Approach to Securing Power for Shinkansen Construction in Japan

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Features of JRTT

- Public agency of railway construction
- Comprehensive railway engineers' group
- Correspond to various railways such as Shinkansen (HSR), Urban railway and so on
- Supervise and manage railway construction from planning stage to opening of railway

Manufacturing of rolling stocks and O&M are conducted by railway operators.

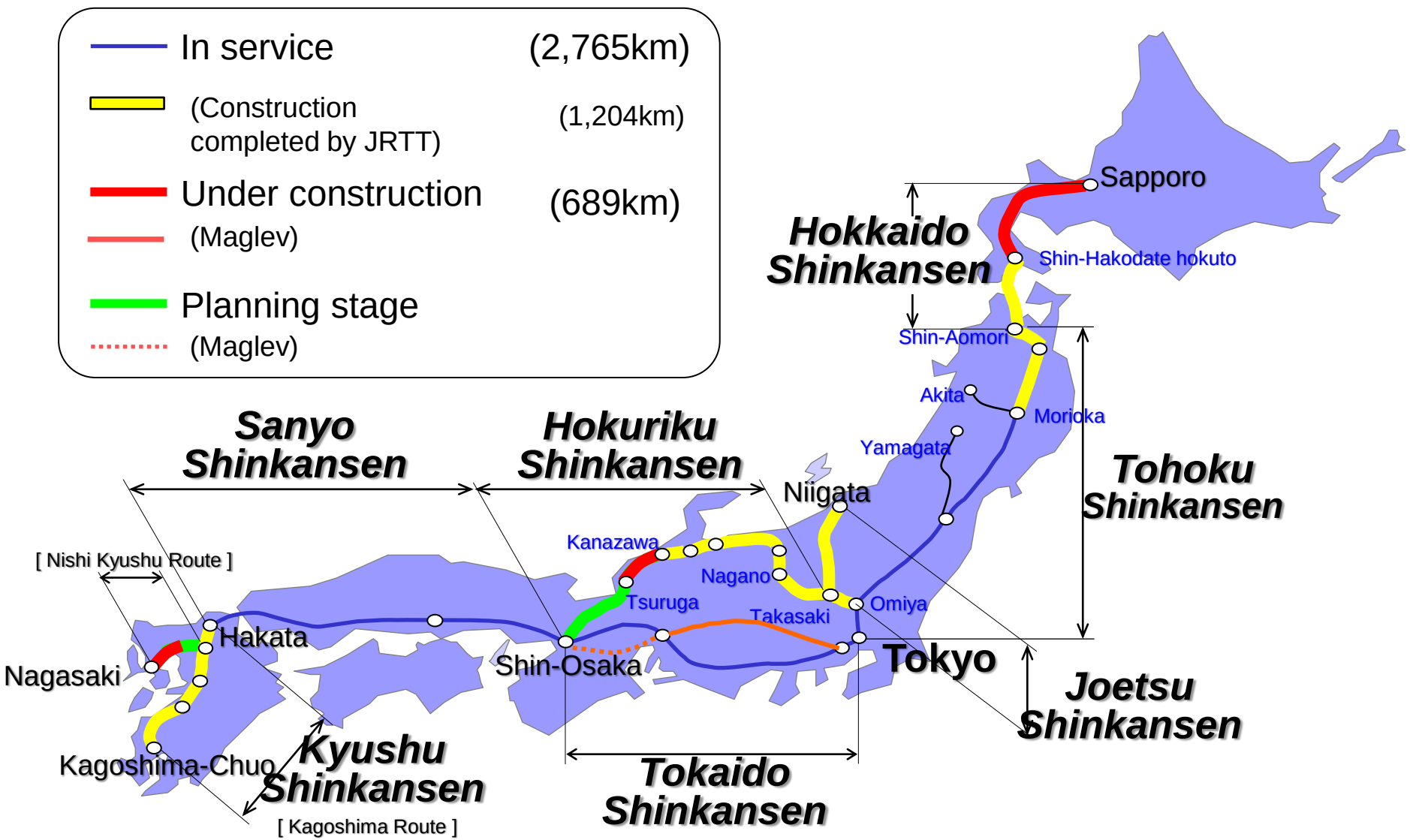
Shinkansen

Urban Railway

* O&M: operation and maintenance

Japan's Shinkansen network

JRTT
Japan Railway Construction, Transport and Technology Agency



Roles in Shinkansen project from planning to construction

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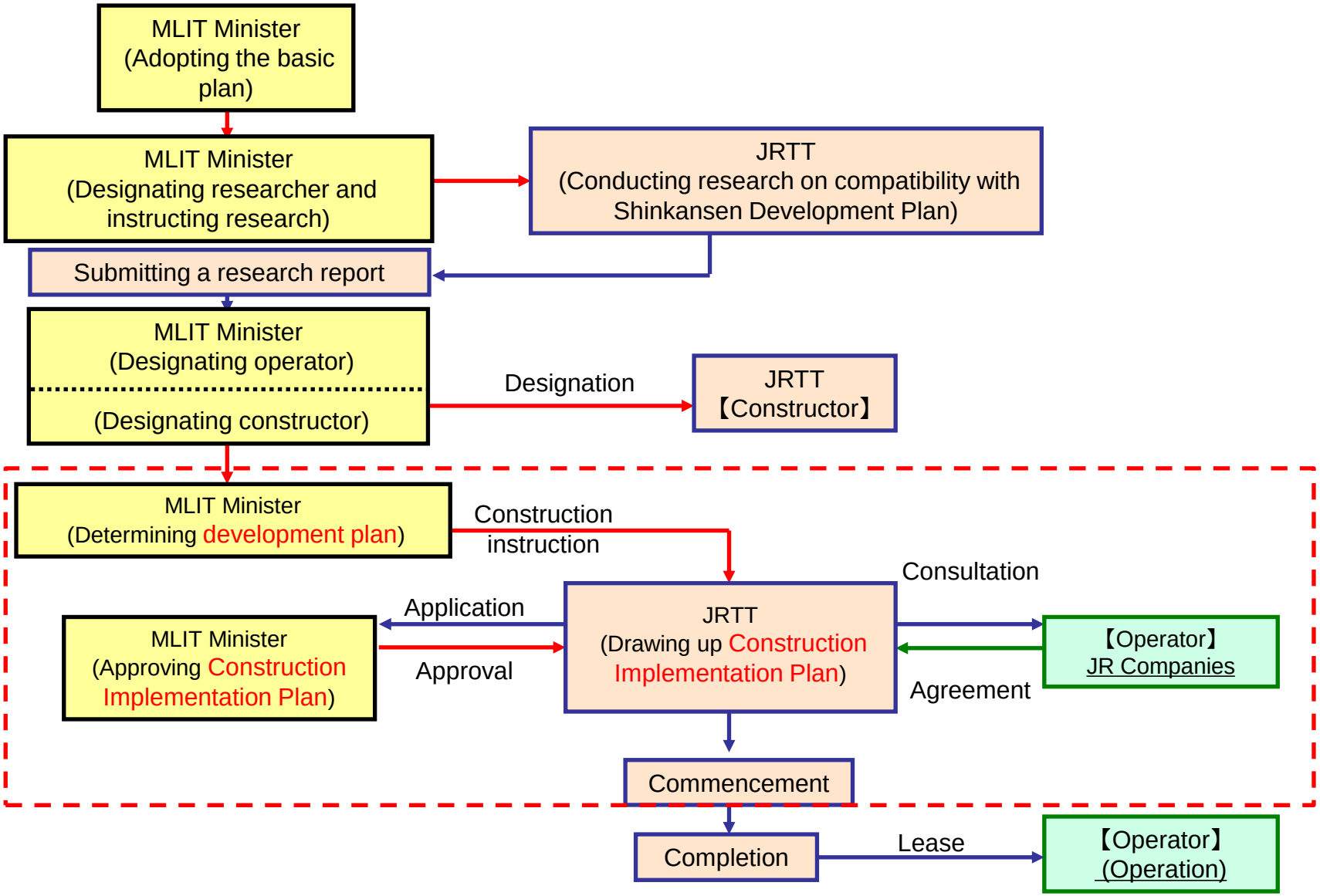

Consulting with the Operator from preparation of the Construction Implementation Plan to construction completion considering railway operation and maintenance.

Shinkansen construction planning

JRTT
Japan Railway Construction, Transport and Technology Agency

Construction Implementation Plan
prepared by JRTT and submitted to Minister of MLIT for approval

1. Route name
2. Construction section
3. Track locations
4. Total track length
5. Station locations
6. Locations of depots and inspection / repair facilities
7. Construction method
   ・・・
   o. Overview of power plants and substations (Receiving voltage, Transformer capacity)
   ・・・
8. Construction budget
9. Scheduled construction commencement and completion

Attached documents

1. Line floor plan
2. Vertical section of the track
3. Station floor plan
   ・・・
10. Electrical feeding system diagrams, Transmission system diagrams, and Distribution system diagrams
