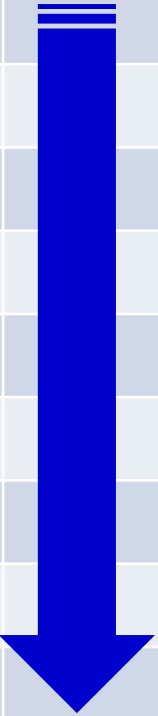
- ✓ As of December 2018, nine nuclear power plants have been restarted in Japan, six plants have been given safety design or lifetime extension approval, and 10 plants are under safety review.
- ✓ For such reasons as massive investment in safety enhancing measures, decisions have been made to decommission 10 nuclear power plants (excluding Units 1 to 6 of the Fukushima Daiichi Nuclear Power Station and Units 1 to 4 of the Fukushima Daini Nuclear Power Station).
- ✓ The time has come for making decisions on the fate of six nuclear power plants that are at least 30 years old and have yet to be subjected to applications for safety review.
- ✓ Not only nuclear power plant operators but also regulators are required to make careful explanations to restore public trust in nuclear plants.
- ✓ The presence of Russia and China is remarkable in the international nuclear market.
- ✓ As for small modular reactor (SMR) development that has attracted attention in developed countries over recent years, a future challenge is the regulatory readiness to secure the predictability for business operators.

# 1. Status of safety examination (December 2018)

## (1) 9 plants restarted

### TOP Group: 9

Unit	Application	Restart	Lead time (days)
Sendai Unit 1	7/8/2013	8/14/2015	767
Sendai Unit 2	7/8/2013	10/21/2015	835
Ikata Unit 3	7/8/2013	8/15/2016	1134
Takahama Unit 3	7/8/2013	6/9/2017	1442
Takahama Unit 4	7/8/2013	5/22/2/17	1414
Ohi Unit 3	7/8/2013	3/16/2018	1712
Ohi Unit 4	7/8/2013	5/11/2018	1768
Genkai Unit 3	7/12/2013	4/18/2018	1741
Genkai Unit 4	7/12/2013	6/19/2018	1803



# 1. Status of safety examination (December 2018)

## (2) 6 plants given safety design/lifetime extension approval

### 2nd Group: 6

Unit	Application	Safety design approval	Lead time (days)	Number of hearing from operators* (from April 2018)
Kashiwazaki-Kariwa Units 6/7	9/27/2013	12/27/2017	1,552	646(0)

Unit	Lifetime extension application	Lifetime extension approval	Lead time (days)	Number of hearings from operators
Takahama Units 1/2	3/17/2015	6/20/2016	461	233
Mihama Unit 3	3/17/2015	11/16/2016	610	201
Tokai Daini	11/24/2017	11/7/2018	348	1,322

\* Hearings from operators:

Hearings from operators are meetings between Nuclear Regulation Authority officials and business operators on technical matters and preparations before examination meetings in which NRA commissioners participate.

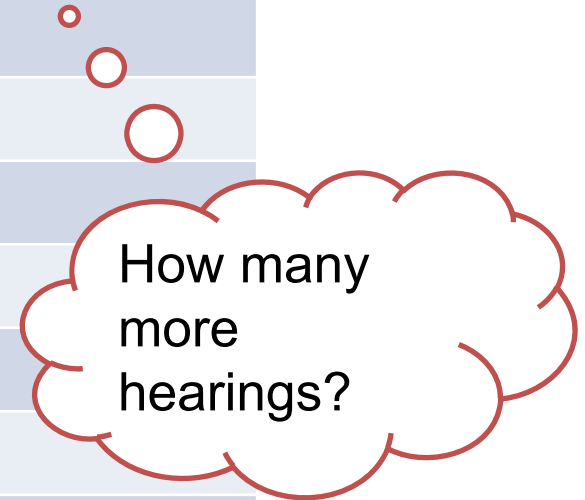
6+9=15

# 1. Status of safety examination (December 2018)

## (3) 10 plants under review

### 3rd Group: 10

Unit	Application	Number of hearings from operators (From September 2018)
Tomari Unit 3	7/8/2013	375(1)
Shimane Unit 2*	12/25/2013	190(0)
Onagawa Unit 2*	12/27/2013	327(16)
Hamaoka Unit 4	2/14/2014	187(0)
Higashidori Unit 1	6/10/2014	-
Tomari Units 1/2	7/8/2013	51(1)
Shika Unit 2	8/12/2014	-
Hamaoka Unit 3	6/16/2015	-
Tsuruga Unit 2	11/5/2015	-
Ohma (new)	12/16/2014	-
Shimane Unit 3 (new)	8/10/2018	-



$$15+10=25$$

\* The design basis ground motion has been fixed for Shimane Unit 2 and Onagawa Unit 2.

