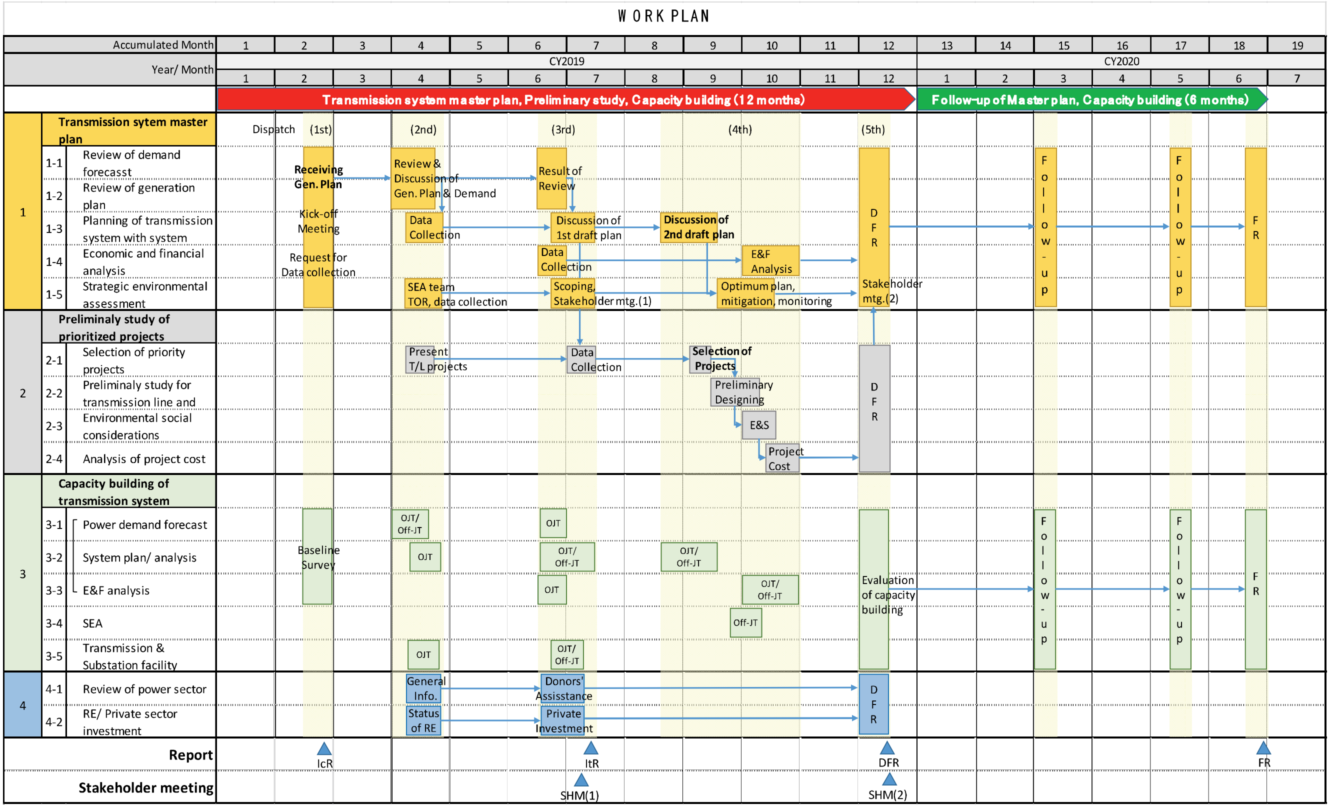
2.5 Project schedule



Thank you for your attention

The Project for the Study of Upgrading National Power System Expansion Plan in The Islamic Republic of Pakistan

1st Stakeholders Meeting

9 July 2019

JICA Expert Team
NEWJEC Inc.

Session II

The Project and the Strategic Environmental Assessment

USUI Shunji

JICA Expert Team
NEWJEC Inc.

CONTENTS

1. Strategic Environmental Assessment
2. SEA studies in other countries: Sri Lanka and Ireland
3. Objectives and organizations
4. Methodology of the SEA
5. Progress of the SEA

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1. <u>Strategic Environmental Assessment</u>
2. SEA studies in other countries: Sri Lanka and Ireland
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1.1 Strategic Environmental Assessment

The requirement by Japan International Cooperation Agency (JICA)

All master plan studies like the Project are required to implement a strategic environmental assessment according to JICA's "Guidelines for Environmental and Social Considerations (2010) ".

1.2 Strategic Environmental Assessment

1. Identification and integration of environmental concerns and goals at the earliest planning and designing stages of policies, plans or programmes.
2. Where there are threats of serious or irreversible damage, the lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.

IUCN Pakistan formulated Strategic Environmental Assessment Rules (Draft), 2014

1.3 Strategic Environmental Assessment

3. Consideration of all feasible alternatives to avoid and prevent adverse effects and cumulative effects on the environment during the planning and designing stage, including the alternative of not proceeding to develop the policy, programme or plan.
4. Ensuring transparency and accountability in Government decision-making, including the documentation of results and the provision of free public access to information.

IUCN Pakistan formulated Strategic Environmental Assessment Rules (Draft), 2014

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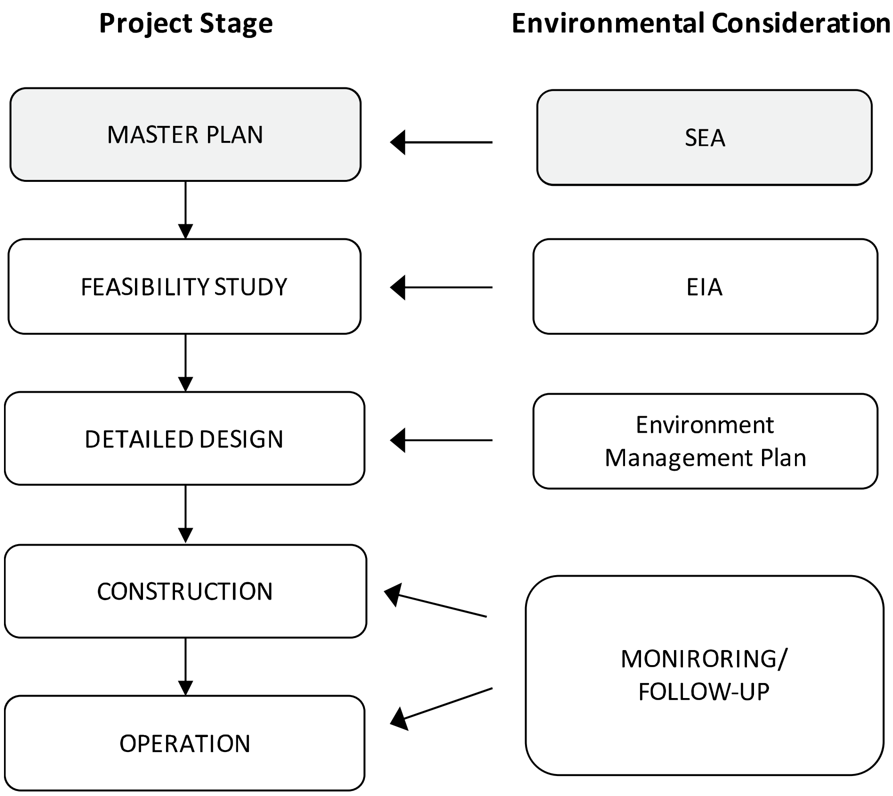
1.4 Strategic Environmental Assessment



Source: JICA Expert Team

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1.5 Strategic Environmental Assessment

Types of SEA: Examples

PPP	Geographical area	MP
Policy	Nation wide	National Energy Policy, National Land Development Policy
	Region	Energy policy at a provincial or district level
Programme	Nation wide	Upgrading National Power System Expansion Plan
	Region	Power plan / road development plan at a provincial or district level
Project	City	City plan or transportation plan

Source: JICA Expert Team

CONTENTS

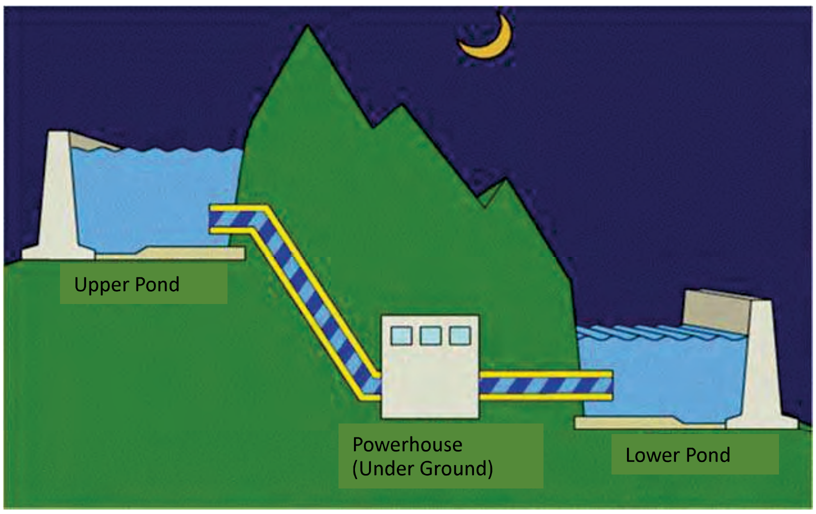
2.1 SEA studies in other countries

Sri Lanka: Development Planning on Optimal Power Generation for Peak Power Demand

Source: CIA World Factbook: https://www.cia.gov/library/publications/the-world-factbook/geos/ce.html

2.2 SEA studies in other countries

Sri Lanka



Pumped Storage Power Plant
An option for peak power generation

Source: : Development Planning on Optimal Power Generation for Peak Power Demand (JICA, 2015)

2.3 SEA studies in other countries

Sri Lanka

Stage1
- Selection of Suitable Power Generation Option for Peak Power Demand(1st SHM)

Stage2
- Study on 10 Candidate Sites of PSPP
- Review of Long-term Power Development Plan

Stage 3
- Selection of 3 Promising Sites (2nd SHM)
- Study on the 3 Candidates
- Selection of the Most Promising Site (3rd SHM)

Source: : Development Planning on Optimal Power Generation for Peak Power Demand (JICA, 2015)

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2.4 SEA studies in other countries

Sri Lanka

Natural environment	Impacts on fauna and flora	Inundated forest area
		Impacts on protected areas
		Impacts on endangered species (especially fish and other aquatic species)
Social environment	Impacts on local communities	Number of those who to be resettled
		Area of land to be appropriated
		Impacts on water utilization (e.g. drinking water)
		Impacts on utilization of forest and grassland
		Impacts on public facilities (e.g. school)
	Impacts on industries	Agriculture
		Forestry
		Tourism
	Impacts on cultural heritages	Religious and/or cultural facilities
		Impacts on landscape

Source: : Development Planning on Optimal Power Generation for Peak Power Demand (JICA, 2015)

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2.5 SEA studies in other countries

Sri Lanka

Three promising sites

Source: : Development Planning on Optimal Power Generation for Peak Power Demand (JICA, 2015)

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2.6 SEA studies in other countries

Sri Lanka

	Score Allocation	Halgran 3	Maha 2	Maha 3	Loggal
1. Technical Evaluation	25.00	15.50	22.00	21.75	12.50
2. Economic Evaluation	25.00	18.75	18.75	25.00	6.25
3. Natural Environment	25.00	7.25	9.68	10.75	7.20
4. Social Environment	25.00	17.50	10.35	13.75	9.40
Total	100.00	59.00	60.78	71.25	35.35
Rank		3	2	1	4

Source: : Development Planning on Optimal Power Generation for Peak Power Demand (JICA, 2015)

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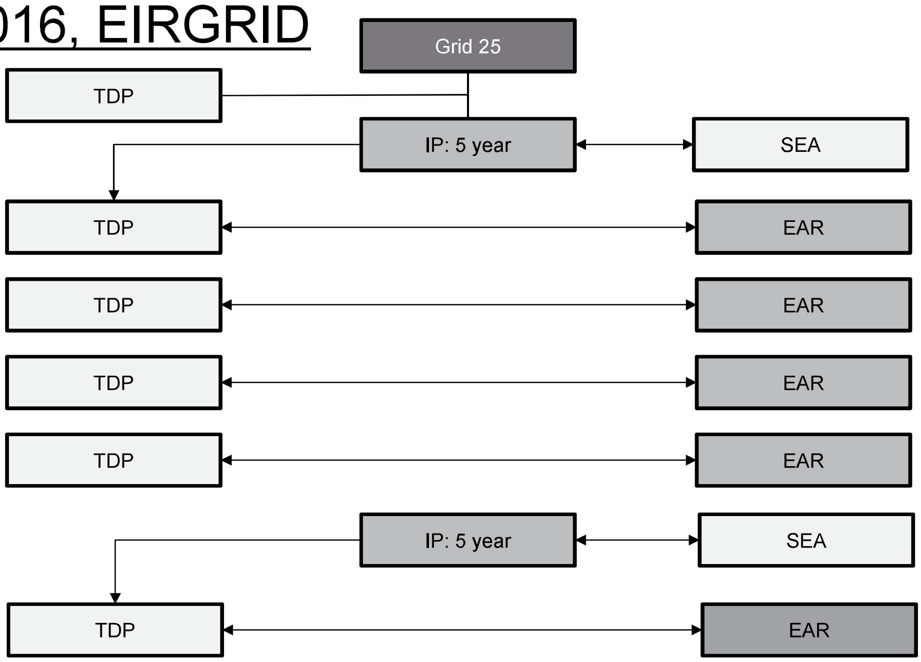
2.7 SEA studies in other countries

Ireland: Implementation Programme 2011- 2016, EIRGRID



TDP: Transmission Development Plan, IP: Implementation Programme
EAR: Environment Appraisal Report

Source: SEA Statement of the GRID 25 Implementation Programme 2011 – 2016 (EIRGRID, 2013)

2.8 SEA studies in other countries

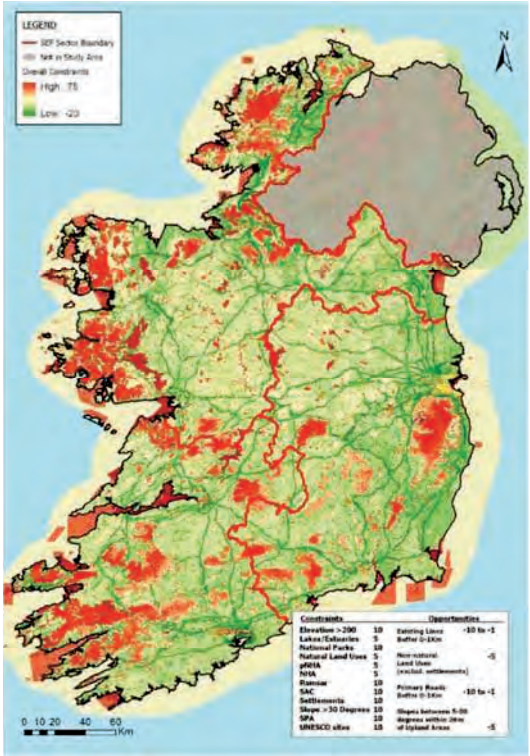
Ireland

Constraint factors	Opportunity factors
➢ Special Area of Conservation ➢ Special Protection Area ➢ Ramsar Sites ➢ National Parks ➢ UNESCO Sites ➢ Elevation > 200 m ➢ Slope > 30 degrees ➢ Settlements ➢ Natural Heritage Areas / proposed NHAs ➢ Natural Land Use types ➢ Lands and Estuaries	➢ Existing transmission lines ➢ National priority roads ➢ Slope < 30 degrees ➢ Non natural land use areas excluding settlements

Source: SEA Statement of the GRID 25 Implementation Programme 2011 – 2016 (EIRGRID, 2013)

2.9 SEA studies in other countries

Ireland



Sensitivity Map
Implementation Programme for GRID 25

Source: SEA Statement of the GRID 25 Implementation Programme 2011 – 2016 (EIRGRID, 2013)

2.10 SEA studies in other countries

Benefits of the implementation of SEA

- to avoid / minimize negative impacts at early stage of project;
- to involve stakeholders to make the formulation process more effective in terms of better decision-making for evaluation of the master plan; and,
- to enhance capacity of counterpart agency and other related agencies for undertaking environmental and social considerations from early stage of development project.

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1. Strategic Environmental Assessment
2. SEA studies in other countries: Sri Lanka and Ireland
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4. Methodology of the SEA
5. Progress of the SEA

3.1 Objectives and organization

Goal of the SEA

- SEA for the Project will enable the Government of Pakistan and the people to save their time and efforts at a project formulation stage in future that usually goes with an Environmental Impact Assessment.

3.2 Objectives and organization

Objectives

- to facilitate sustainable power resources utilization for the country;
- to avoid, mitigate and minimize adverse environmental impacts and/or cumulative environmental impacts, and to enhance positive impacts; and,
- to strengthen and support implementation of environmental and social considerations at planning stage.