11. Substation single-wire connection diagram
    ・・・

JRTT consults the operator in drawing up the Construction Implementation Plan

Time schedule for power feeding systems (1)

1. Environmental Impact Survey (Shinkansen outline route announced)
2. Plan substation locations and Transformer capacity by JRTT
3. Coordinating with power companies (Transmission system)
4. Coordination with railway operators (Plan substation locations, Receiving voltage and Transformer capacity)
5. Agreement with railway operators
6. Approval of construction implementation plan (Part 1) (Land acquisition for substations and approval of construction budget)
7. Start of substation construction reclamation
8. Coordination with railway operators (Substation single-wire diagram)
9. Approval of construction implementation plan (Part 2) (Approval of construction budgets for transmission lines and substations)

About 5 years

About 5 years

Time schedule for power feeding systems (2)

9. Approval of construction implementation plan (Part 2)
   (Approval of construction budgets for transmission lines and substations)
10. Start substation detail design and Contract for substation equipment.
11. Conclusion of transmission line construction contract
12. Substation construction contract
13. Substation equipment installation
14. Test adjustment of substation equipment
15. Conclusion of Substation receiving contract
16. Pre-use inspection of transmission lines and substations
17. Start supplying transmission lines and substations.
18. Pre-use inspection of overhead contact line
19. Energizing test of overhead contact line
20. Test run of the train and Mastery of driving
21. Start commercial operation of Shinkansen