## 2. Prospects

### (1) Costs for safety measures to meet new regulatory standards

- As of April 2018, costs for additional safety measures were estimated at some JPY4.4 trillion for 35 plants (34 GW), based on media and other reports.
- Costs for safety measures may increase depending on future safety examination conditions.

The final investment amount remains uncertain. The estimate may vary depending on conditions.

Electric power company	Site	Capacity (GW)	Safety measure costs (JPY1 billion)
Hokkaido	Tomari	2.07	200
Tohoku	Higashidori/Onagawa	3.27	300
Japan Atomic Power	Tokai Daini	1010	174
Tokyo	Kashiwazaki-Kariwa	8.21	680
Chubu	Hamaoka	3.62	400
Hokuriku	Shika	1.75	200
Kansai	Ohi/Mihama/Takahama	6.58	830
Chugoku	Shimane	2.20	500
Shikoku	Ikata	0.89	190
Kyushu	Genkai/Sendai	4.70	900
<b>Total</b>		<b>34.39</b>	<b>4374</b>

Sources)  
Estimated and prepared from media reports, company press reports, etc.

## 2. Prospects

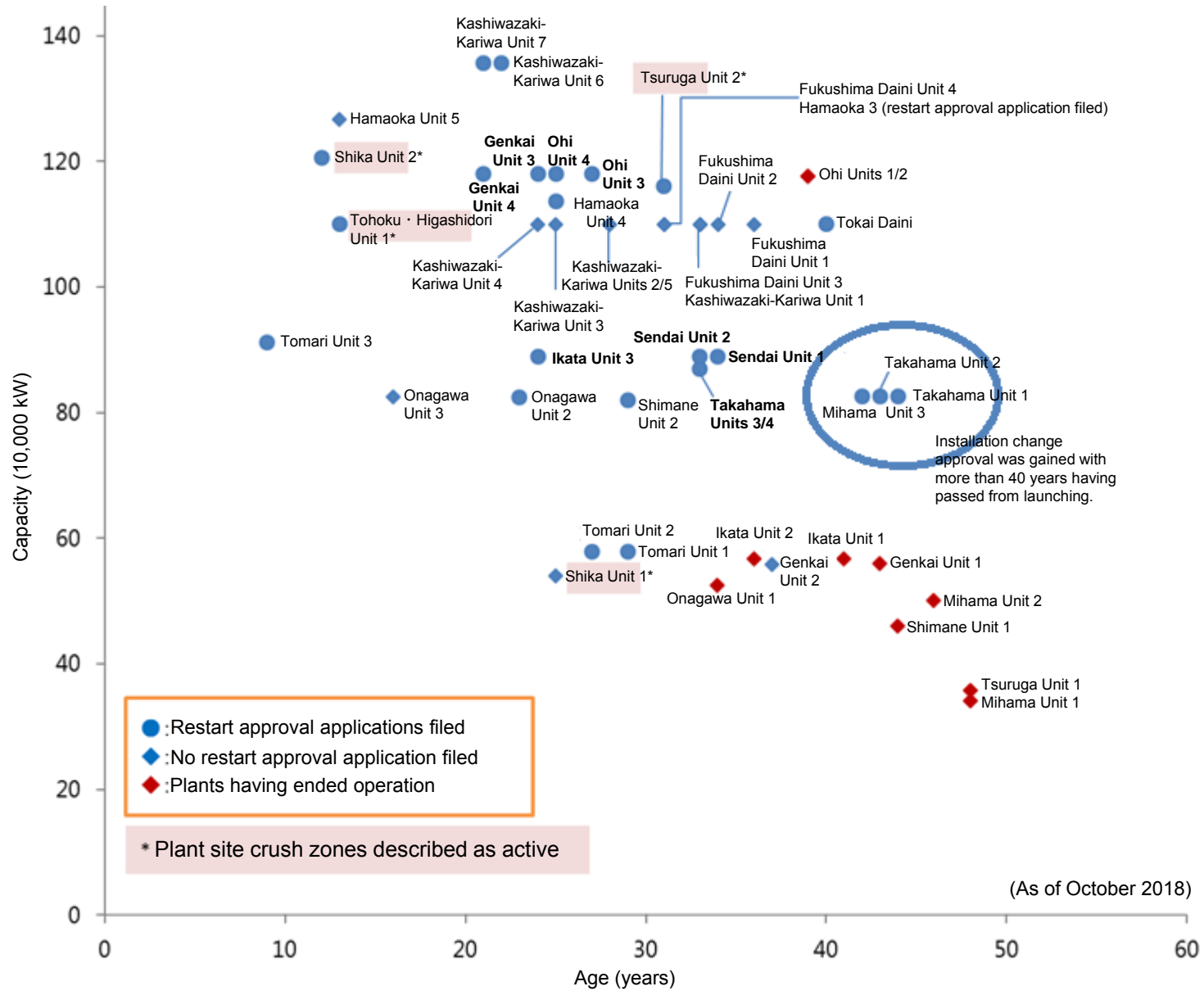
### (2) 10 plants subjected to decommissioning decisions since March 2015