3.3 Objectives and organization

Organization

The SEA Team is established to efficiently implement the SEA. The SEA Team consists of Environmental and Social Impact Cell, NTDC, the JICA Expert Team and Sustainability Through Environmental Professional Services (STEPS).

CONTENTS

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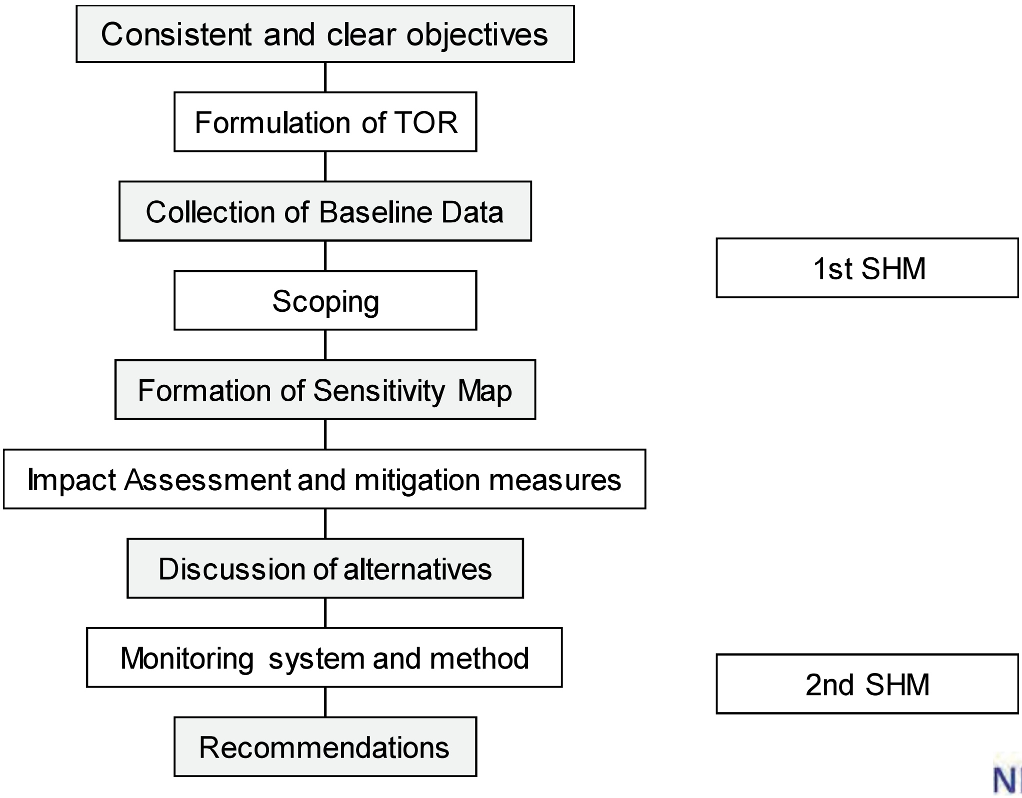
4.1 Methodology of the SEA
Flow of the implementation



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4.2 Methodology of the SEA Collection of Baseline Data

1. General information on Pakistan
2. Natural environment
3. Social environment

4.3 Methodology of the SEA Baseline Data: General information on Pakistan

- Relevant laws, acts, degrees
- Natural conditions (climate, topography, fauna and flora, natural disasters, protected areas)
- Social conditions (economical condition, population, ethnic composition, industry and agriculture, gender, cultural heritage, poverty)

4.4 Methodology of the SEA Baseline Data: Natural environment

- National Parks
- Wildlife Sanctuaries
- Game Reserves
- Ramsar Sites
- World Natural Heritage sites (including the proposed sites)
- Important Bird and Biodiversity Area (proposed by BirdLife International, international bird conservation NGO)
- Other sensitive sites to be protected, if any
- Geographical information such as slope, flood prone areas

4.5 Methodology of the SEA Baseline Data: Social environment

- Cities and/or settlements
- Roads
- Rail roads
- Airports (international and domestic)
- World Cultural Heritage sites (including the proposed sites)
- Military facilities

4.6 Methodology of the SEA Baseline Data

STEPS visited relevant 43 stakeholders in May 2019

- Federal government: NDMA, NHA, National Commission for UNESCO, Bureau of Statistics
- Provincial governments: 4 provinces
- NGOs

4.7 Methodology of the SEA Scoping

Cate-gory	No.	Environmental Item	Evaluation		Explanation of impacts
			Planning and construction stages	Operation & monitoring stage	
Pollution Control	1	Air quality			
	2	Water quality			
	3	Wastes			
	4	Soil contamination			
	5	Noise and vibration			
	6	Subsidence			
	7	Odor			
	8	Sediment			
Natural Environment	9	Protected areas			
	10	Ecosystem			
	11	Hydrology			
	12	Topography and geology			

- Scoping of the SEA is conducted.
- The above scoping table is used for this exercise.

4.8 Methodology of the SEA Scoping

The table is commonly used in JICA projects. The table covers 30 items in the following fields.

- Pollution control
- Natural Environment
- Social Environment
- Others (accidents and transboundary issues)

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4.9 Methodology of the SEA Scoping: tentative items

Item	SEA
Protected areas	✓
Ecosystem	✓
Topography and geology	✓
Involuntary resettlement	✓
Land use and utilization of local resources	✓
Existing social infrastructures and services	✓
Cultural heritages	✓

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4.10 Methodology of the SEA Sensitivity Map: tentative layers

- Protected areas
- Ramsar sites
- Important Bird and Biodiversity Areas (IBAs)
- Sloped areas
- Flood-prone areas
- World Heritage Sites (including the sites in the tentative list)
- Populated areas
- Airports

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4.15 Methodology of the SEA Populated cities

No.	Name of city	Population 2017
1	KARACHI CITY	14,910,352
2	LAHORE CITY	11,126,285
3	FAISALABAD M.CORP.	3,203,846
4	RAWALPINDI CITY	2,098,231
5	GUJRANWALA M.CORP.	2,027,001
6	PESHAWAR CITY	1,970,042
7	MULTAN CITY	1,871,843
8	HYDERABAD CITY	1,732,693
9	ISLAMABAD METROPOLITAN CORP.	1,014,825
10	QUETTA CITY	1,001,205

Source: Bureau of Statistics, Pakistan
http://www.pbs.gov.pk/content/provisional-summary-results-6th-population-and-housing-census-2017-0

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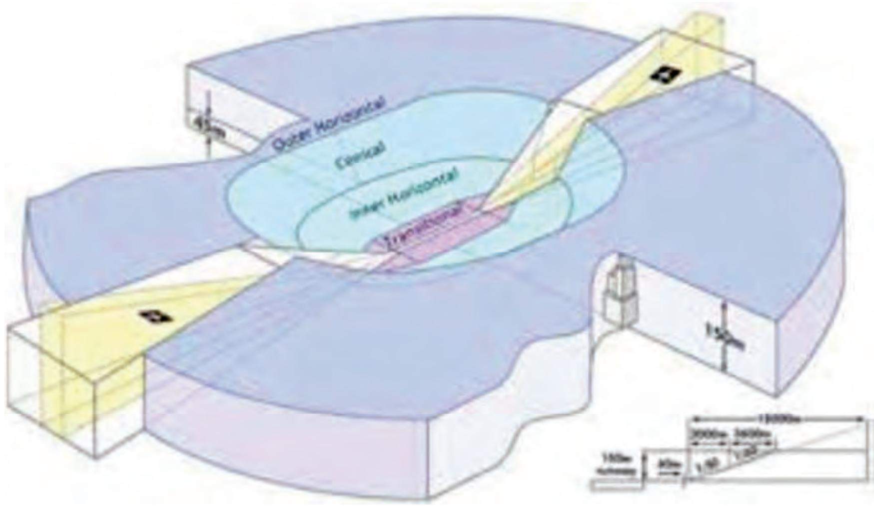
4.17 Methodology of the SEA Airports



Obstacle Limitation Surfaces of an airport

Source: Aerodrome Safeguarding Workshop (International Civil Aviation Organization, 2017)

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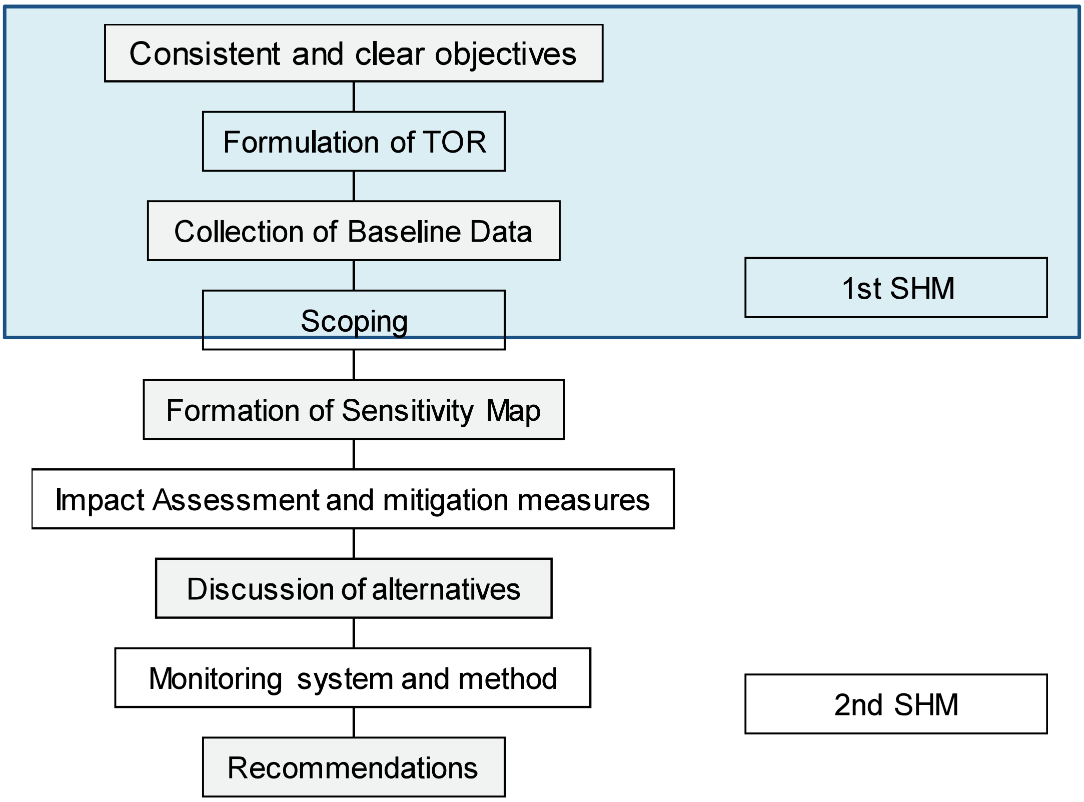
5.1 Progress of the SEA



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Your comments, opinions are highly appreciated.

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بہت بہت شکریہ

Thank you for listening.

ありがとうございました。

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第 4 次現地調査

The Project for the Study of Upgrading National Power System Expansion Plan in The Islamic Republic of Pakistan

Work Shop

22 October, 2019

Japan International Cooperation Agency
NEWJEC Inc.

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Today's Agenda

1. General
2. Network map of 2040 system model
3. Study for Alternatives
4. Precondition of Power System Analysis
   - Generator setting
   - Analysis standard
   - Demand allocation
5. Analysis Result (Summer and Winter (peak/off-peak))
6. About Pre-FS

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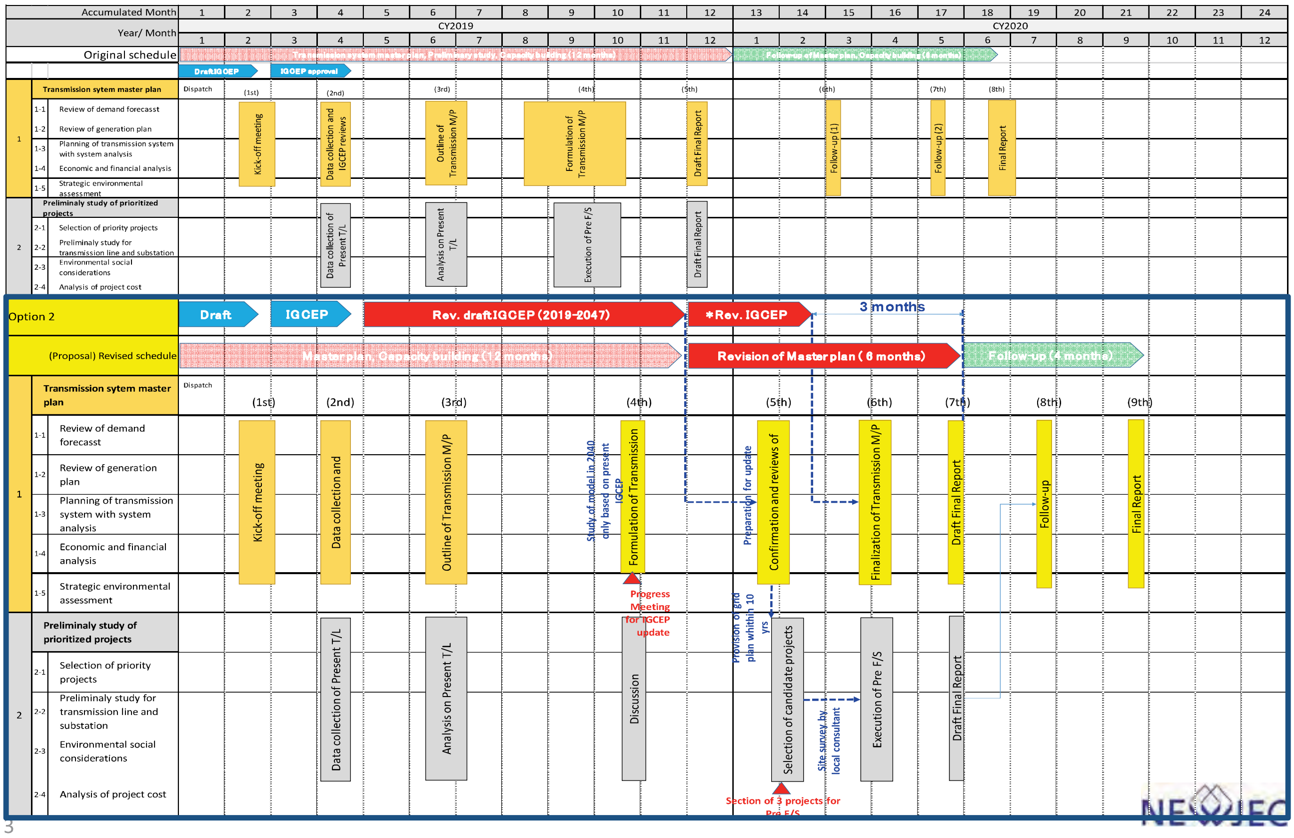
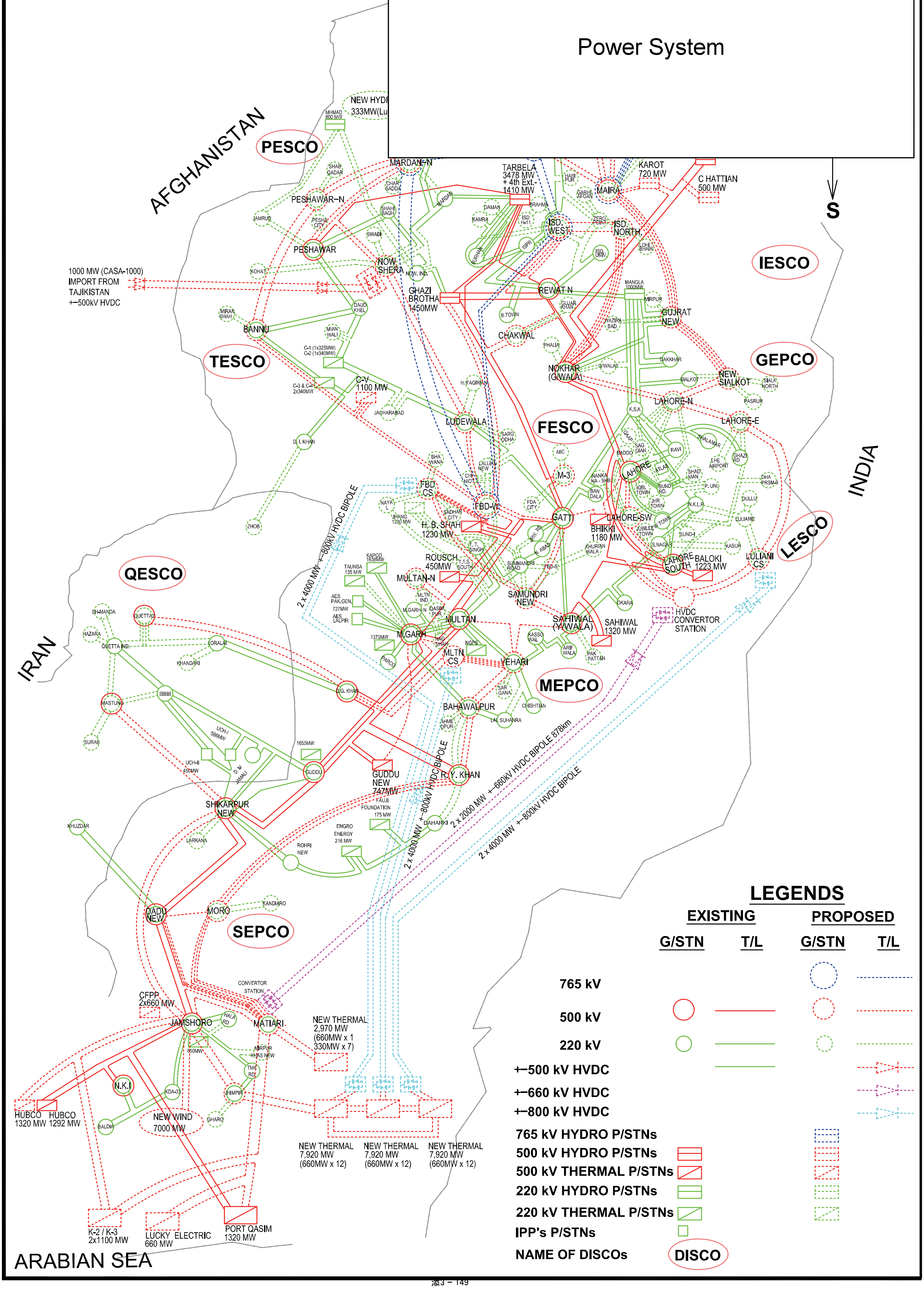
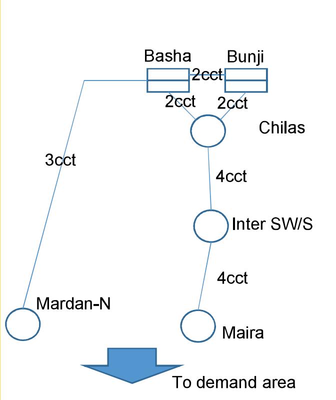
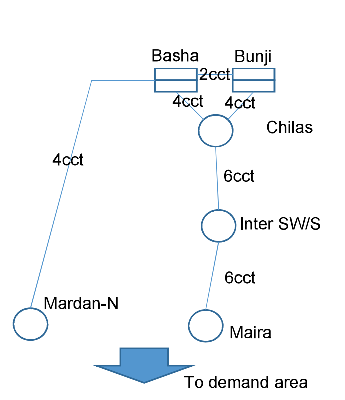
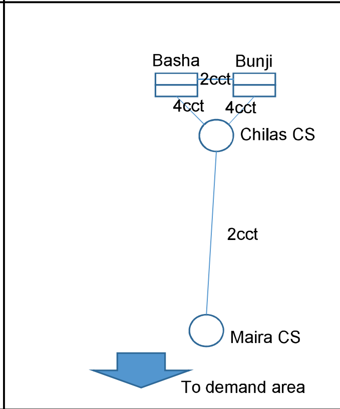
Overall schedule of transmission system M/P