About 5 years

About 1 years

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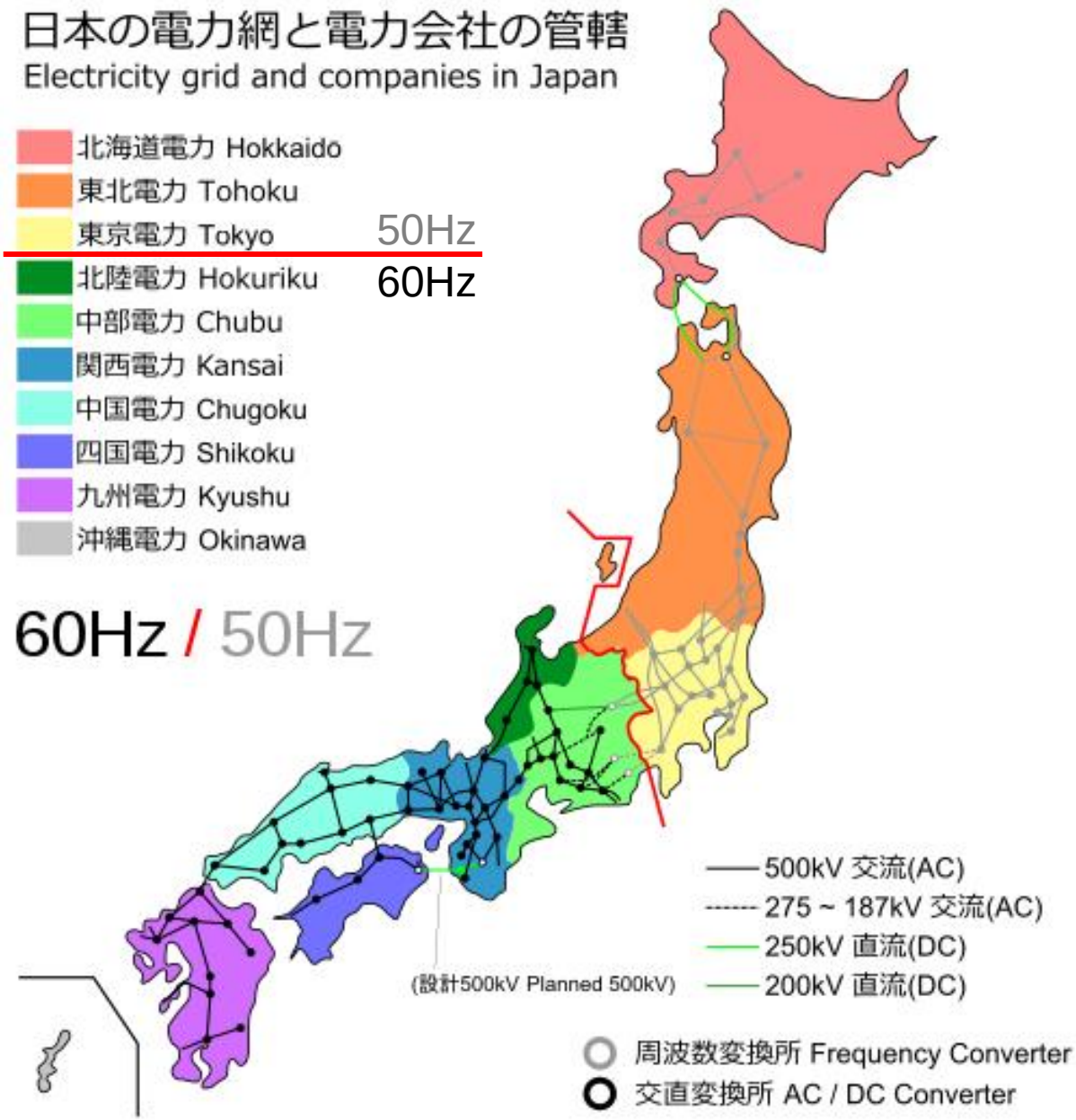
Characteristics of Japanese electric power companies



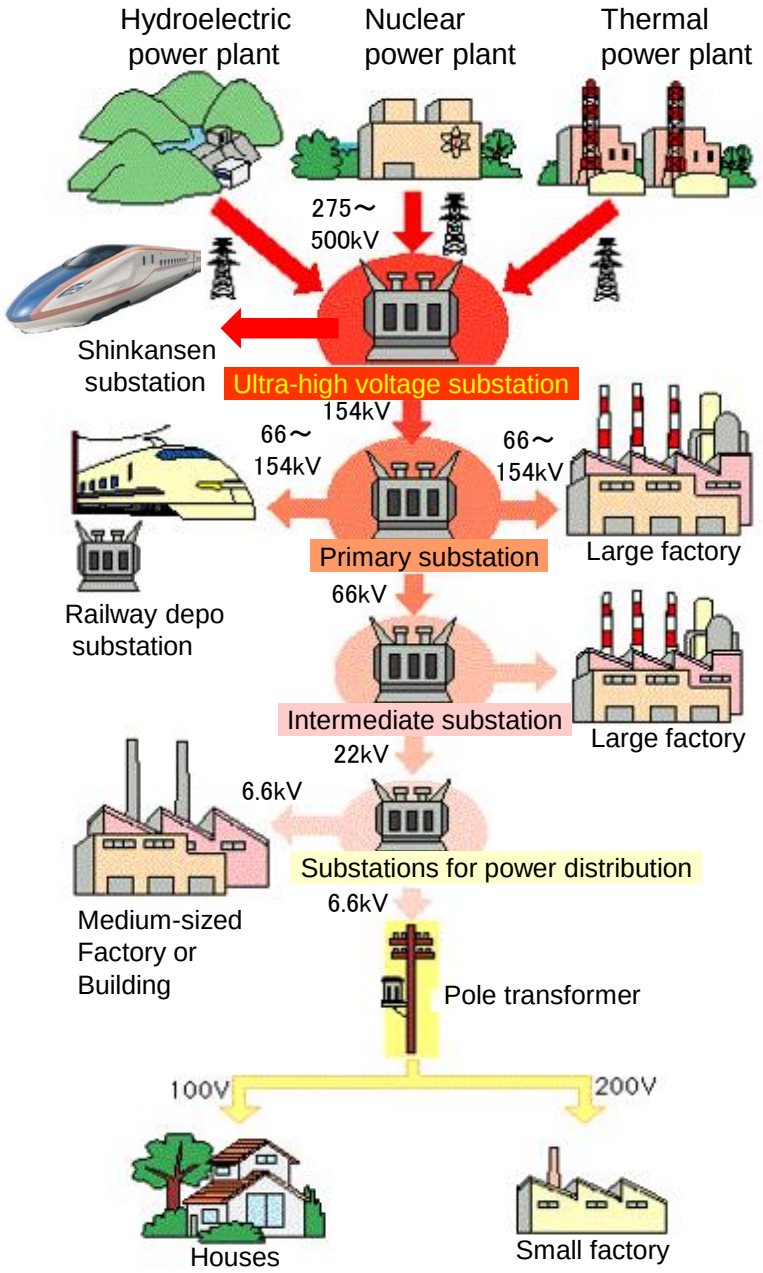
General transmission and distribution business operator