- Major reasons include uncertainties about recovery of investment in additional equipment over a long term and supply capacity.
- Another reason may be that while one plant is under review for lifetime extension, other plants' safety review is stalled.

Date	Electric power company	Unit	Reasons for decommissioning (from company press releases)	
2015/3/17	Japan Atomic Power	Tsuruga Unit 1	Massive unanticipated additional investment and long-term construction will be required.	
2015/3/17	Kansai	Mihama Units 1/2	Supply capacity, technological establishment of various safety measures, construction costs, operational periods and other factors were considered.	2015/3/17 Kansai applies for extending the lifetime for Mihama Unit 3 and Takahama Units 1/2
2015/3/18	Kyushu	Genkai Unit 1	Large-scale construction for additional safety measures will be required, making it difficult to recover additional investment within an operation period after the construction.	
2015/3/18	Chugoku	Shimane Unit 1	Long-term, massive investment in safety measures, later electricity demand, supply capacity and other factors were comprehensively considered.	
2016/3/25	Shikoku	Ikata Unit 1	Supply capacity, technological establishment of various safety measures, relevant costs and other factors were comprehensively considered.	2016/5/20 Kansai gains lifetime extension approval for Takahama Units 1/2
2017/12/22	Kansai	Ohi Units 1/2	Additional equipment for the small containment vessel will reduce operationality.	2016/11/16 Kansai gains lifetime extension approval for Mihama Unit 3
2018/3/27	Shikoku	Ikata Unit 2	Large-scale, long-term seismic retrofitting construction, the operation period after a restart, capacity and other factors were considered.	2017/11/24 Japan Atomic Power applies for extending the lifetime for Tokai Daini
2018/10/25	Tohoku	Onagawa Unit 1	Capacity, the operation period after a restart and other factors were comprehensively considered	2018/11/7 Japan Atomic Power gains lifetime extension approval for Tokai Daini