2040 NTDC Network Map



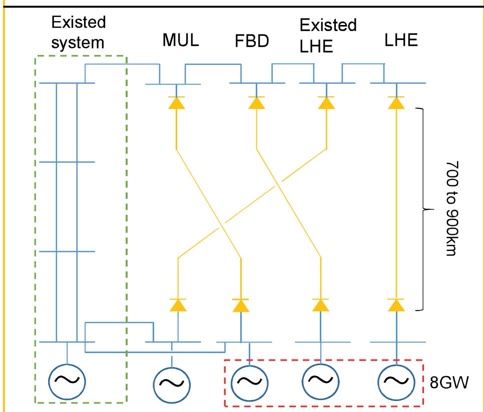
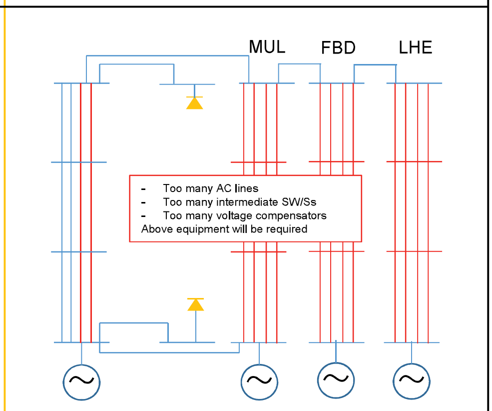
Northern Hydro transmission technique

	AC 765kV	AC 500kV	HVDC
System Diagram			
Reliability	+++	+++	+++
Feasibility (Note)	++ 2 routes	+ 3 routes	+++ 1 route
Cost	+++	++	+ Short distance (260km)
Total Estimation	+++	+	++

good +++ ↕ + bad

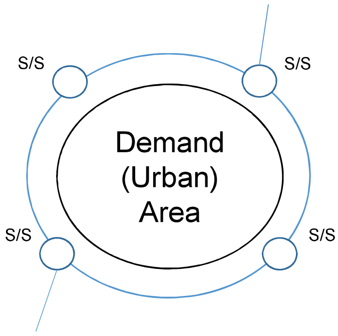
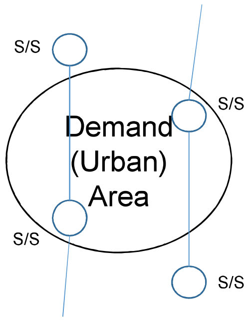
Note : Bunji - Maira routes can be only secured 2 routes from Dasu research report

Southern Thermal transmission technique

	HVDC	AC 500 or 765 or 1000kV
System Diagram		
Reliability	+++	+ Power transmission clearly difficulty in terms of static stability
Feasibility	+++ 3 routes	+ Too many routes
Cost	+++	+
Total Estimation	+++	+

good +++ ↕ + bad

Demand Area supply method

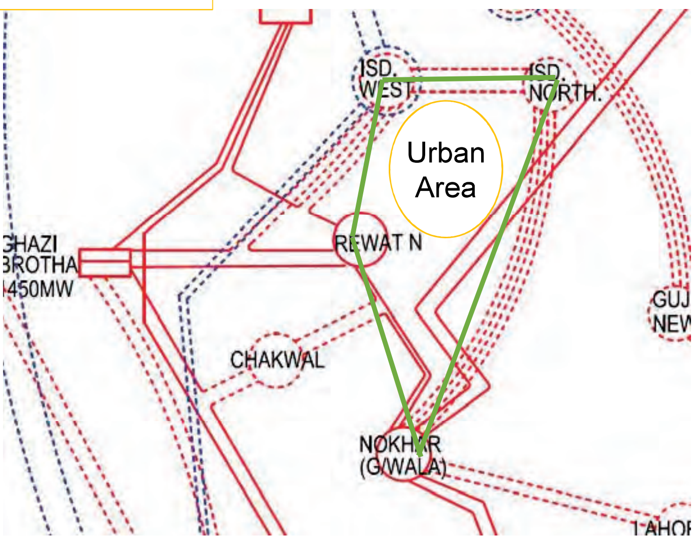
	Loop	Radial
500kV System Diagram		
Reliability	+++ Transmission is possible even if on 1 route is cut off	+
Feasibility	+++	+ difficult to create a G/S in the city center
Cost	+++	+ High cost to use underground line
Total Estimation	+++	+

good +++ ↕ + bad

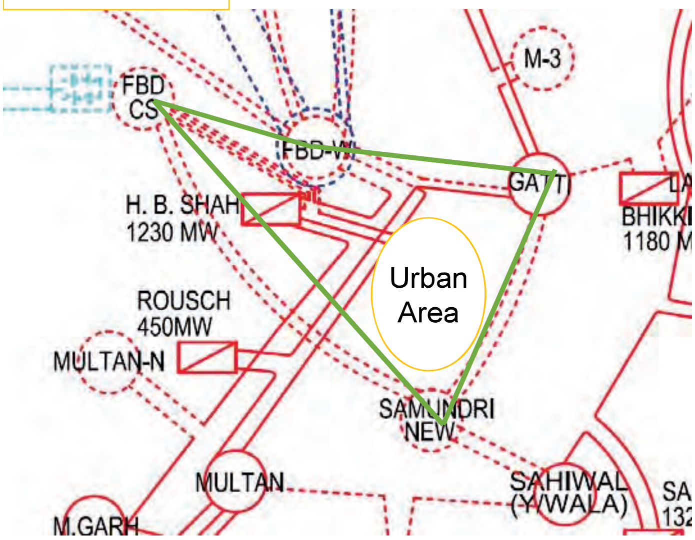
Example of Urban Network in 2040 model

: loop

Faisalabad area



Islamabad area



Criteria for power system analysis of this submission 1

Study year : 2040
Used data : NPCC demand and generation record in 2018, PSSE 2025 model

Demand and power source condition

Study cross section		Demand	Power source
Summer (Jun.)	Peak 15:00*	Total : approx. 80GW (incl. T/L loss) (IGCEP 2040 normal case demand) Area : Demand allocation to each 220kV G/S according to DISCO's scale and growth rate in Power Market Survey 2017-27	(Hydro****) ROR : 68.2%** Reservoir : 90%*** Irrigation : 90%*** (Renewable) Solar : 34.5%** Wind : 48.9%** Bio : 49.6%** And adjust the rest with Thermal and Nuclear
	Off-Peak 07:00*	Ratio of average demand during off-peak hours in Jun. based on operational records in 2018 to summer peak demand	(Hydro) ROR : 55.7%** Reservoir : 68%*** Irrigation : 70%*** (Renewable) Solar : 8.3%** Wind : 41.5%** Bio : 50.3%** And adjust the rest with Thermal and Nuclear
Winter (Feb.)	Peak 19:00*	Ratio of average demand during peak hours in Feb. based on operational records in 2018 to summer peak demand	(Hydro) ROR : 52%** Reservoir : 39.2%** Irrigation : 23.8%** (Renewable) Solar : 0%** Wind : 12.2%** Bio : 39.4%** And adjust the rest with Thermal and Nuclear
	Off-Peak 04:00*	Ratio of average demand during off-peak hours in Feb. based on operational records in 2018 to summer peak demand	(Hydro) ROR : 26.3%** Reservoir : 10%** Irrigation : 14.3%** (Renewable) Solar : 0%** Wind : 10.7%** Bio : 39.1%** And adjust the rest with Thermal and Nuclear

* : Monthly average peak (or off-peak) occurrence hour in 2018
** : Monthly average utilization rate in 2018
*** : The utilization rate can't cover supply in 2018
**** : Designed power source line capacity is 100%

Criteria for power system analysis of this submission 2

Renewable energy

Type	Placement	Remark
Hydro	Informed planned development points	
Photovoltaic	Equal allocation according to demand amount	Generated power is set each 220kV G/S according to 220kV G/S demand
Wind	Sindh area	

Power system standard

Reference : NTDC Grid Code 2005

Items	Criteria
Heat capacity	Continuous rated capacity (Transmission line) 100% (Transformer) 2 units : 75% 3 or 4 units : 100%
Voltage	Rated voltage : +-5%
Short circuit current	• Operation status : Driving all generators • Generator reactance : Xd''（subtransient reactance） • Fault aspect : 3LS • Upper limit : 63kA (765,500,220kV)
Transient stability	• T/L Fault point : At the near end of a power plant / substation • 3LG-O fault clearing time : By 5 cycle (0.1sec.) • Stability condition: The generators can continue to operate without out-of-phase

Criteria for power system analysis of this submission 3

Transmission lines

Voltage class	Type of conductor	Thermal capacity [MVA/cct]
220kV	TACSR/AS 810 Double	1,560
500kV	ACSR/AS Drake 795MCM Quad	2,940
765kV	ACSR/AS Drake 795MCM Quad	4,500

Conditions

Item	ACSR/AS	TACSR/AS
Emissivity	0.9	0.9
Solar Radiation	0.1 W/cm^2	0.1 W/cm^2
Wind Velocity	3 feet/s	3 feet/s
Ambient Temperature	40 degree	40 degree
Conductor Temperature	90 degree	150 degree

For 2047 study

Following issues are considered in the analysis of 2047 model

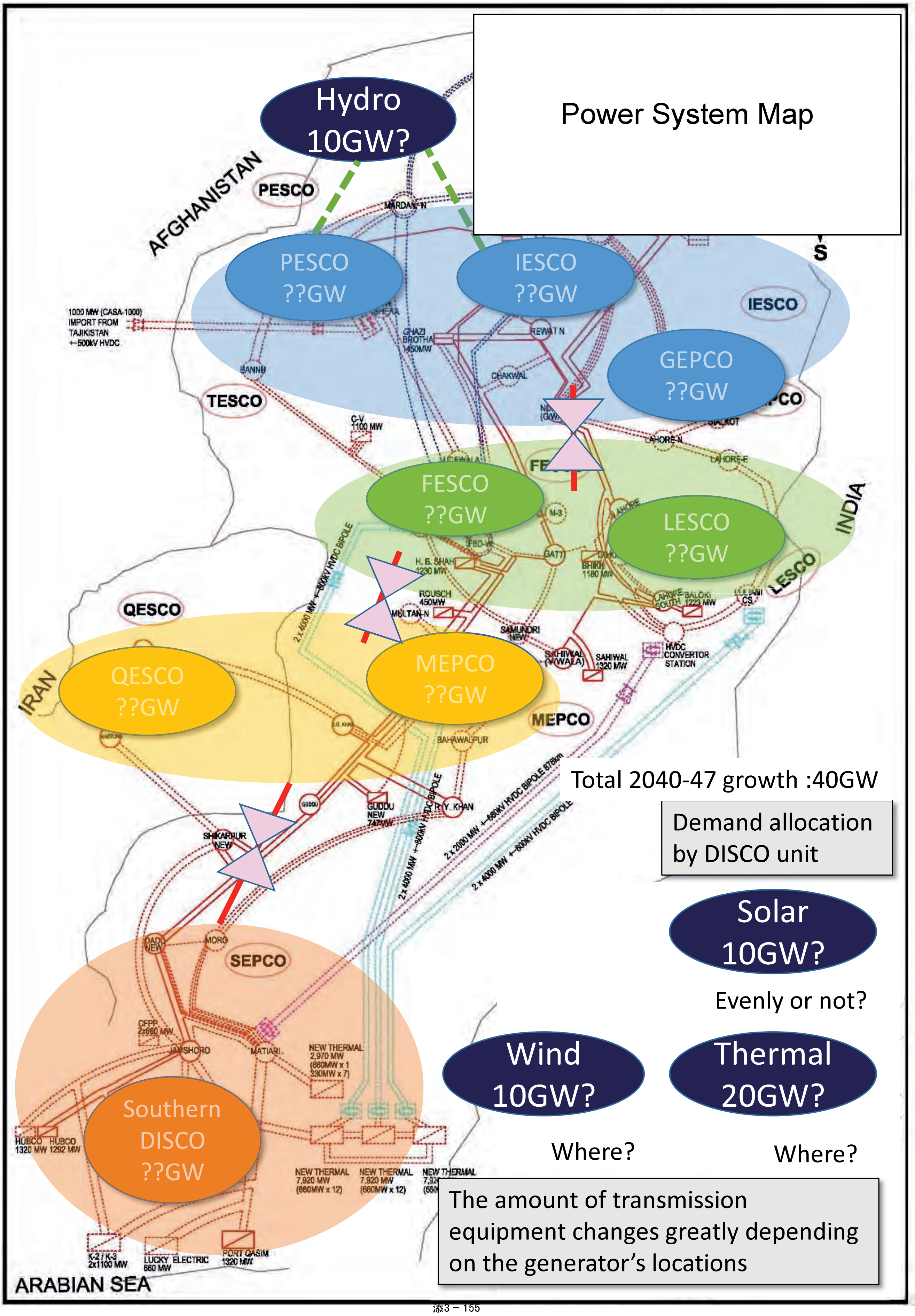
- If demand forecast is expanded based on the IGCEP, additional demand from 2040 reach to approx. 40GW.
- However, location of power plants are supposed to be not identified.
- Detailed configuration of the power system is seemed to be non sense in this situation.