Electric Power Companies	Demand power(Gwh)
Hokkaido	30,583
Tohoku	82,787
Tokyo	289,387
Hokuriku	29,953
Chubu	135,957
Kansai	144,997
Chugoku	61,073
Shikoku	27,382
Kyushu	86,431
Okinawa	7,924

Since April 2018 to April 2019

Shinkansen substation receiving voltage

JRTT
Japan Railway Construction, Transport and Technology Agency



Shinkansen substation receiving voltage

Shinkansen Route	Voltage class of main Substation	Voltage class of depo Substation
Hokkaido	275kV,187kV	66kV
Tohoku	275kV,154kV	154kV,66kV
Joetsu	275kV,154kV	154kV
Hokuriku	275kV,154kV	154kV,77kV
Tokaido	154kV,77kV	77kV,66kV
Sanyo	275kV,220kV	66kV
Kyushu	220kV	66kV

Rough estimated costs for transmission line construction

66～154kV(EHV)：About 10 million yen
187kV～(UHV)：1 billion yen or more
（UHV is not on the standard supply covenants of the electric power company, so it will be special supply covenants)

Workflow of transmission system diagram approval (1)

【Operator】
JR Companies

provide →

Conditions for calculation of:
- Maximum power for 30 minutes during commercial operation
- Main transformer capacity

【Constructor】
JRTT

provide →

- Maximum power for 30 minutes during commercial operation
- Substation placement plan
- Timing of start operation

【Power Supply】
Electric Power Companies

investigating

Conditions for calculation of maximum power for 30 minutes during commercial operation and main transformer capacity are as below:

1) Maximum current per train

2) Maximum number of trains per hour

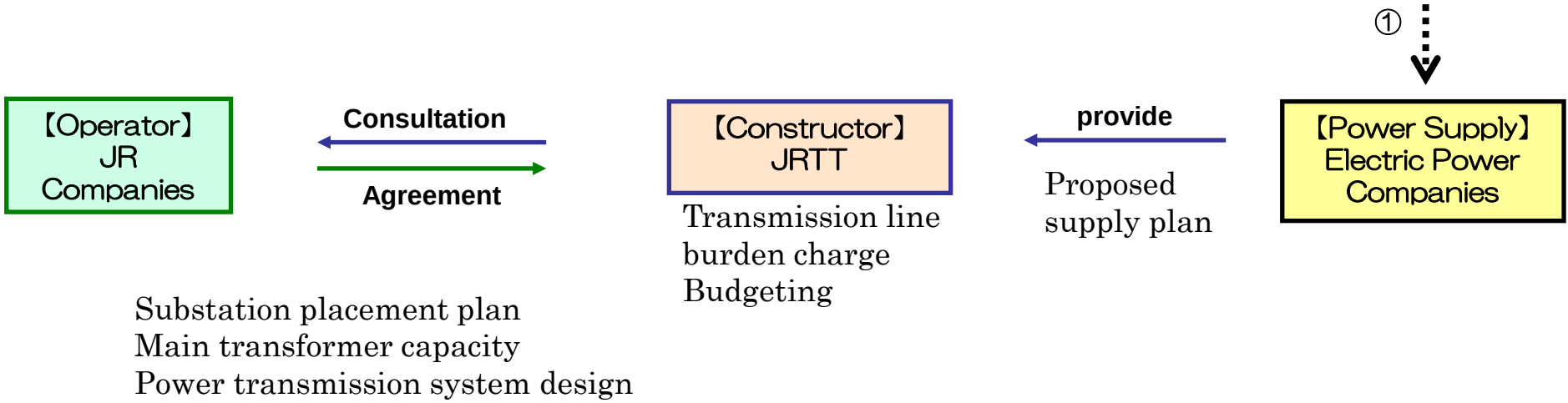
3) Total weight per train (t)

4) Average power consumption rate (kWh/1000･km)

5) Electric power feeding distance (km) of the substation

②

Workflow of transmission system diagram approval (2)



Contents of supply plan presented by electric power companies:

1) Voltage class and supply form
2) Maximum minimum short-circuit capacity
3) Length of transmission line construction
4) Transmission line pull-in system (overhead / ground)
5) Transmission line protection system
6) Transmission line construction burden charge
7) Required construction period
8) Other supply conditions (voltage fluctuation rate)

Hokuriku Shinkansen substation location map

JRTT
Japan Railway Construction, Transport and Technology Agency

○ : Substation for Hokuriku Shinkansen

Hokuriku Shinkansen power feeding system (1)