# 2. Prospects

## (3) Capacity/age map



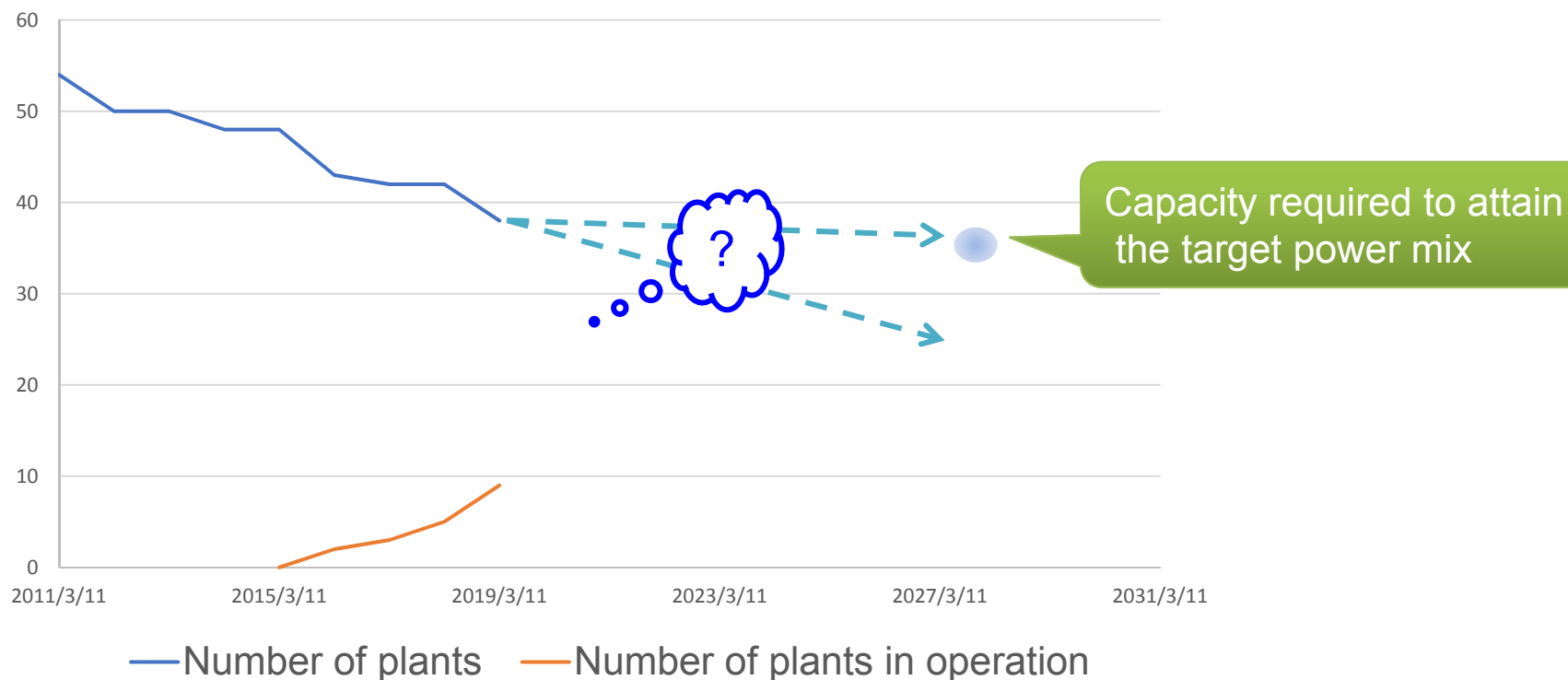


## 2. Prospects

### FAQ: How many plants would be maintained in 2030?

- 30-35 nuclear plants would be required to attain the target power mix for 2030.
- 38 plants as of December 2018 (9 in operation, 6 given approval, 10 under examination, 13 left before safety review application)

Number of commercial plants in Japan



- ✓ The time has come for making decisions on the fate of six nuclear power plants that are at least 30 years old and have yet to be subjected to applications for safety review.

### 3. Restoring public confidence

## Operator's local briefing: Japan Atomic Power Tokai Daini (1/2)

- In February and March 2018, Japan Atomic Power held 25 briefings for residents at 15 municipalities such as Tokai Village, Mito City, Hitachiota City, Hitachi City and Hitachinaka City in Ibaraki Prefecture, attracting 913 participants.

#### Briefing documents (partial)

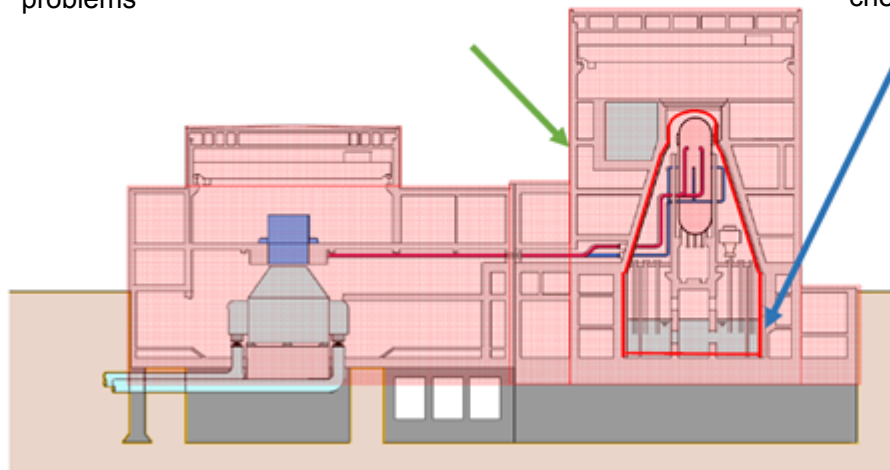
##### Concrete structure checks

Concrete samples are tested to check strength, shielding and other problems

#### Special check ②

##### Reactor containment vessel

Coating on reactor containment vessel steel plates is visually checked



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#### <Background>

On March 29, 2018, the Japan Atomic Power Company signed an agreement with Tokai Village, its five neighboring cities – Hitachi, Hitachiota, Hitachinaka, Naka and Mito – and Ibaraki Prefecture, including their effective advanced approval on the operation of the Tokai Daini Power Station and the extension of its lifetime.