Analysis model in 2047 shall be on concept basis with 500kV or more voltage class

Proposed concept of the power system in 2047 are;

- Diversification and Decentralization of the Power Supply by the Utilization of Domestic Energy (Solar, Wind, hydro and coal)
- Integration of Renewable Energy to the Power System
- Zoning of the National Power System into Four (4) Regional Grids
- Establishment of Interactive International Connection

Example study model as of 2047



PSSE 2040 Model

				Summer				Winter			
			Demand	Peak		Off-Peak		Peak		Off-Peak	
				Completed		Completed		Completed		Completed	
Item			Installed Capacity	Output		Output		Output		Output	
			MW	%	MW	%	MW	%	MW	%	MW
Hydro	1	ROR	3,844.5	68.2%	2,621.0	55.7%	2,142.8	52.0%	1,999.5	26.3%	1,010.7
	2	Reservoir	27,425.5	90.0%	24,683.0	68.0%	18,649.4	39.2%	10,745.7	10.0%	2,755.8
	3	Irrigation	8,782.8	90.0%	7,904.5	70.0%	6,148.0	23.8%	2,093.9	14.3%	1,257.1
Thermal	4	Oil	4,858.3	82.5%	4,008.1	82.5%	4,008.1	0.0%	0.0	0.0%	0.0
	5	Natural Gas	2,506.0	90.0%	2,255.4	90.0%	2,255.4	50.0%	1,253.0	50.0%	1,253.0
	6	RLNG	5,608.0	90.0%	5,047.2	90.0%	5,047.2	60.0%	3,364.8	50.0%	2,804.0
	7	Domestic Coal	26,730.0	90.0%	24,057.0	90.0%	24,057.0	90.0%	24,057.0	65.0%	17,374.5
	8	Imported Coal	5,595.0	90.0%	5,035.5	90.0%	5,035.5	90.0%	5,035.5	60.0%	3,357.0
Renewable	9	Solar	6,500.0	34.5%	2,241.6	8.3%	539.1	0.0%	0.0	0.0%	0.0
	10	Wind	8,141.5	48.9%	3,980.6	41.5%	3,379.2	12.2%	989.5	10.7%	871.4
	11	Bio	473.4	49.6%	234.9	50.3%	237.9	39.4%	186.4	39.1%	184.9
Nuclear	12	Nuclear	4,635.0	90.0%	4,171.5	90.0%	4,171.5	68.3%	3,165.7	68.3%	3,165.6
Others	20	Others	913.6	50.0%	456.8	50.0%	456.8	50.0%	456.8	50.0%	456.8
		Total	106,013.6		86,697.1		76,127.8		53,347.8		34,490.9
				Loss	2,601		2,284		1,600		1,035
				Demand	83,575.3		74,310.6		52,716.6		35,070.4
				Balance	521		-467		-969		-1,614

NTDC 2025 Model

				Summer	
			Demand	Peak	
			43,000.0	100.0%	43,000.0
Item			Supply Capacity	Output	
			MW	%	MW
Hydro	1	ROR	2,183.5	97.0%	2,117.2
	2	Reservoir	11,423.6	94.1%	10,752.1
	3	Irrigation	8,782.8	96.3%	8,459.0
Thermal	4	Oil	4,858.3	94.2%	4,578.5
	5	Natural Gas	2,506.0	93.8%	2,350.8
	6	RLNG	5,208.0	68.2%	3,550.3
	7	Domestic Coal	2,970.0	100.0%	2,970.0
	8	Imported Coal	5,595.0	99.7%	5,580.0
Renewable	9	Solar	1,687.4	44.9%	757.2
	10	Wind	1,141.5	43.0%	491.3
	11	Bio	473.4	95.9%	453.9
Nuclear	12	Nuclear	4,635.0	98.2%	4,552.5
Others	20	Others	913.6	96.0%	877.5
		Total	52,378.0		47,490.3

NPCC 2018 Record (Monthly Average)

				Summer (June)				Winter (February)			
			Demand	Peak (15:00)		Off-Peak (07:00)		Peak (19:00)		Off-Peak (04:00)	
			26,741.0								
Item			Installed Capacity	Output		Output		Output		Output	
			MW	%	MW	%	MW	%	MW	%	MW
Hydro	1	ROR	581.0	68.2%	396.1	55.7%	323.8	52.0%	302.2	26.3%	152.8
	2	Reservoir	2,907.0	59.9%	1,741.9	40.6%	1,180.5	39.2%	1,139.0	10.0%	292.1
	3	Irrigation	6,131.0	52.6%	3,227.9	47.4%	2,904.8	23.8%	1,461.7	14.3%	877.5
Thermal	4	Oil	6,436.6	34.9%	2,243.2	27.1%	1,745.6	16.5%	1,063.5	5.6%	361.6
	5	Natural Gas	4,209.0	57.5%	2,421.9	58.0%	2,442.9	53.3%	2,241.5	51.3%	2,159.3
	6	RLNG	7,415.0	65.6%	4,864.1	60.7%	4,502.3	38.4%	2,850.3	20.4%	1,510.0
	7	Domestic Coal	150.0	0.0%	0.0	0.0%	0.0	0.0%	0.0	0.0%	0.0
	8	Imported Coal	2,640.0	82.7%	2,183.2	79.5%	2,097.9	64.0%	1,689.7	53.9%	1,424.1
Renewable	9	Solar	500.0	34.5%	172.4	8.3%	41.5	0.0%	0.0	0.0%	0.0
	10	Wind	1,184.5	48.9%	579.1	41.5%	491.6	12.2%	144.0	10.7%	126.8
	11	Bio	306.0	49.6%	151.8	50.3%	153.8	39.4%	120.5	39.1%	119.5
Nuclear	12	Nuclear	1,330.0	68.8%	915.2	69.1%	919.6	68.5%	911.0	68.3%	908.4
Others	20	Others	0.0	#DIV/0!	6.0	#DIV/0!	3.0	#DIV/0!	0.0	#DIV/0!	0.0
		Total	33,790.1		18,902.9		16,807.4		11,923.3		7,932.1

1. Standard Specification of Conductors

[765kV]

Type	Nos of Bundle	Nos of Circuit	Thermal Capacity
ACSR/AS Drake 795MCM	Quad (4 Bundled)	Double	5,080 [MVA/cct]

[500kV]

Type	Nos of Bundle	Nos of Circuit	Thermal Capacity
ACSR/AS Drake 795MCM	Quad (4 Bundled)	Double	3,320 [MVA/cct]

[220kV]

Type	Nos of Bundle	Nos of Circuit	Thermal Capacity
TACSR/AS 810 mm^2	Twin (2 Bundled)	Double	1,700 [MVA/cct]

Type	Nos of Bundle	Nos of Circuit	Thermal Capacity
ACSR/AS Rail 954MCM	Quad (4 Bundled)	Double	1,560 [MVA/cct]

- ✓ It is desirable to apply AAAC conductor in the south area of Pakistan.
- ✓ It is desirable to apply LL-ACSR conductor in case of the large capacity and the long line length of T/L's.

2. Conditions of Thermal Capacity Calculation

Item	ACSR/AS	TACSR/AS
Conductor Temperature	90 degree	150 degree
Ambient Temperature	40 degree	
Wind Velocity	3 feet/s	
Solar Radiation	0.1 W/cm^2	
Emissivity	0.9	

Basic Spec for future substation (500kV)

- Transformer

Voltage (kV)	Capacity (MVA)	Qty (unit)	Total (MVA)
500/220 (1 ph x 3)	1,000 750	4 4	4,000 3,000

- Circuit Breaker

Voltage (kV)	Rated Breaking Current (kA)	Insu lation	Operation
500	40 50 63	~~Air~~ SF6 Gas	~~Air~~ Hydraulic or Spring

- Configulations of 500kV Substations

Voltage (kV)	Type	Typical Configuration	Main Bus Configuration
500/220	- Outdoor, Conventional (AIS) AIS Includes Hybrid type GIS - Outdoor / Indoor, Gas Insulated (GIS)	Transformer:3-4unit Circuit Breaker:12-15unit	1-1/2

Basic Spec for future substation (220kV)

- Transformer

Voltage (kV)	Capacity (MVA)	Qty (unit)	Total (MVA)
220/132 (3 phase)	350 250	4 4	1,400 1,000

- Circuit Breaker

Voltage (kV)	Rated Breaking Current (kA)	Insu lation	Operation
220	40 50 63	~~Air~~ SF6 Gas	~~Air~~ Hydraulic or Spring

- Configulations of 220kV Substations

Voltage (kV)	Type	Typical Configuration	Main Bus Configuration
220/132	- Outdoor, Conventional (AIS) AIS Includes Hybrid type GIS - Outdoor / Indoor, Gas Insulated (GIS)	Transformer:3-4unit Circuit Breaker:12-15unit	1-1/2 or Double Bus

1. Demand allocation procedure

Procedure

By DISCO

Calculate demand growth → Allocate demand growth to DISCOs* → Allocate to each grid station**

Note (*): consider scale and growth rate of each DISCO

Note (**): Apply DISCO growth rate regardless of grid station growth records

Precondition

- Used document : The IGCEP and Power Market Survey(PMS) information
- Each grid station demand records : Data collected from 2025 system calculated by PSSE
- The growth rate of peak demand per DISCO : From PMS 2017-26
- The growth rate between 2027 to 2040 : The growth rate in 2026
  (Even if the latest PMS is issued, it will not be revised.)

2. Allocate peak demand to each DISCO

Allocate demand growth to DISCOs by fiscal year

Based on total growth amount allocation, allocate it to DISCOs according to the scale and growth forecast of each DISCO (Peak demand called MW)

Calculate the MW growth by DISCO, by fiscal year

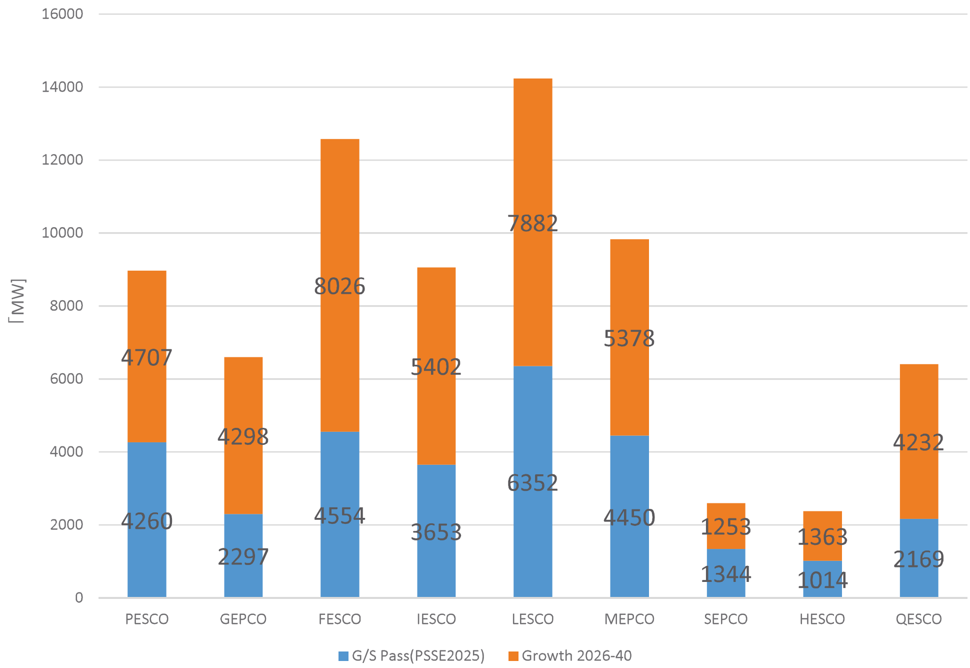
Expected MW growth in the next FY by each DISCO[MW] (Based on PMS) = **MW record or forecast in a certain year by DISCOs [MW]** (From PMS) × **Growth rate by DISCOs [%]** (From PMS) /100

According to the ratio of MW growth of each DISCO to the total MW growth,
Calculate distribution amount of each DISCO based IGCEP MW growth
(PMS MW growths are converted IGCEP MW growths)

MW Distribution amount of a DISCO at a certain FY [MW] = **MW growth of IGCEP [MW]** × (**Expected MW growth in the next FY by each DISCO [MW]** / **Total expected MW growth in the next FY of all DISCOs[MW]**)

The MW growth ratio of each DISCO at a certain FY in PMS

3. Result of allocation (by sum total of DISCO)



Demand growth: demand forecast of IGCEP (2026-40:43,963MW)
Demand growth rate: PMS 2017-26
DISCOs scale: PMS 2017-26

4. Formulate by each grid station (Transformer)

Procedure

Calculate demand growth → Allocate demand growth to DISCOs → By S/S: Allocate to each grid station*

Note (*): Assume that the growth rate of demand in DISCO is constant

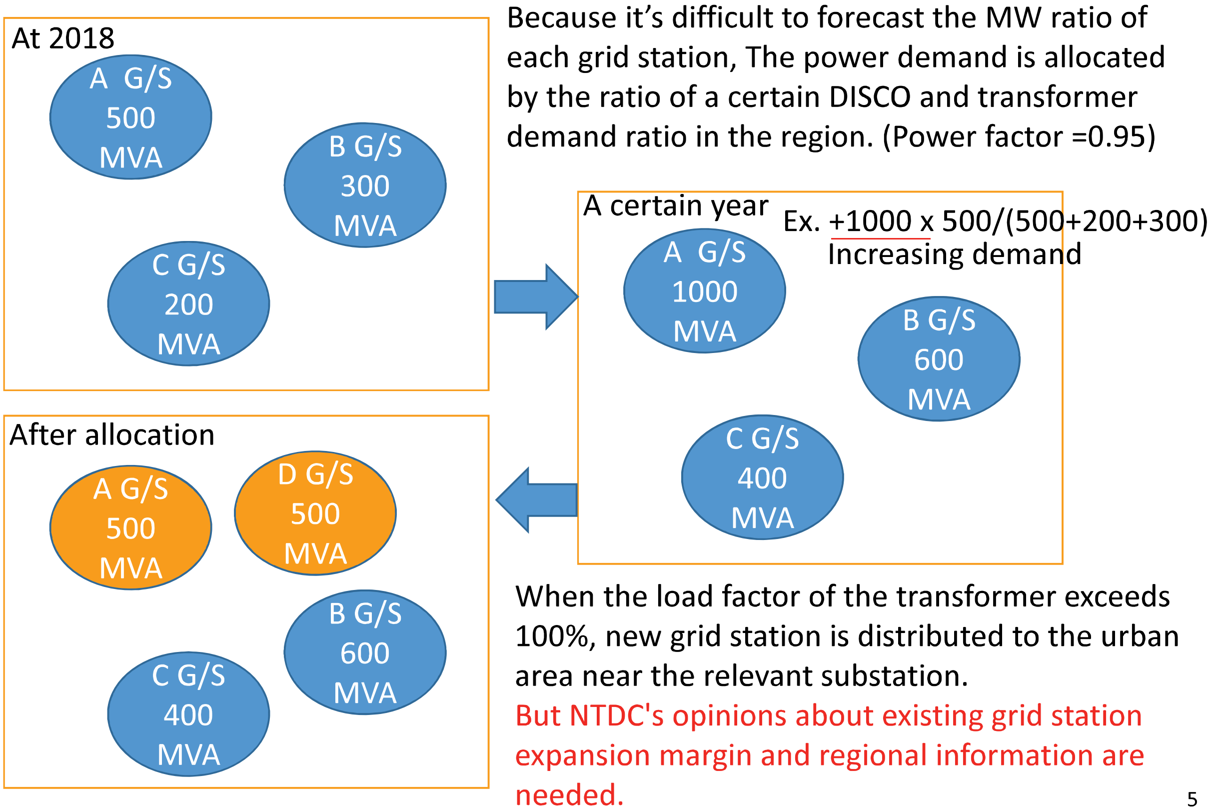
MW Distribution amount of each grid station [MW] = **MW Distribution amount of a DISCO [MW]** × **MW in 2018 by each grid station [MW]** / **Total MW in 2018 at a DISCO[MW]**

The MW ratio of grid station based on 220kV Tr passing power in PSSE2025

Confirm that the sum of the forecasted values for the grid station matches the IGCEP forecast

5. To allocate grid stations (220kV)

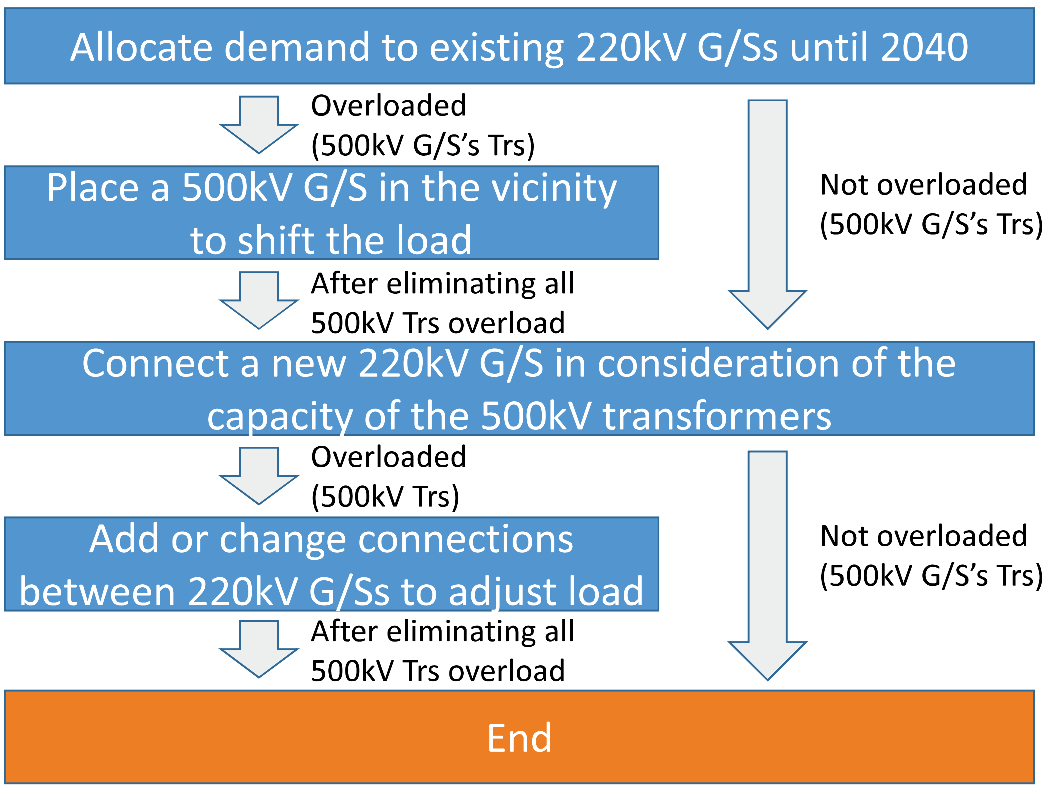
Because it's difficult to forecast the MW ratio of each grid station, The power demand is allocated by the ratio of a certain DISCO and transformer demand ratio in the region. (Power factor =0.95)



When the load factor of the transformer exceeds 100%, new grid station is distributed to the urban area near the relevant substation.
But NTDC's opinions about existing grid station expansion margin and regional information are needed.