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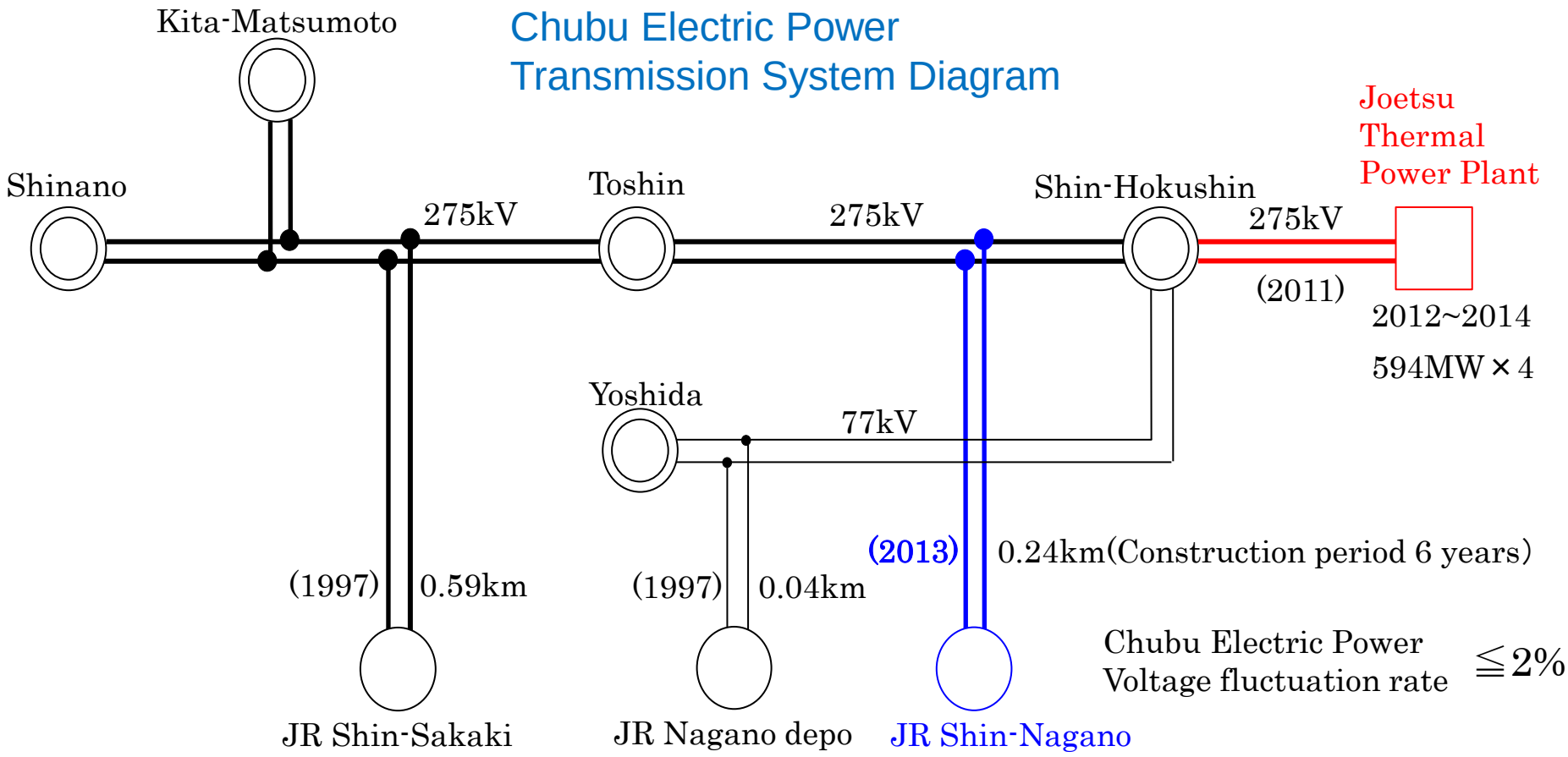


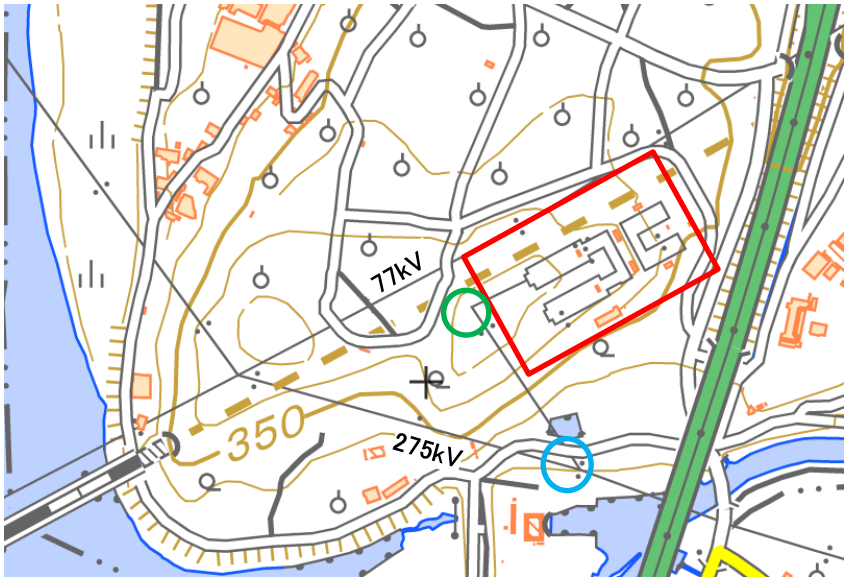
legend

- □ : Electric Power Company Power Plant
- ◎ : Electric Power Company Substation
- ○ : Substation for Shinkansen

	Short-circuit capacity (MVA)	Before planning	After planning
JR Shin-Nagano	Maximum	3,100	7,200
	Minimum	1,800	3,000

Voltage fluctuation rate : satisfied

Shin-Nagano substation



Shin-Nagano substation

275kV Transmission Branch tower

275kV Transmission Final Tower

The substation of Shinkansen is planned to be positioned in the vicinity of the transmission line.

If the construction of ultra-high voltage transmission line is carried out over long distances, the construction cost will increase and the construction period will be longer. To minimize these, substations are planned near power lines.