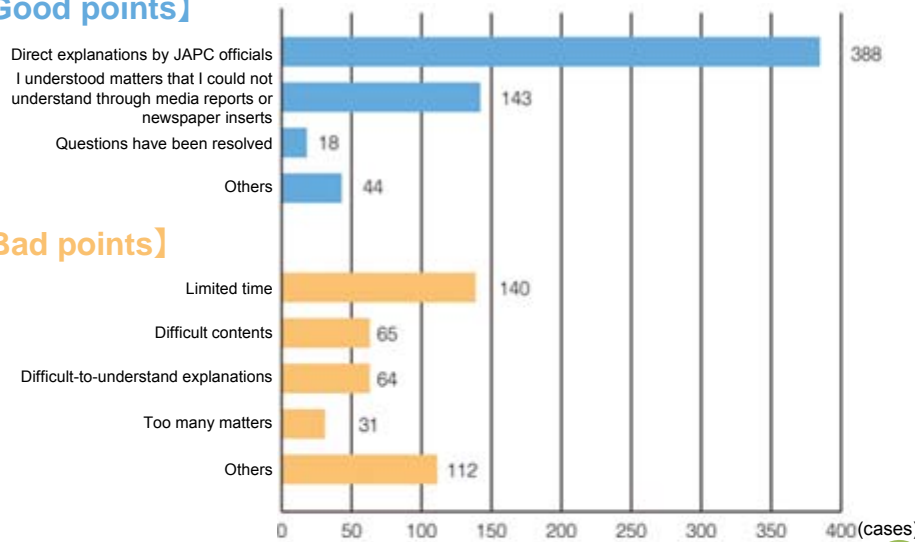
Source) Japan Atomic Power Co. press release on March 30, 2018

# 3. Restoring public confidence

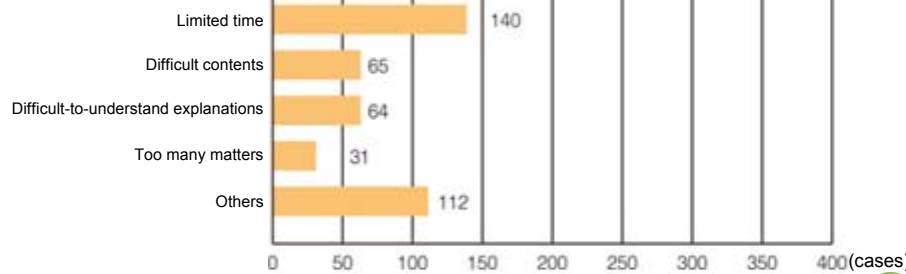
## Operator's local briefing: Japan Atomic Power Tokai Daini (2/2)

- “A good point” cited by participants: “Direct explanations by JAPC officials”
- Problems include the limited time and difficult contents. Careful explanations are indispensable.