6. To allocate grid stations (500kV)

The Allocation flow of a 500kV G/S at a certain DISCO is shown below.



7. Criteria for grid expansion

Application for transformer capacity in final grid station form
765kV : 1,200MVA x 4 units
500kV : 750MVA x 4 units
220kV : 250MVA x 4 units
(In existing substations, 250MVA (220kV) and 750MVA (500kV) transformers are added until there are 4 units.)

Criteria for allocation and expansion

- Add new transformer if the grid station capacity exceeds 100%.
- Add new grid station if the transformer numbers exceeds 4 units.
- Consider supplying the 220kV grid station from another 500kV grid station in the case of the overloaded 500kV grid station.
- The locations of the new grid stations are near where the urban area is close to the overloaded grid station and many of them are referenced the 2030 network model of Lavalin’s report.

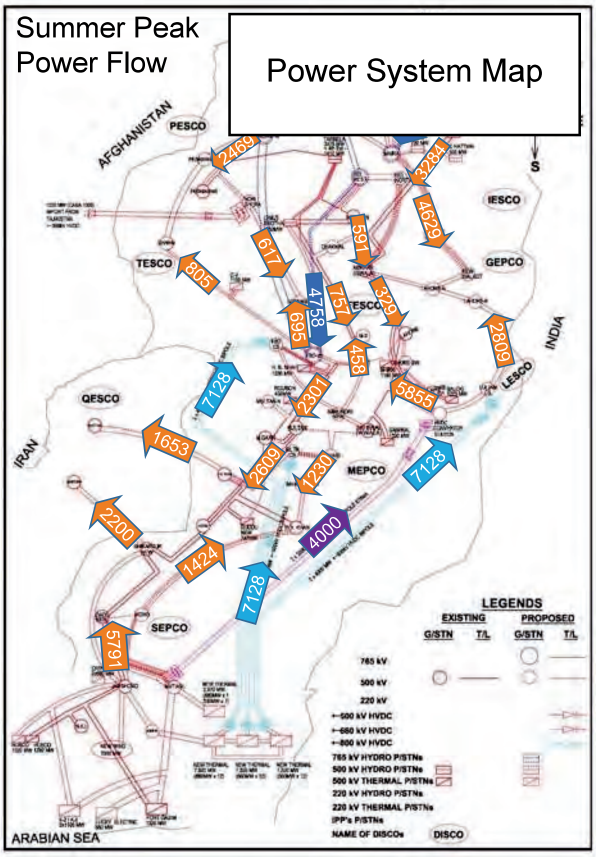
220kV Substation demand Allocation

S/S Installation date
Tr Installation
New Substation

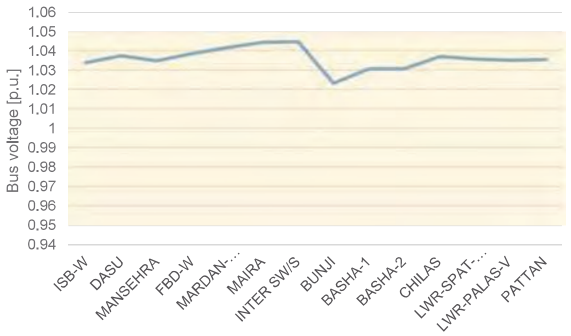
Attachment-2

Responsible DISCO,KE	NodeNo.	Name of Substation	Name of Substation(PSSE)	DISCO Total	MVA	MW PF0.95	record 2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040
PESCO	1	Peshawar	SH-MUHDI		500	475	331.4	338.7	356.6	374.9	393.9	414.8	436.7	153.2	161.5	170.2	179.2	188.9	199.0	209.6	220.8	232.5
	2	Peshawar	SHMUHDI-1		500	475	302.4	309.1	325.4	342.1	359.4	378.5	398.5	419.5	442.1	155.3	163.6	172.4	181.6	191.2	201.5	212.2
	3	Peshawar North	SHABQADAR		500	475								306.5	323.0	340.4	358.5	377.8	398.0	419.2	441.6	465.0
	4	Peshawar City	PESHA-C		500	475										310.6	327.1	344.7	363.2	382.5	402.9	424.3
	5	Kohat	KOHAT-NEW		750	712.5	278.6	284.8	299.8	315.2	331.1	348.7	367.1	386.4	407.3	429.2	452.0	476.4	501.9	528.6	556.8	586.4
	6	Shahi bagh	SHAIBG-N		640	608	419.2	428.5	451.1	474.3	498.3	524.6	552.4	226.9	239.2	252.0	265.4	279.7	294.7	310.4	327.0	344.3
	7	Shabqadar	CHARSADDA		500	475								354.6	373.7	393.8	414.7	437.1	460.5	485.0	510.9	538.0
	8	Chakdara	CHAKDARA-NEW		750	712.5	228	233.0	245.3	257.9	271.0	285.3	300.5	316.3	333.3	351.2	369.9	389.9	410.8	432.6	455.7	479.9
	9	Dera Ismail Khan	DI.KHN-N	4259.9	750	712.5	288	294.4	309.9	325.8	342.3	360.4	379.5	399.5	421.1	443.7	467.3	492.5	518.9	546.4	575.6	606.2
	10	Jamrud	JAMRUD-I		750	712.5	324.6	331.8	349.3	367.2	385.8	406.2	427.8	450.3	474.6	500.1	526.7	555.1	584.8	615.9	648.8	683.2
	11	Bannu	BANNU-N		750	712.5	360.6	368.6	388.0	408.0	428.6	451.3	475.2	500.2	527.2	555.5	585.1	616.6	649.7	293.2	308.9	325.3
	12	Miran Shah	MIRAN-SH		500	475														391.0	411.8	433.7
	13	Haripur	HARIPUR-NEW		1000	950	373.8	382.1	402.2	422.9	444.3	467.8	492.6	518.5	546.5	575.9	606.5	639.2	673.5	709.2	747.1	786.8
	14	Mansehra	MANSHR-N		500	475	196.2	200.5	211.1	222.0	233.2	245.6	258.6	272.2	286.8	302.3	318.3	335.5	353.5	372.3	392.1	413.0
	15	Nowshera Industry	NOSHRA-I		730	693.5	313.8	320.7	337.7	355.0	373.0	392.7	413.5	435.3	458.8	483.4	509.2	536.6	565.4	595.4	627.2	660.5
	16	Mardan	MARDAN		1000	950	503.1	514.2	541.3	569.2	598.0	629.6	663.0	697.9	735.5	775.0	816.3	860.3	906.4	954.5	1005.5	1059.0
	17	Swabi	SWABI-NEW		1000	950	340.2	347.7	366.1	384.9	404.4	425.8	448.3	471.9	497.4	524.1	552.0	581.8	612.9	645.5	680.0	716.1
GEPCO	18	Sialkot (Sahowal)	SAHUWALA		730	693.5	236.7	244.4	264.3	284.9	306.5	330.5	356.1	383.1	412.7	444.1	477.3	513.1	551.0	591.1	634.1	679.6
	19	Ghakkar	GAKKHAR		640	608	445.2	459.7	497.1	535.8	225.0	242.6	261.4	281.2	302.9	326.0	350.3	376.6	404.4	433.9	465.4	498.8
	20	Mirpur	MIRPUR		1000	950					351.5	379.0	408.4	439.4	473.3	509.4	547.4	588.4	631.9	677.9	727.2	779.4
	21	Gujrat	NEW GUJRAT		1000	950	451.5	466.2	504.1	543.4	584.6	630.4	679.2	730.8	787.3	847.2	455.2	489.4	525.5	563.8	604.7	648.2
	22	Wazirabad	WAZIRABAD	2297	750	712.5											455.2	489.4	525.5	563.8	604.7	648.2
	23	Gujranwala2	GUJIRANWALA2		1000	950	380.8	393.2	425.2	458.3	493.1	531.7	572.8	616.4	664.0	714.5	767.9	825.5	443.2	475.5	510.0	546.7
	24	Pasrur	PASRUR		750	712.5													443.2	475.5	510.0	546.7
	25	Nokhar	NOKHAR		1000	950	782.8	808.3	874.0	314.1	337.9	364.3	392.5	422.4	455.0	489.6	526.2	565.6	607.4	651.6	699.0	749.2
	26	Phalia	PHALIA		1000	950				314.1	337.9	364.3	392.5	422.4	455.0	489.6	526.2	565.6	607.4	651.6	699.0	749.2
	27	Sialkot North	SIALKOT-N		1000	950				314.1	337.9	364.3	392.5	422.4	455.0	489.6	526.2	565.6	607.4	651.6	699.0	749.2
FESCO	28	Daud Khel	DAUDKHEL		730	693.5	219.0	225.0	240.8	257.4	275.0	294.9	316.2	339.1	364.5	391.7	420.8	452.5	486.6	523.1	562.6	605.0
	29	Lude wala	LUDWLA-N		1000	950	432.0	443.8	475.0	507.8	542.5	581.6	623.8	669.0	718.9	772.6	830.0	446.3	479.9	515.9	554.9	596.7
	30	(New) Sargodha	SARGODHA		750	712.5												446.3	479.9	515.9	554.9	596.7
	31	Bandala FSD	BANDALN		730	693.5	256.5	263.5	282.0	301.5	322.1	345.3	370.4	397.2	426.9	458.7	492.8	530.0	569.9	612.6	658.9	299.0
	32	Khurianwala	KHURIAN		750	712.5																409.6
	33	M-3-Industrial city	M3-5		1000	950	358.0	367.8	393.6	420.8	449.6	482.0	517.0	554.4	595.8	640.3	687.8	739.8	795.5	855.0	459.8	494.5
	34	(New) FDA City	FDA-CITY		750	712.5															459.8	494.5
	35	Samundri road	S.RD NEW		730	693.5	234.6	241.0	257.9	275.8	294.6	315.9	338.8	363.3	390.4	419.6	450.7	484.8	521.3	560.3	602.7	648.1
	36	Nishatabad	NSHTBD-1		500	475	360.4	370.2	396.3	423.6	150.9	161.7	173.5	186.0	199.9	214.9	230.8	248.2	266.9	286.9	308.6	331.9
	37	Nishatabad	NSHTBD-3		320	304	217.4	223.3	239.0	255.5	273.0	71.0	76.1	81.6	87.7	94.3	101.3	108.9	117.1	125.9	135.4	145.6
	38	Faisalabad South	FBD-S		750	712.5					301.7	323.5	346.9	372.1	399.9	429.7	461.6	496.5	533.9	573.8	617.2	663.7
	39	Samundri	New Samundri		750	712.5						221.7	237.8	255.0	274.1	294.6	316.4	340.3	366.0	393.4	423.1	455.0
	40	Toba Tek Singh	TTSINGHN 132.00	4553.7	1000	950	636.8	654.2	700.2	748.5	799.7	857.4	459.8	493.1	529.9	569.4	611.7	657.9	707.5	760.5	817.9	879.6
	41	T.T.Singh South	TTSINGH-S		1000	950							459.8	493.1	529.9	569.4	611.7	657.9	707.5	760.5	817.9	879.6
	42	Lalian	LALIAN NEW		1000	950	362.4	372.3	398.5	426.0	455.1	487.9	523.3	561.2	603.1	648.1	696.3	748.9	805.2	865.5	465.5	500.6
	43	Chiniot	CHINIOT		750	712.5															465.5	500.6
	44	Jaranwala Road	J.W-RD		640	608	391.2	401.9	430.1	459.8	491.3	526.7	564.9	236.4	254.1	273.0	293.3	315.5	339.2	364.6	392.2	421.7
	45	Naya Lahore	NAYA-L		750	712.5								369.4	397.0	426.6	458.3	492.9	530.0	569.7	612.8	659.0
	46	Faisalabad West	FSD-W		1000	950	691.6	710.5	760.4	812.9	868.6	310.4	332.9	357.0	383.7	412.3	442.9	476.4	512.2	550.6	592.2	636.9
	47	Bhawana	BHAWANA		750	712.5						310.4	332.9	357.0	383.7	412.3	442.9	476.4	512.2	550.6	592.2	636.9
	48	(New) Sadhar City	SADHAR		750	712.5						310.4	332.9	357.0	383.7	412.3	442.9	476.4	512.2	550.6	592.2	636.9
	49	Jauharabad	JAUHRABD		750	712.5	252.4	259.3	277.5	296.7	317.0	339.8	364.5	390.9	420.0	451.4	484.9	521.6	560.8	602.8	648.4	697.3
	50	Head Faqirian	H.FAQIRN		500	475	141.4	145.3	155.5	166.2	177.6	190.4	204.2	219.0	235.3	252.9	271.7	292.2	314.2	337.7	363.2	390.6
IESCO	51	Kamra	KAMRA NEW		750	712.5	278.2	284.7	302.2	320.6	340.0	361.7	384.9	409.7	436.9	466.0	496.9	530.6	566.4	604.5	645.7	689.6
	52	Burhan	BURHAN		500	475	343.7	351.7	373.4	396.1	420.0	446.8	158.5	168.7	179.9	191.9	204.6	218.5	233.3	249.0	265.9	284.0
	53	(New) Daman	DAMAN		1000	950							317.0	337.4	359.8	383.8	409.3	437.0	466.5	497.9	531.8	567.9
	54	Burhan	BURHAN-2		500	475	327.4	335.0	355.7	377.3	400.1	425.6	453.0	160.7	171.4	182.8	194.9	208.1	222.2	237.1	253.3	270.5
	55	(New) Garhi Afganan	GARHI-AFGAN		1000	950								321.4	342.8	365.6	389.9	416.3	444.4	474.3	506.6	541.0
	56	Islamabad West	ISB-WEST		1000	950	477.3	488.4	518.6	550.1	583.3	620.5	660.4	702.8	749.6	799.5	852.6	455.1	485.9	518.6	553.9	591.5
	57	(New) Brahma	BRAHMA		1000	950												455.1	485.9	518.6	553.9	591.5
	58	Sangjani (ISPR)	SANGJANI		640	608	374.4	383.1	406.8	431.5	457.6	486.7	518.0	551.3	229.5	244.7	261.0	278.6	297.5	317.5	339.1	362.2
	59	H-11	H-11		750	712.5									358.5	382.4	407.8	435.4	464.8	496.1	529.8	565.9
	60	Islamabad Univ	ISB-UNIVERTY132.00	3653	750	712.5	243.3	249.0	264.3	280.4	297.3	316.3	336.6	358.3	382.1	407.5	434.6	464.0	495.3	528.7	564.7	603.1
	61	Zero Point	220-ZERO-PT		1000	950	339.3	347.2	368.6	391.0	414.7	441.1	469.4	499.6	532.9	568.3	606.1	647.1	690.8	737.3	787.5	841.0
	62	Bahria Town	BT PH-8		126	119.7	19.0	19.4	20.6	21.9	23.2	24.7	26.3	28.0	29.8	31.8	33.9	36.2	38.7	41.3	44.1	47.1
	63	Rewat	REWAT132-1		500	475	261.4	267.5	284.0	301.3	319.5	339.8	361.7	384.9	410.5	437.9	155.6	166.2	177.4	189.3	202.2	216.0
	64	Rewat	REWAT132-2		500	475	354.6	362.8	385.3	408.7	433.4	153.7	163.5	174.1	185.6	198.0	211.1	225.4	240.6	256.9	274.3	293.0
	65	Lhohi Bhair	LHOHI-B		750	712.5											311.3	332.3	354.8	378.7	404.5	432.0
	66	Islamabad North	ISB-N		750	712.5						307.3	327.1	348.1	371.3	396.0	422.3	450.8	481.3	513.7	548.7	586.0
	67	Mangla	MANGLA-132		664	630.8	224.4	229.6	243.8	258.6	274.2	291.7	310.5	330.4	352.4	375.9	400.8	428.0	456.9	487.6	520.8	556.2
	68	Chakwal	CHAKWAL-NEW		640	608	410.0	419.5	445.4	472.5	501.1	533.0	567.2	235.6	251.3	268.0	285.8	305.1	325.8	347.7	371.3	396.6
	69	Gujar Khan	GUJAR-K		750	712.5								368.1	392.6	418.8	446.6	476.8	509.0	543.3	580.2	619.7
LESCO	80	QAP	QAP-1		750	712.5	240.2	245.6	259.3	273.5	288.3	304.7	322.1	340.4	360.5	381.6	403.9	427.8	453.1	479.8	508.2	538.3