Electric feeding area for Shinkansen

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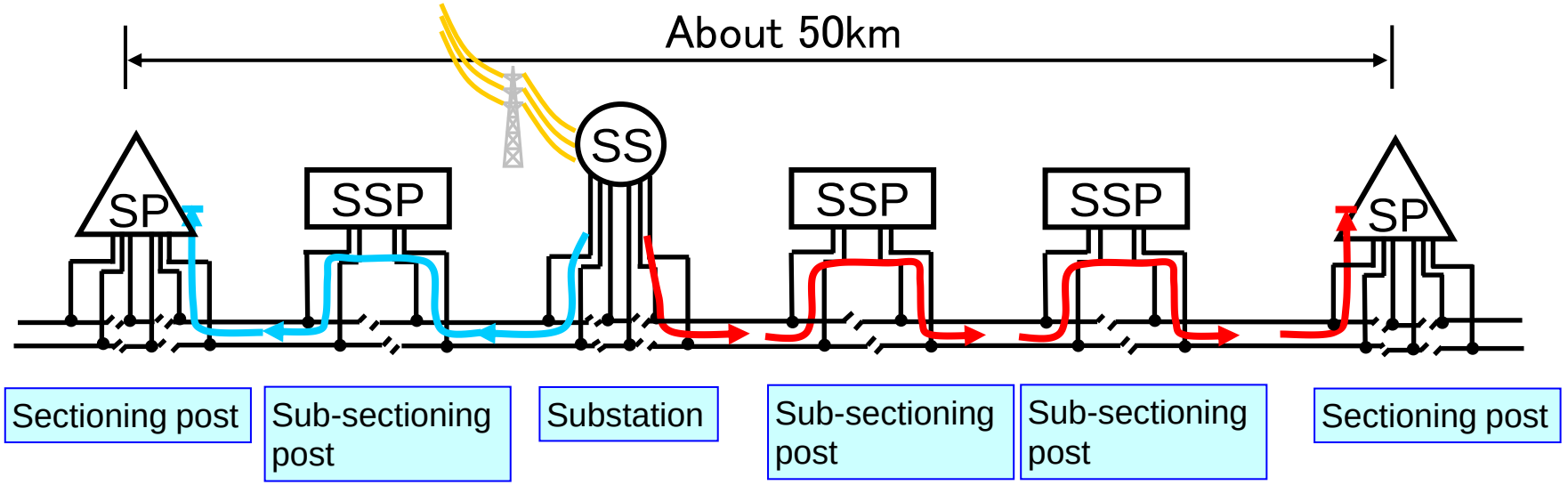
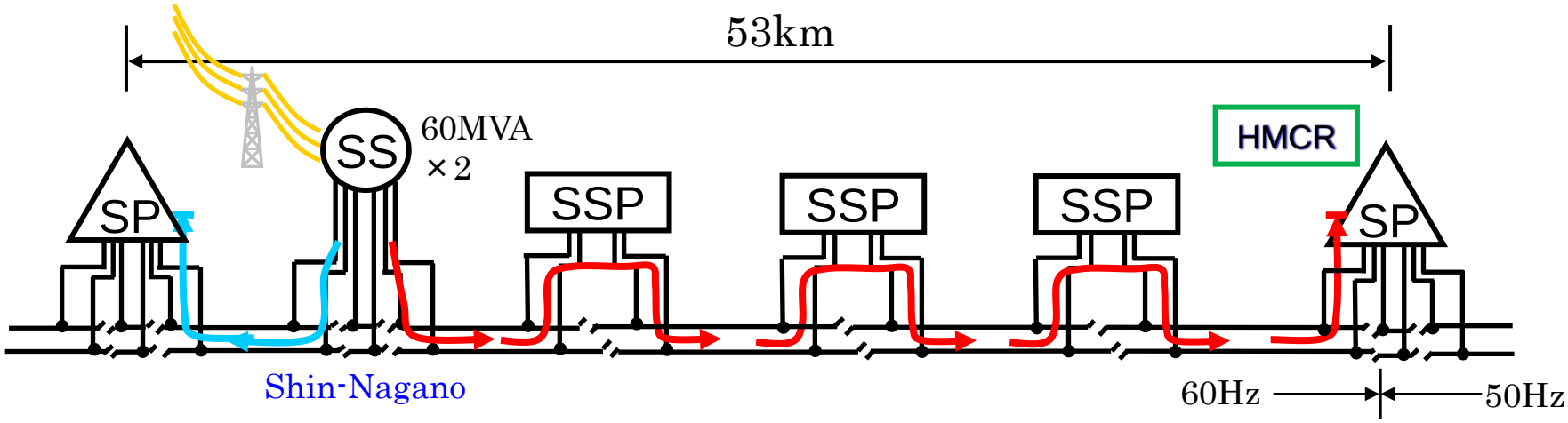
Japan Railway Construction, Transport and Technology Agency

Standard Electric Feeding area

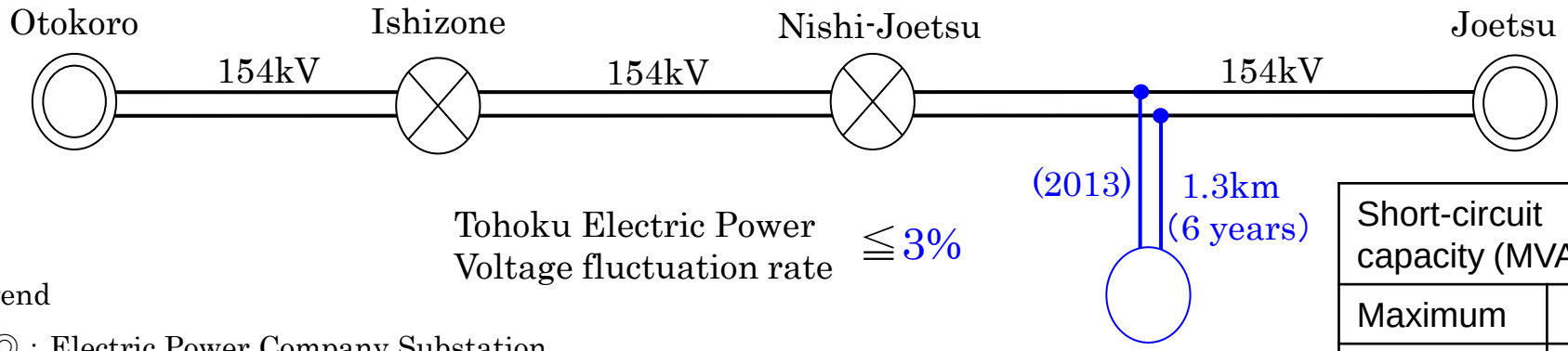


Shin-Nagano Substation Feeding area



Hokuriku Shinkansen power feeding system (2)