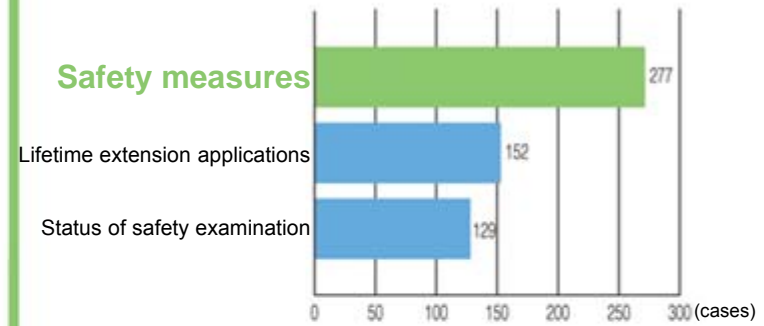
### 【Good points】



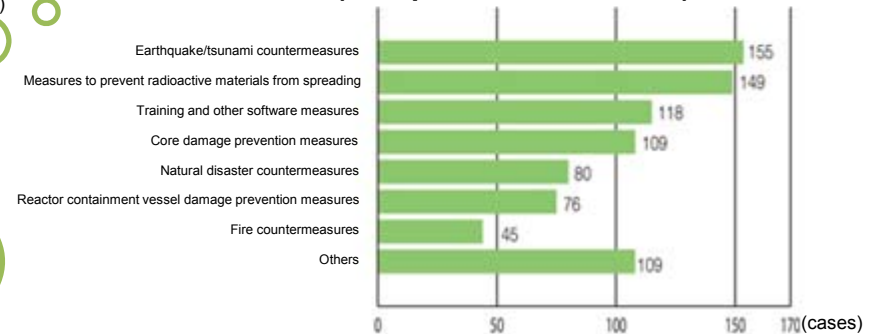
### 【Bad points】



### Matters about which participants want to hear in the future (multiple answers allowed)



### Breakdown of safety measures about which participants want to hear (multiple answers allowed)



The operator explained as much as possible (seemingly). Required for “effective prior approval” are:

Planning to hold briefings by Nuclear Regulation Authority officials in the urgent protection zone (UPZ) within 30 kilometers from the nuclear power station in 2019, according to minutes of a press conference by Ibaraki Prefecture Governor Kazuhiko Oigawa on November 16, 2018.

## 4. International nuclear market in 2019

### (1) International ranking 2010→2018: China's rise and Western countries' stagnation

- While 31 countries implement nuclear power generation in the world, the top 3 countries account for more than half the global power generation capacity.
- This means that more than three-quarters of countries in the world have never considered nuclear energy use.

January 2010



January 2018

Country	In operation		Under construction/planning	
	Capacity (10,000 kW)	No. of plants	Capacity (10,000 kW)	No. of plants
1 U.S.	10,534	104	1,060	9
2 France	6,602	59	163	1
3 Japan	4,885	54	1,959	15
4 Russia	2,319	27	1,640	17
5 Germany	2,151	17	0	0
6 Korea	1,772	20	960	8
7 Ukraine	1,382	15	200	2
8 Canada	1,328	18	0	0
9 U.K.	1,195	19	0	0
10 Sweden	938	10	0	0
11 China	912	11	3,847	36
12 Spain	773	8	0	0
Others	4,124	70	4,146	52
Total	38,916	432	13,974	140

Country	In operation		Under construction/planning	
	Capacity (10,000 kW)	No. of plants	Capacity (10,000 kW)	No. of plants
1 U.S.	10,356	99	626	5
2 France	6,588	58	163	1
3 Japan	4,148	42	1,572	11
4 China	▲ 3,566	37	4,835	45
5 Russia	▲ 2,794	31	2,475	24
6 Korea	▼ 2,253	24	700	5
7 Canada	1,427	19	0	0
8 Ukraine	1,382	15	200	2
9 U.K.	1,036	15	326	2
10 Germany	▼ 1,001	7	0	0
11 Sweden	919	9	0	0
12 Spain	740	7	0	0
Others	4,727	80	5,837	57
Total	40,938	443	16,735	152

▼ Year-on-year fall ▲ Year-on-year rise

Source: "World nuclear power plants 2018," JAIF

In 2018, seven nuclear power plants launched commercial operation in China and two in Russia. How about the international ranking in 2019?

## 4. International nuclear market in 2019

### (2) China's rise: Aggressive expansion into emerging countries and the U.K.

- China introduced technologies from France, the United States, Russia and Japan before launching domestic nuclear power plant construction.
- China participated in the nuclear market for developed countries in 2015, approaching the United Kingdom and France and competing with Japan.

Date	Event
2017/1/19	The <b>U.K.</b> Office of Nuclear Regulation (ONR) launches the generic design assessment of the Chinese HPR1000 reactor.
2017/3/16	The King <b>Abdullah</b> City for Atomic and Renewable Energy (KACARE) signs an agreement with China Nuclear Engineering & Construction Corporation (CNEC) on cooperation in a feasibility study on the construction of a high-temperature gas reactor.
2017/3/22	The China General Nuclear Power Group (CGN) signs agreements with the <b>Kenya</b> Nuclear Electricity Board on cooperation in human resources development and other areas regarding Kenya's introduction of nuclear power generation.
2017/4/24	The CGN holds an international workshop on <b>China-U.K. cooperation</b> in nuclear supply chains in Beijing.
2017/5/17	China National Nuclear Corporation (CNNC) signs a turnkey contract with <b>Argentina's</b> Nucleoeléctrica Argentina S.A. (NA-SA) on the construction of a pressurized heavy-water reactor as Argentina's fourth nuclear plant and its first pressurized-water reactor as its fifth.
2017/11/16	The general design assessment of the Chinese Hualong-1 (HPR1000) reactor in <b>the United Kingdom</b> enters the second phase.
2018/3/28	Daya Bay Nuclear Power Company wins first place in a capacity factor and safety benchmark competition sponsored by France's EDF.
2018/8/9	The State Council announces a policy of establishing China's own nuclear reactor standards as <b>international standards</b> , seeking to make China a nuclear power plant standards power by 2027.