	81	Kala shah kaku	K.S.KAKU		320	304	210.8	215.5	227.6	240.0	253.0	267.4	282.7	72.4	76.7	81.2	85.9	91.0	96.4	102.1	108.1	114.5
	82	Kala shah kaku	K.S.K-2		320	304	133.0	136.0	143.6	151.4	159.6	168.7	178.3	188.5	199.6	211.3	223.6	236.9	250.9	265.6	281.4	298.0
	83	Saggian	SAGGIAN		750	712.5								226.3	239.6	253.7	268.5	284.4	301.3	319.0	337.9	357.9
	84	Lahore North	LAHORE-N		1000	950	484.2	495.1	522.7	551.3	581.1	614.2	649.3	686.3	726.6	769.3	814.1	862.4	456.7	483.6	512.2	542.5
	85	(New) Baddo	BADDO		750	712.5													456.7	483.6	512.2	542.5
	86	Bund road	BUND-RD		500	475	311.0	318.0	335.7	354.1	373.3	394.5	417.0	440.8	155.6	164.7	174.3	184.6	195.6	207.1	219.3	232.3
	87	JHR-Town	JHR-Town		750	712.5									311.1	329.4	348.6	369.3	391.1	414.1	438.7	464.6
	88	WAPDA Town	WAPDATWN		750	712.5	516.9	528.5	558.0	588.5	620.4	655.6	297.1	314.0	332.4	351.9	372.5	394.6	417.9	442.5	468.7	496.4
	89	Lahore South-West	LHE-SOW		750	712.5							396.1	418.6	443.2	469.3	496.6	526.1	557.2	590.0	625.0	661.9
	90	Bund road	BUNDRD-2		500	475	318.6	325.8	343.9	362.7	382.4	404.1	427.2	150.5	159.4	168.7	178.6	189.2	200.3	212.1	224.7	238.0
	91	(New) Jubilee Town	JUBILEE-T		750	712.5								301.0	318.7	337.4	357.1	378.3	400.7	424.2	449.4	476.0
	92	Punjab University	220-PNJB-UNI		1000	950	423.3	432.8	457.0	482.0	508.0	536.9	567.6	600.0	635.2	672.5	711.8	754.0	798.5	845.5	895.6	948.6
	93	Ghazi Road	GHAZI-RD		1000	950	358.8	366.9	387.3	408.5	430.6	455.1	481.1	508.5	538.4	570.0	603.3	639.1	676.9	716.7	759.2	804.1
	94	DHA-Prism	DHA-PSM132		1000	950	354.9	362.9	383.1	404.1	425.9	450.2	475.9	503.0	532.6	563.8	596.7	632.1	669.5	708.9	750.9	795.3
	95	New Kot Lakhpat	NKLP-1		500	475	315.8	322.9	340.9	359.6	379.0	400.6	423.5	447.6	158.0	167.2	177.0	187.5	198.6	210.3	222.7	235.9
	96	(New) Dullu	DULLU	6351.5	750	712.5									315.9	334.5	354.0	375.0	397.2	420.5	445.5	471.8
	97	New Kot Lakhpat	NKLP-2		500	475	313.2	320.2	338.1	356.6	375.9	397.3	420.0	443.9	156.7	165.9	175.5	186.0	196.9	208.5	220.9	234.0
	98	Luliani2	LULIANI2		750	712.5									313.3	331.7	351.1	371.9	393.9	417.1	441.8	467.9
	99	Sundar Industrial Estate	S.INDUST		500	475	243.6	249.1	263.0	277.4	292.4	309.0	326.6	345.3	365.6	387.0	409.6	433.9	459.5	486.6	515.4	545.9
	100	Sheikhupura(Lahore)	LAHORE		500	475	358.2	366.2	386.7	407.8	429.9	151.4	160.1	169.2	179.2	189.7	200.8	212.7	225.2	238.5	252.6	267.6
	101	Sheikhupura(Lahore)	LAHORE-2		500	475	263.2	269.1	284.1	299.7	315.9	333.8	352.9	373.0	395.0	418.2	442.6	156.3	165.5	175.2	185.6	196.6
	102	IQBL Town	IQBL-T		750	712.5						302.9	320.2	338.5	358.4	379.4	401.5	425.3	450.5	477.0	505.3	535.1
	103	(New) Nankana Sahib	NANKANA-S		750	712.5												312.5	331.0	350.5	371.3	393.2
	104	New Shalimar	NEW SHALIMAR132.00		730	693.5	227.7	232.8	245.8	259.2	273.3	288.8	305.3	322.7	341.7	361.8	382.9	405.6	429.6	454.8	481.8	510.3
	105	Ravi	RAVI-I		500	475	283.6	290.0	306.2	322.9	340.4	359.7	380.3	402.0	425.6	150.2	159.0	168.4	178.3	188.8	200.0	211.8
	106	Ravi	RAVI-II		500	475	275.2	281.4	297.1	313.3	330.3	349.1	369.0	390.1	413.0	437.2	154.2	163.4	173.1	183.2	194.1	205.6
	107	(New) Lahore Airport	LHE-AIRP		750	712.5										300.4	317.9	336.8	356.7	377.6	400.0	423.7
	108	(New) Shadman	SHADMAN		750	712.5											308.5	326.8	346.1	366.5	388.2	411.1
	109	Sarfaraz nagar	SRFZNG-1		320	304	112.0	114.5	120.9	127.5	134.4	142.1	150.2	158.7	168.1	177.9	188.3	199.5	211.3	223.7	237.0	251.0
	110	Sarfaraz nagar	SRFZNG-2		320	304	112.0	114.5	120.9	127.5	134.4	142.1	150.2	158.7	168.1	177.9	188.3	199.5	211.3	223.7	237.0	251.0
	111	Kasur	KASUR132		750	712.5	169.2	173.0	182.7	192.6	203.1	214.6	226.9	239.8	253.9	268.8	284.5	301.4	319.2	338.0	358.0	379.2
	112	Okara	OKARA-N		1000	950	326.1	333.4	352.0	371.3	391.4	413.6	437.3	462.2	489.4	518.1	548.3	580.8	615.2	651.3	690.0	730.8
MEPCO	120	Yousafwala Sahiwal	YOUSFWLA		640	608	466.0	476.3	502.8	530.1	558.5	230.2	243.2	256.8	271.6	287.2	303.6	321.2	339.7	359.2	379.8	401.6
	121	(New) Pakpattan	PAKPATTAN		750	712.5						359.7	380.0	401.3	424.4	448.8	474.4	501.9	530.8	561.2	593.5	627.6
	122	Arifwala	ARIFWALA-NEW		750	712.5	249.4	254.9	269.1	283.7	298.9	315.7	333.5	352.2	372.5	393.9	416.4	440.5	465.9	492.6	520.9	550.8
	123	Vehari	VEHARI-N		640	608	412.8	422.0	445.4	469.6	494.8	522.6	552.0	227.5	240.6	254.5	269.0	284.5	300.9	318.1	336.5	355.8
	124	Ahmedpur	AHMEDPUR		750	712.5								355.5	376.0	397.6	420.3	444.6	470.2	497.1	525.8	555.9
	125	Kassowal	KASSOWAL		570	541.5	175.6	179.5	189.5	199.8	210.5	222.3	234.8	248.0	262.3	277.4	293.2	310.2	328.0	346.8	366.8	387.8
	126	Multan	MULTAN-N		750	712.5	272.7	278.8	294.2	310.2	326.9	345.2	364.7	385.1	407.3	430.7	455.3	481.7	509.4	538.6	569.6	602.3
	127	Nag Shah	NAGSHAH132		750	712.5	280.2	286.4	302.3	318.8	335.8	354.7	374.7	395.7	418.5	442.6	467.8	494.9	523.4	553.4	585.3	618.8
	128	PIRNGHAB?	P.GAIB-1		500	475	181.4	185.4	195.7	206.4	217.4	229.6	242.6	256.2	271.0	286.5	302.9	320.4	338.9	358.3	378.9	400.6
	129	PIRNGHAB?	P.GAIB-2		320	304	163.4	167.0	176.3	185.9	195.8	206.9	218.5	230.8	244.1	258.1	272.8	70.0	74.0	78.2	82.7	87.5
	130	Sargana	SARGANA	4449.5	750	712.5												218.7	231.2	244.5	258.6	273.4
	131	Qasimpur Colony	QASIMPUR		750	712.5	267.0	272.9	288.1	303.7	320.0	338.0	357.0	377.1	398.8	421.7	445.8	471.6	498.8	527.3	557.7	589.7
	132	Muzaffargarh	M GARH NEW		750	712.5	275.0	281.1	296.7	312.8	329.6	348.1	367.7	388.4	410.8	434.4	459.2	485.7	513.7	543.1	574.4	607.4
	133	KAPCO	KAPCO		500	475	303.5	310.2	327.5	345.3	363.8	384.2	405.9	428.6	151.1	159.8	168.9	178.7	189.0	199.8	211.3	223.4
	134	Multan Industry	MULTAN-I		750	712.5									302.2	319.6	337.8	357.4	378.0	399.6	422.6	446.9
	135	Bahawalpur	B.W.P-N		1000	950	428.1	437.6	461.9	487.0	513.1	541.9	572.5	604.6	639.4	676.2	714.8	756.2	799.7	845.5	894.2	472.7
	136	Chishtian	CHSTAN-N		750	712.5	250.8	256.4	270.6	285.3	300.6	317.5	335.4	354.2	374.6	396.2	418.8	443.0	468.5	495.3	523.9	553.9
	137	Rahim Yar Khan	R Y KHAN		1000	950	350.4	358.2	378.1	398.6	420.0	443.6	468.6	494.8	523.4	553.5	585.1	618.9	654.6	692.0	731.9	773.9
	138	Lal Sohanra			750	712.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	472.7
	139	Daharki	DHARKI		500	475	92.4	94.5	99.7	105.1	110.7	117.0	123.6	130.5	138.0	146.0	154.3	163.2	172.6	182.5	193.0	204.1
	140	Dera Ghazi Khan	D.G.Khan		750	712.5	280.8	287.0	303.0	319.4	336.6	355.5	375.5	396.6	419.4	443.5	468.8	496.0	524.6	554.6	586.5	620.2
SEPCO	150	Rohri	ROHRI-NW		750	712.5	271.2	276.3	289.1	302.2	315.7	330.4	345.8	361.9	379.1	397.1	415.8	435.7	456.3	477.8	500.5	524.1
	151	Guddu	GUDDU-2		500	475	164.6	167.7	175.5	183.4	191.6	200.5	209.9	219.6	230.1	241.0	252.4	264.4	277.0	290.0	303.8	318.1
	152	Guddu	GUDDU-1		250	237.5	112.8	114.9	120.3	125.7	131.3	137.4	143.8	150.5	157.7	165.2	172.9	181.2	189.8	198.7	208.2	218.0
	153	Shikarpur	SHIKAR-N	1344.2	750	712.5	279.9	285.2	298.4	311.9	325.8	341.0	356.9	373.5	391.3	409.9	429.2	449.6	471.0	493.2	516.5	540.9
	154	Dadu	DADU NEW		730	693.5	365.1	372.0	389.2	406.8	425.0	444.8	465.5	487.1	510.4	534.6	559.8	586.5	614.3	643.3	284.3	297.7
	155	(New) Kandiaro	KANDIARO		750	712.5															389.5	407.8
	156	Larkana	NEW LARKANA		500	475	150.6	153.4	160.6	167.8	175.3	183.5	192.0	200.9	210.5	220.5	230.9	241.9	253.4	265.3	277.9	291.0
HESCO	160	Jamshoro	JAMSHORO		730	693.5	210.3	215.7	229.5	243.8	258.5	274.7	291.7	309.5	328.7	348.8	369.8	392.2	415.6	440.0	465.9	493.0
	161	Hala road	HALAROAD		250	237.5	78.1	80.1	85.2	90.5	96.0	102.0	108.3	114.9	122.1	129.5	137.3	145.6	154.3	163.4	173.0	183.1
	162	Hala road	HALAROAD-1		1000	950	304.6	312.4	332.5	353.1	374.4	397.8	422.5	448.2	476.0	505.2	535.6	568.0	601.9	637.3	674.8	714.1
	163	Mirpur Khas	M.KHS.NW	1014.1	750	712.5	206.6	211.9	225.5	239.5	254.0	269.8	286.6	304.0	322.9	342.7	363.3	385.3	408.3	432.3	457.7	484.3
	164	Tando Muhammad	HYD-TMK-2		250	237.5	78.9	80.9	86.1	91.5	97.0	103.0	109.4	116.1	123.3	130.9	138.7	147.1	155.9	165.1	174.8	185.0
	165	Tando Muhammad	HYD-TMRD		500	475	135.6	139.1	148.0	157.2	166.7	177.1	188.1	199.5	211.9	224.9	238.4	252.9	268.0	283.7	300.4	317.9
QESCO	170	Zhob	ZHOB NEW		570	541.5	144.0	148.7	160.8	173.4	186.7	201.6	217.5	234.5	253.1	273.0	294.1	317.0	341.4	367.3	395.2	425.0
	171	Mastung	MASTUNG		1000	950	420.0	433.7	469.0	505.9	544.7	588.0	634.5	683.9	738.3	796.2	857.8	462.3	497.9	535.7	576.4	619.8
	172	(New) Quetta2	QUETTA2		750	712.5												462.3	497.9	535.7	576.4	619.8
	173	Sibi	SIBBI		730	693.5	231.9	239.4	258.9	279.3	300.7	324.7	350.3	377.6	407.6	439.6	473.6	510.5	549.8	591.5	636.5	288.8
	174	(New) Khadrani	KHADRANI		750	712.5																395.6
	175	Loralai	LORALAI		750	712.5	207.3	214.0	231.5	249.7	268.8	290.2	313.2	337.6	364.4	393.0	423.4	456.3	491.5	528.8	569.0	611.8
	176	Quetta	QUETTAIN	2168.9	1000	950	407.4	420.7	454.9	490.7	528.3	570.4	615.5	663.4	716.1	772.3	832.0	448.4	482.9	519.6	559.1	601.2
	177	(New) Hazara Town	HAZARA-T		750	712.5												448.4	482.9	519.6	559.1	601.2
	178	SH-MANDA?	Q.S.MAND		1000	950	281.0	290.1	313.8	338.4	364.4	393.4	424.5	457.6	493.9	532.7	573.9	618.6	666.2	716.8	771.3	829.3
	179	Khuzdar	KHUZDAR		730	693.5	381.3	393.7	425.8	459.2	494.5	533.8	576.0	620.9	282.8	305.0	328.6	354.2	381.5	410.4	441.6	474.9
	180	(New) Surab	SURAB		750	712.5									387.4	417.8	450.1	485.2	522.5	562.2	605.0	650.5
	181	Dera Murad Jamali	DM.J-132		510	484.5	96.0	99.1	107.2	115.6	124.5	134.4	145.0	156.3	168.7	182.0	196.1	211.3	227.6	244.9	263.5	283.3