Tohoku Electric Power Transmission System Diagram



Tohoku Electric Power
Voltage fluctuation rate ≦3%

Short-circuit capacity (MVA)	
Maximum	2,500
Minimum	1,500

legend

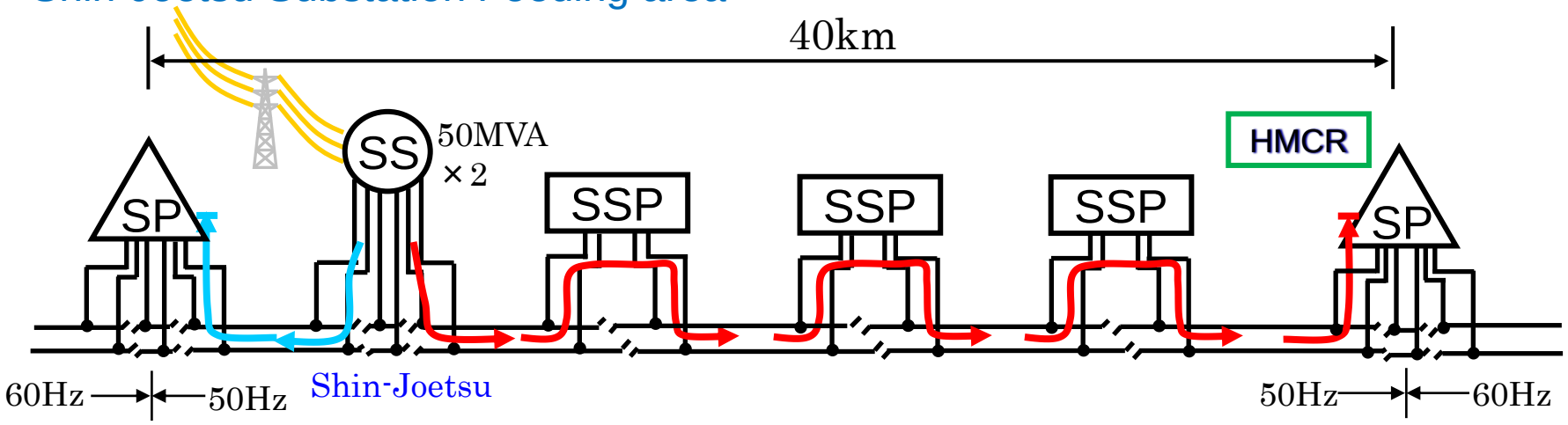
◎ : Electric Power Company Substation

⊗ : Electric Power Company Switching Station

○ : Substation for Shinkansen

Voltage fluctuation rate : satisfied

Shin-Joetsu Substation Feeding area



Hokuriku Shinkansen power feeding system (3)

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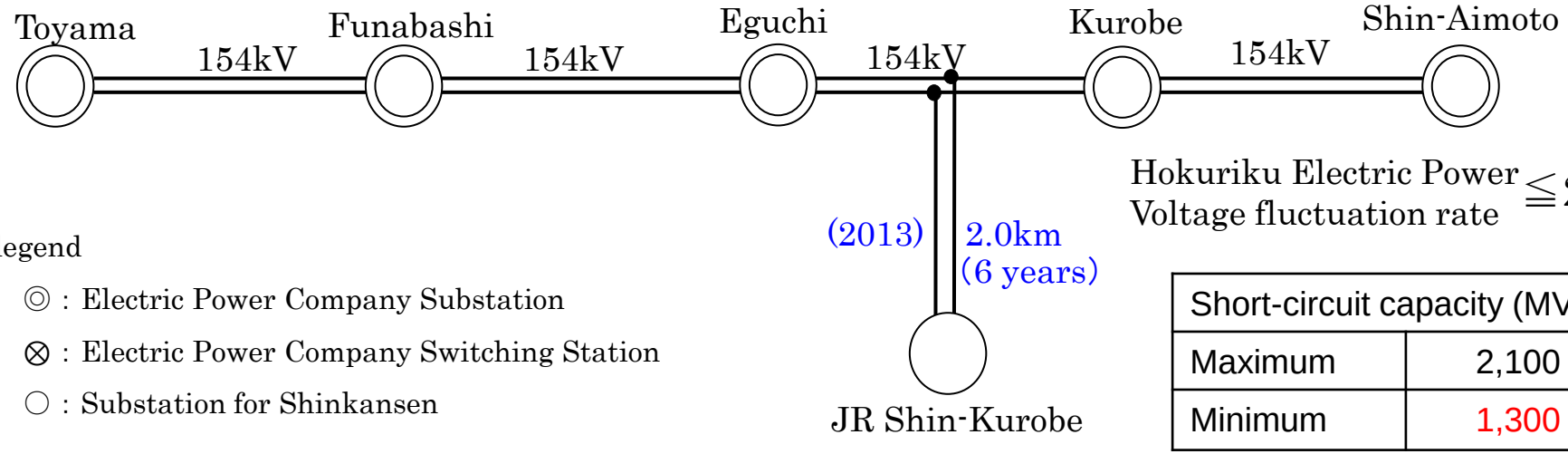
Hokuriku Electric Power Transmission System Diagram (1)