**Nuclear plant exports are a key component of China's Belt & Road international expansion initiative.**

## 4. International nuclear market in 2019

### (3) Russia's international expansion: Eying regions into which developed countries do not expand

- Russia is one of the global leaders in nuclear power plant and nuclear fuel cycle technologies. Particularly, Russia accounts for half the global uranium enrichment capacity.
- Major nuclear technology export destinations are Commonwealth of Independent States members and Eastern Europe. In recent years, Russia has expanded into the Middle East, Africa and South America as well.

Date	Event
2017/6/29	Rosatom agrees with <b>Vietnam's</b> Ministry of Science and Technology to create a nuclear science and technology center.
2017/7/20	Rosatom introduces Russian technologies at Power Gen <b>Africa</b> .
2017/10/30	Rosatom signs an agreement with the <b>Nigeria</b> Atomic Energy Commission on cooperation in constructing and building a nuclear research center and working out a nuclear development roadmap
2017/10/31	The Rosatom director general attends a ceremony for launching the construction of the second unit of <b>Iran's</b> Bushehr nuclear power station.
2017/11/30	Construction is launched for the Rooppur 1 reactor in <b>Bangladesh</b> .
2017/12/11	Rosatom signs a contract with the Egyptian government to construct the El Dabbaa nuclear power station, the first one in <b>Egypt</b> .
2018/4/3	Construction is launched for the first reactor of Turkey's Akkuyub nuclear power station in the presence of Presidents Recep Tayyip Erdogan of Turkey and Vladimir Putin of Russia.
2018/6/22	Russia and <b>Rwanda</b> agree on a memorandum of cooperation in peaceful use of nuclear energy.
2018/7/17	Construction is launched for the Rooppur 2 reactor in <b>Bangladesh</b> .
2018/10/19	<b>Uzbekistan</b> holds a ceremony to launch its first nuclear introduction plan at a candidate site for a nuclear plant.
2018/11/21	Construction is launched to install structures for the first plant of the Ostrovets nuclear power station in <b>Belarus</b> .

Russia's "Graded Approach" and BOO (Build-Own-Operate) approach that emerging countries can accept easily,  
compared with "one of the world's highest safety levels" offered by Japan



# 4. International nuclear market in 2019

## Special topic: Small Modular Reactors

- In November 2018, the U.K., Canadian and U.S. governments announced SMR development policies.
- Attention is paid to regulatory readiness that secures the predictability for business operators.



(\*) GDA: Generic Design Assessment

The government seeks to take account of lessons learned from previous assessments and introduce greater flexibility into the GDA\* process while leaving the inherent objectives and advantages of the GDA process unchanged. For this purpose, the government is ready to provide up to £7 million to the Office for Nuclear Regulation and the Environment Agency. Source) "Policy paper, Advanced Nuclear Technologies, Updated 7 November 2018" BEIS, UK  
<https://www.gov.uk/government/publications/advanced-nuclear-technologies/advanced-nuclear-technologies>

Current regulations and laws are applicable to the SMRs, although they are required to be improved with consideration given to the size and characteristics of the SMRs.

Source) "A Call to Action: A Canadian Roadmap for Small Modular Reactors"  
[https://smrroadmap.ca/wp-content/uploads/2018/11/SMRroadmap\\_EN\\_nov6\\_Web-1.pdf](https://smrroadmap.ca/wp-content/uploads/2018/11/SMRroadmap_EN_nov6_Web-1.pdf)

Canadian Small Modular Reactor Roadmap Steering Committee (2018)



Photo: Seto Wind Hill Power Plant seen from Seto  
Wind Hill Park in Ikata, Ehime Prefecture  
2018/9/18