Summer Peak

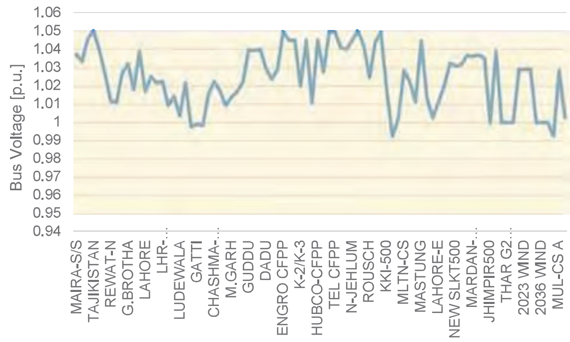

Summer Peak
Power Flow
Power System Map
AFGHANISTAN
PESCO
IESCO
GEPCO
TESCO
INDIA
LESCO
QESCO
IRAN
MEPCO
SEPCO
ARABIAN SEA
2469
3284
4629
617
591
805
4758
757
329
695
458
2809
7128
2301
5855
1653
2609
1230
7128
2200
4000
1424
7128
5791
LEGENDS
EXISTING
PROPOSED
G/STN
T/L
765 kV
500 kV
220 kV
±500 kV HVDC
±660 kV HVDC
±800 kV HVDC
765 kV HYDRO P/STNs
500 kV HYDRO P/STNs
500 kV THERMAL P/STNs
220 kV HYDRO P/STNs
220 kV THERMAL P/STNs
IPP's P/STNs
NAME OF DISCOs
DISCO

Bus Voltage (765kV)

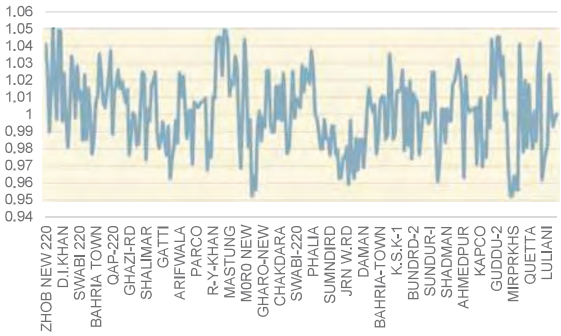


Bus Voltage (500kV)

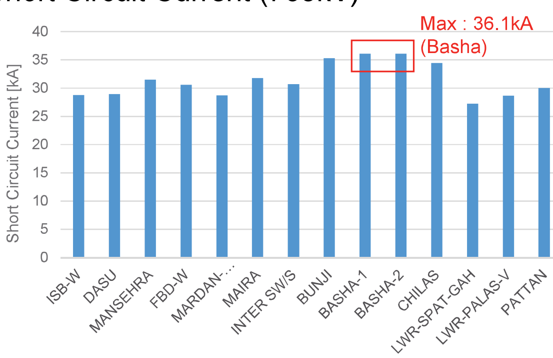
: Voltage range (+-5%)



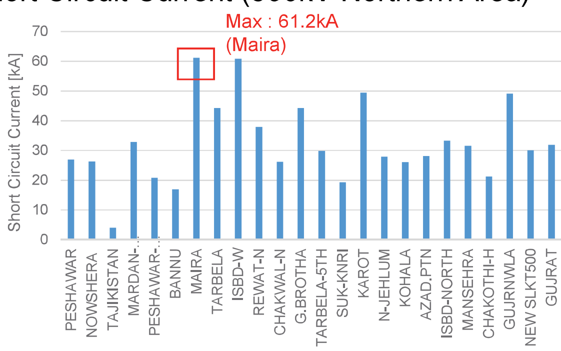
Bus Voltage (220kV)



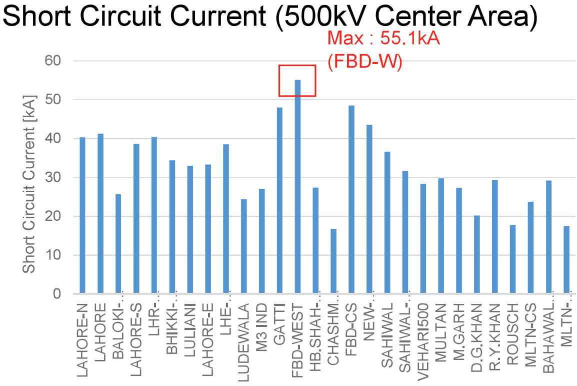
Short Circuit Current (765kV)



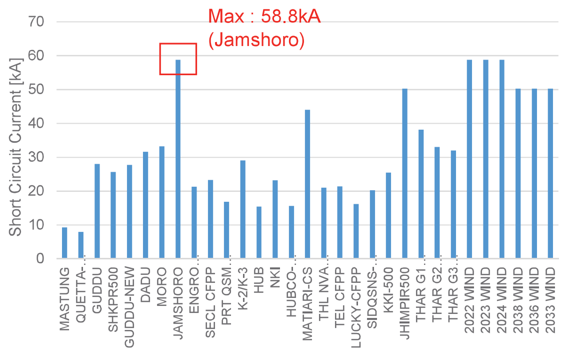
Short Circuit Current (500kV Northern Area)



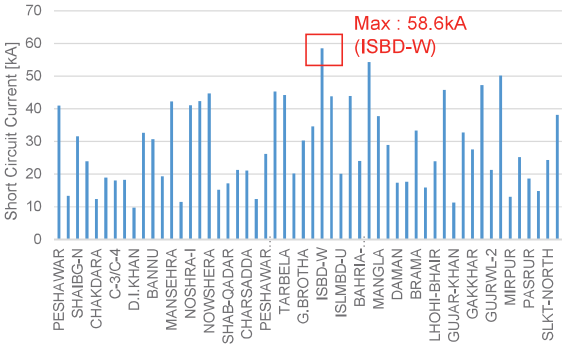
Short Circuit Current (500kV Center Area)



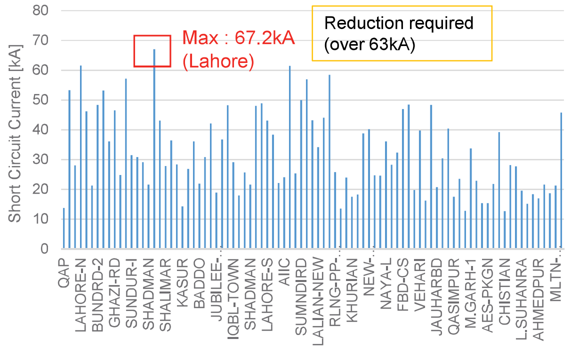
Short Circuit Current (500kV Southern Area)



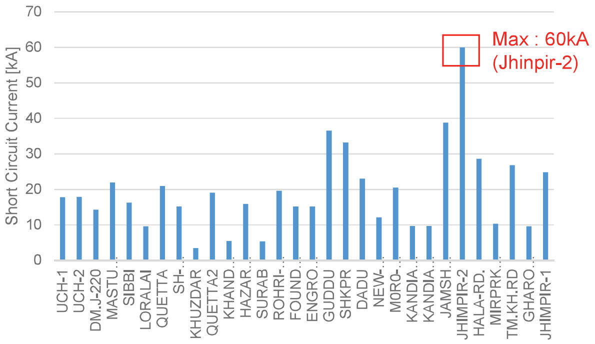
Short Circuit Current (220kV Northern Area)



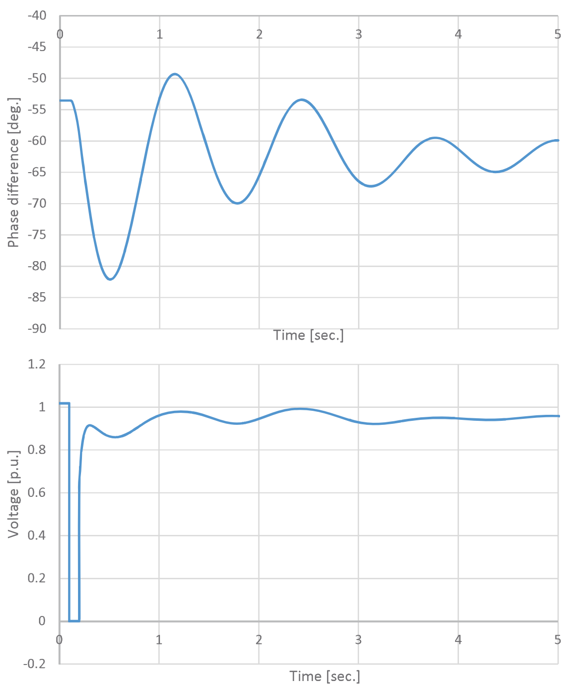
Short Circuit Current (220kV Center Area)



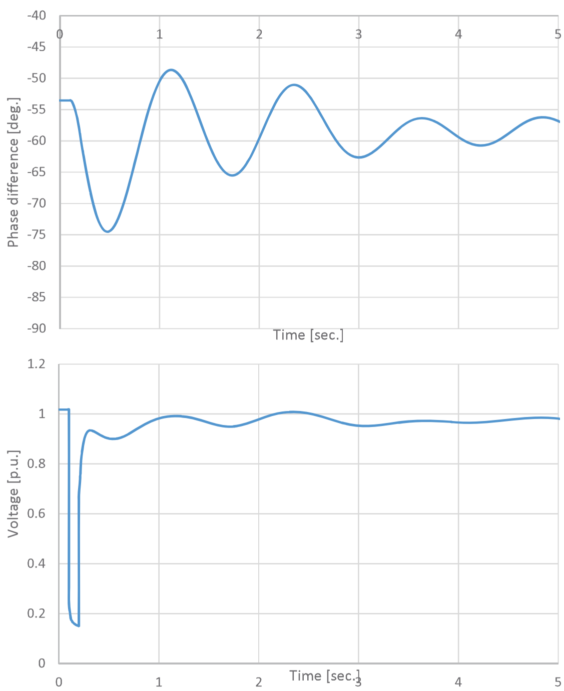
Short Circuit Current (220kV Southern Area)



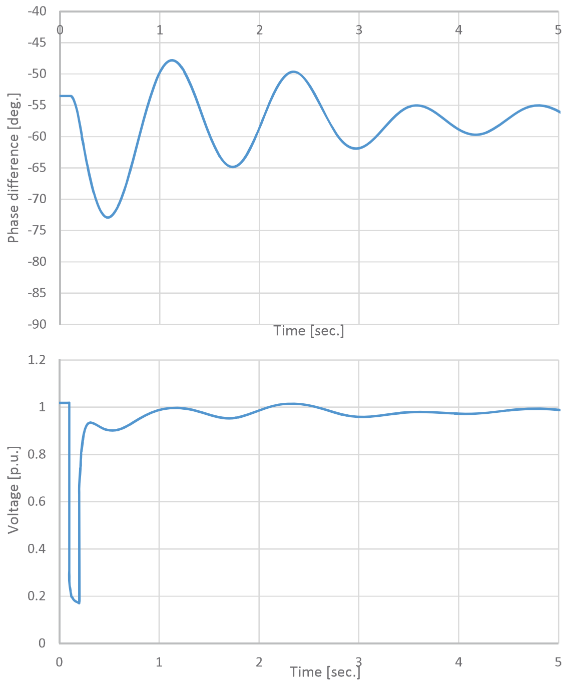
Bunji – Chilas line fault (Bunji side)
Reference phase : N. Jelum and Bunji



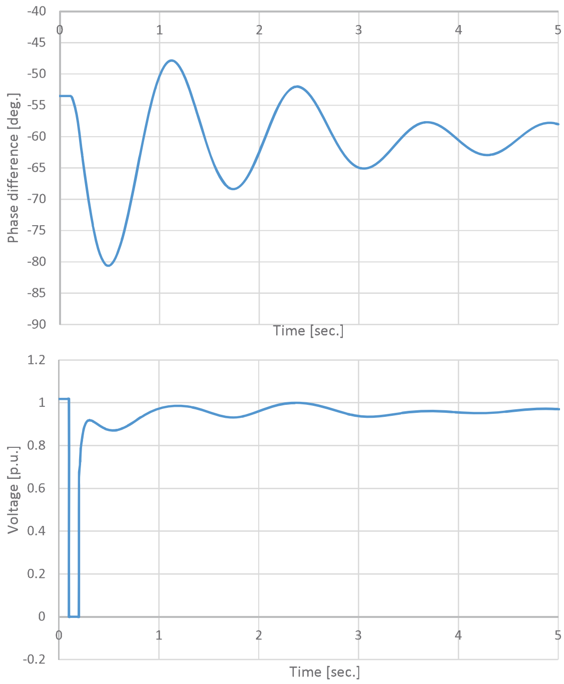
Chilas – Inter SW/S line fault (Chilas side)
Reference phase : N. Jelum and Bunji



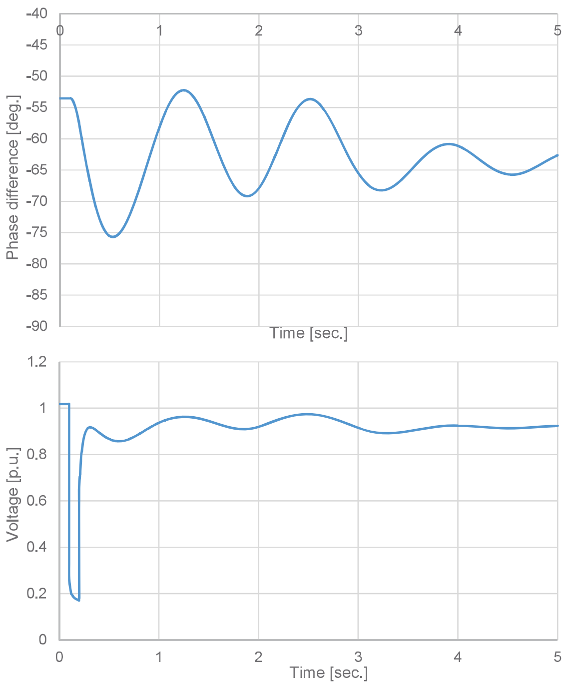
Basha – Chilas line fault (Basha side)
Reference phase : N. Jelum and Bunji



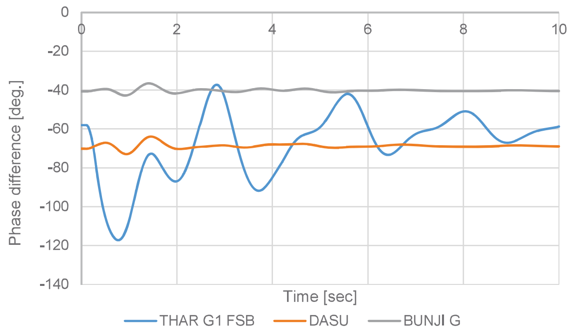
Bunji – Basha line fault (Bunji side)
Reference phase : N. Jelum and Bunji

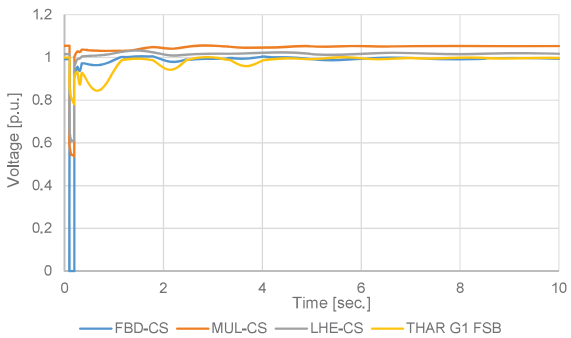


Basha – Mardan line fault (Basha side)
Reference phase : N. Jelum and Bunji

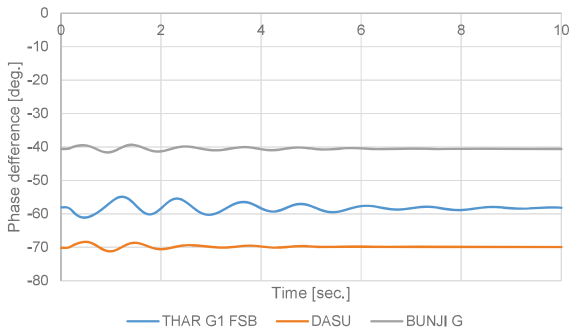


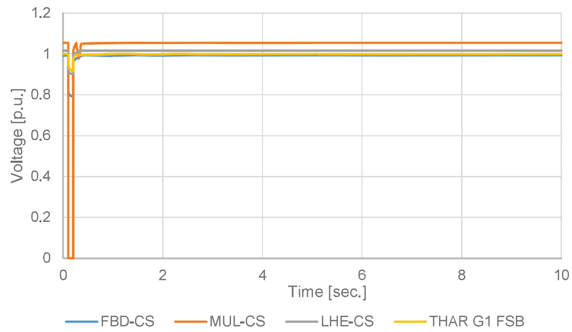
FBD CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