Hokuriku Electric Power Voltage fluctuation rate ≦2%

legend

◎ : Electric Power Company Substation

⊗ : Electric Power Company Switching Station

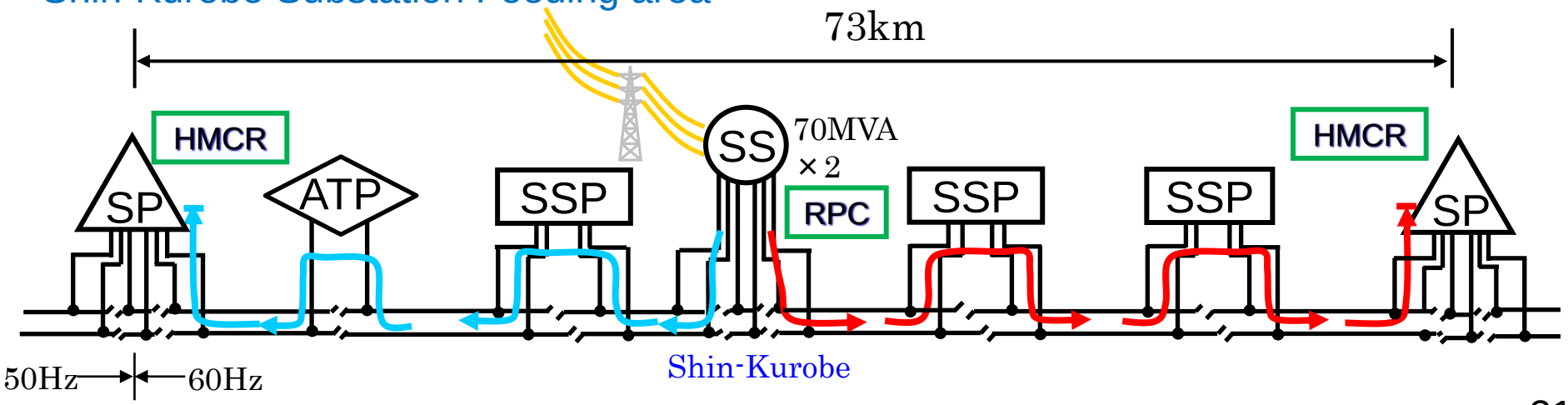
○ : Substation for Shinkansen

Short-circuit capacity (MVA)	
Maximum	2,100
Minimum	1,300

Voltage fluctuation rate：over 3%

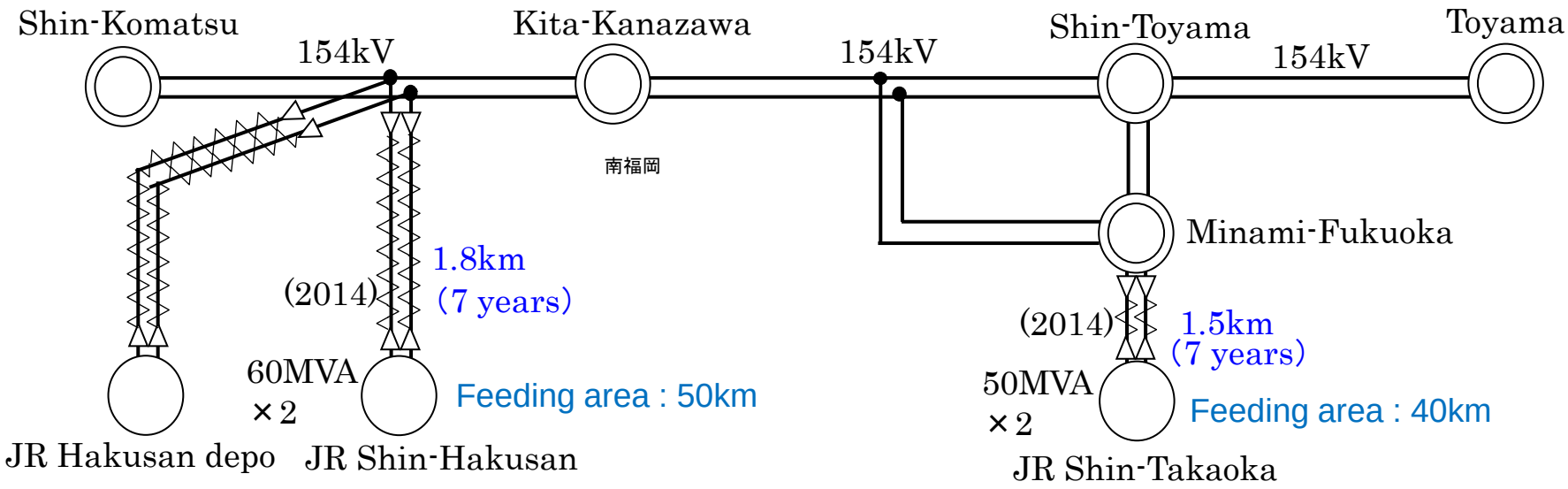
Need Railway static Power Conditioner

Shin-Kurobe Substation Feeding area



Hokuriku Shinkansen power feeding system (4)

Hokuriku Electric Power Transmission System Diagram (2)
(Power receiving by ground transmission cable)



Short-circuit capacity (MVA)	
Maximum	2,900
Minimum	1,900

Short-circuit capacity (MVA)	
Maximum	4,800
Minimum	2,100

legend

◎ : Electric Power Company Substation

⊗ : Electric Power Company Switching Station

○ : Substation for Shinkansen

Voltage fluctuation rate : satisfied

Hokuriku Electric Power Voltage fluctuation rate $\leqq 2\%$