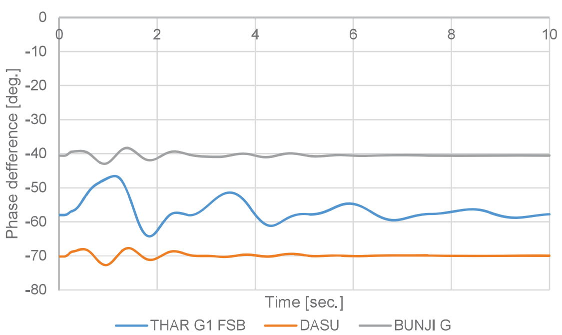


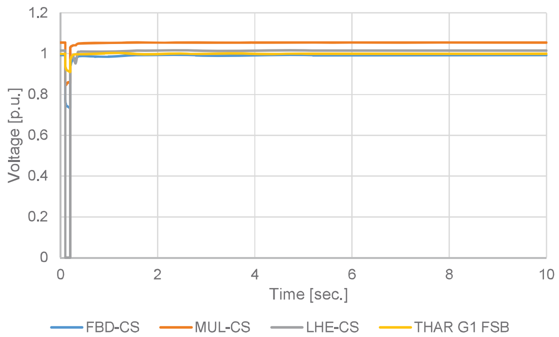
MUL CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



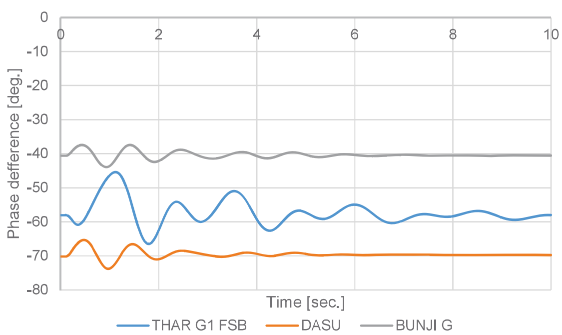


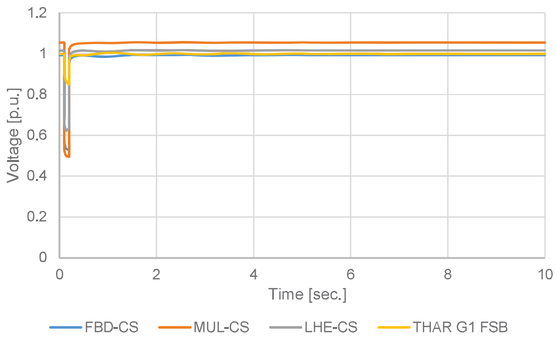
LHE CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



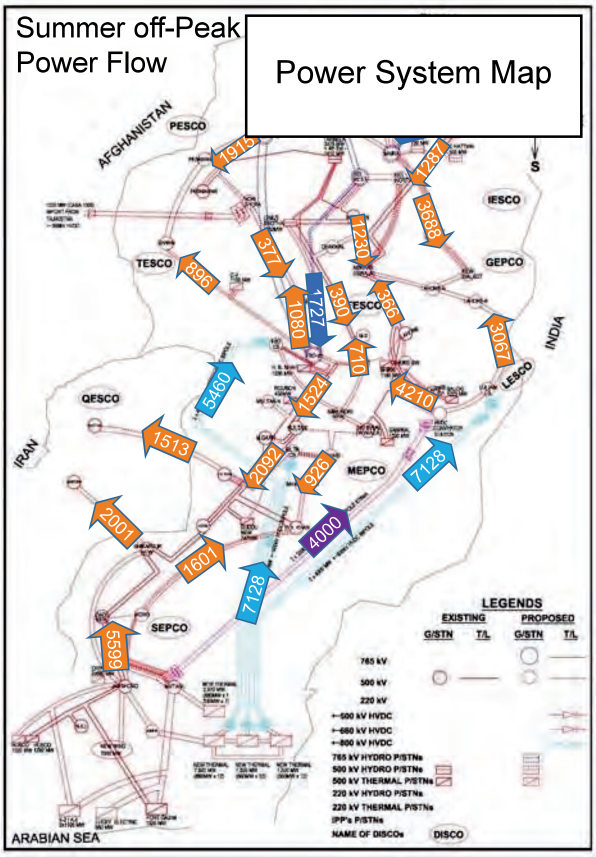


Sahiwal S/S Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum

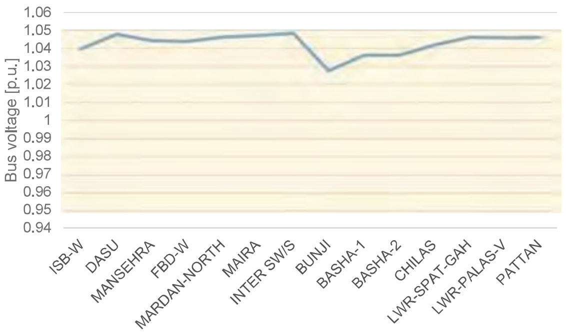




Summer off-Peak

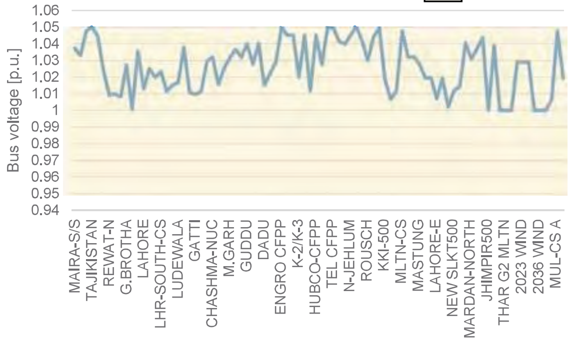


Bus Voltage (765kV)

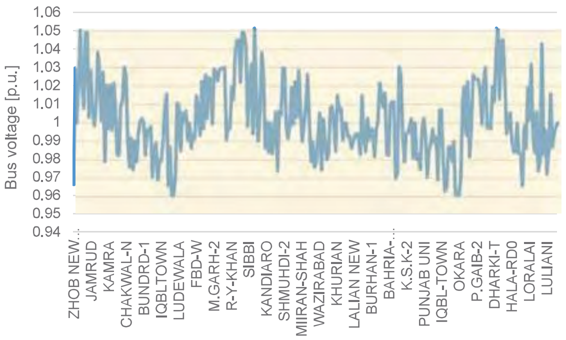


Bus Voltage (500kV)

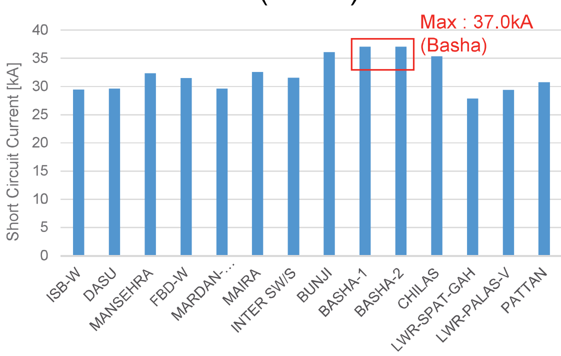
: Voltage range (+-5%)



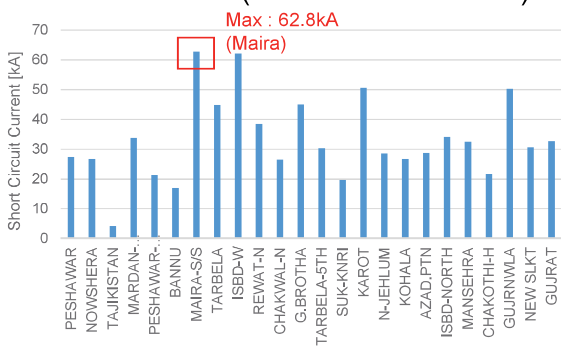
Bus Voltage (220kV)



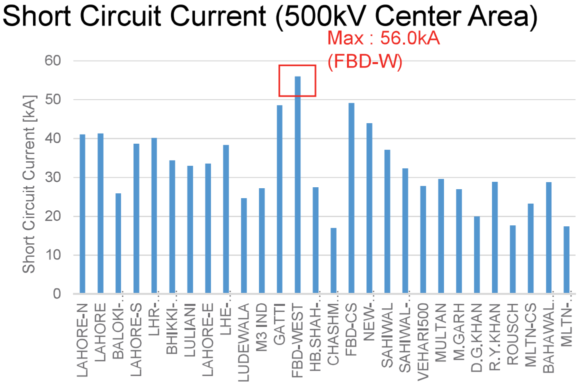
Short Circuit Current (765kV)



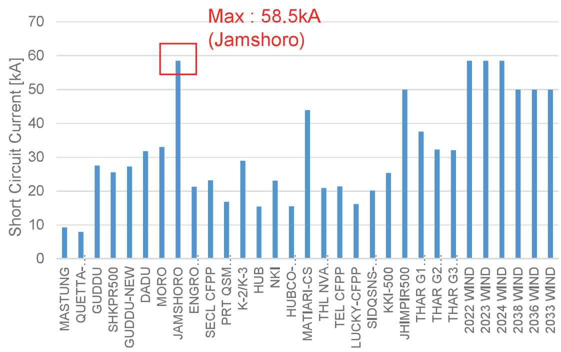
Short Circuit Current (500kV Northern Area)



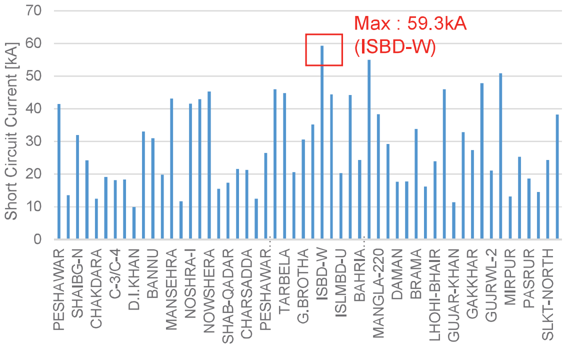
Short Circuit Current (500kV Center Area)



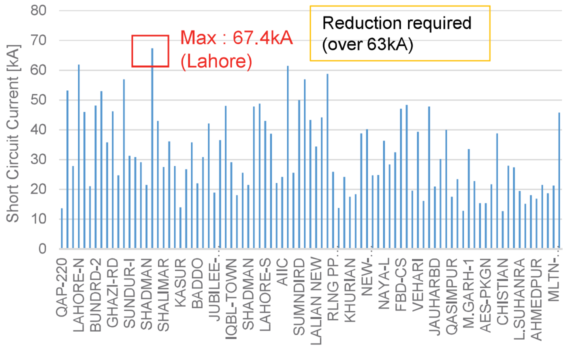
Short Circuit Current (500kV Southern Area)



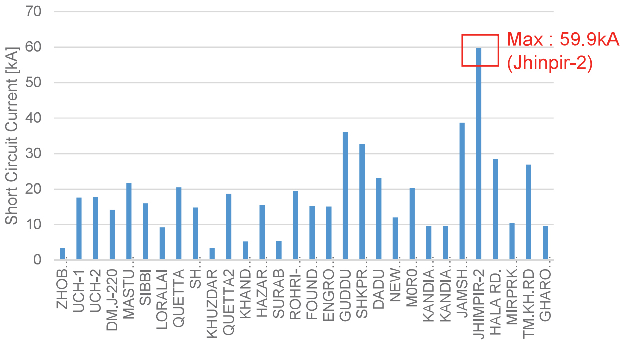
Short Circuit Current (220kV Northern Area)



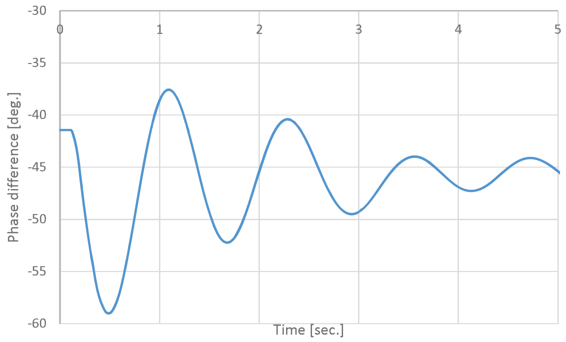
Short Circuit Current (220kV Center Area)

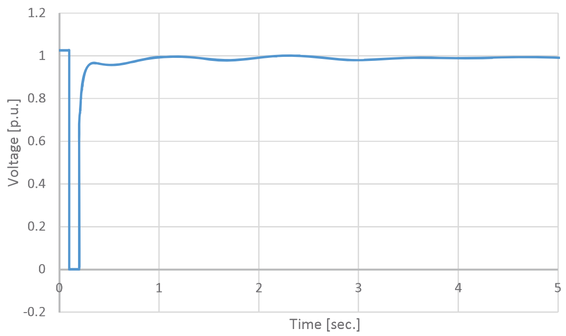


Short Circuit Current (220kV Southern Area)

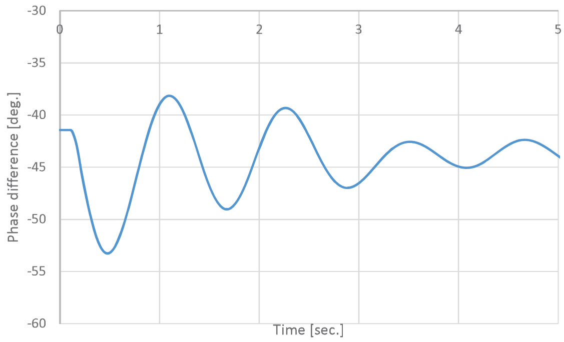


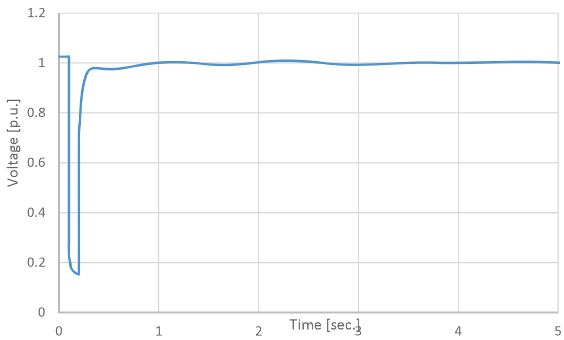
Bunji – Chilas line fault (Bunji side)
Reference phase : N. Jelum and Bunji



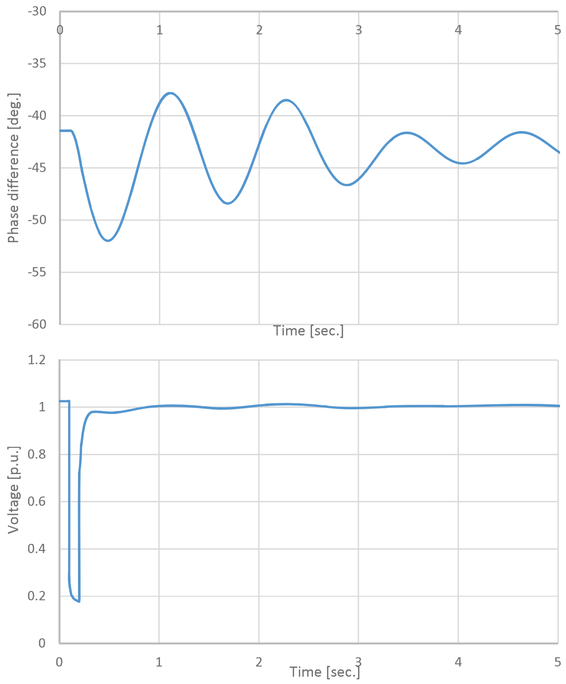


Chilas – Inter SW/S line fault (Chilas side)
Reference phase : N. Jelum and Bunji

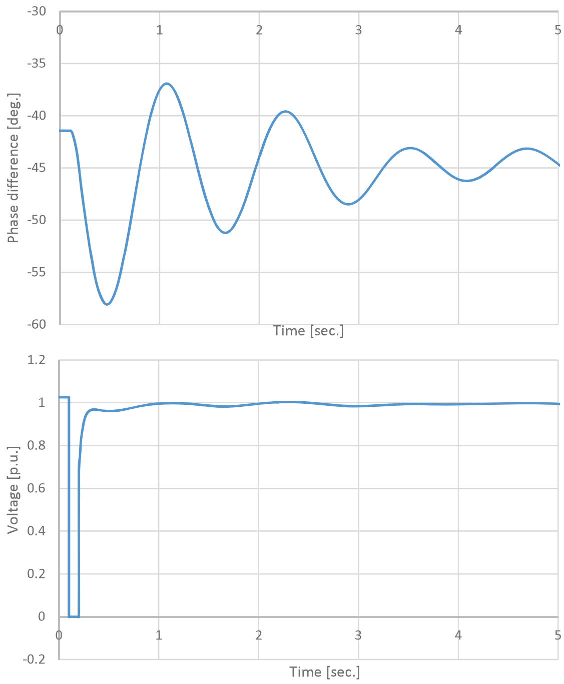




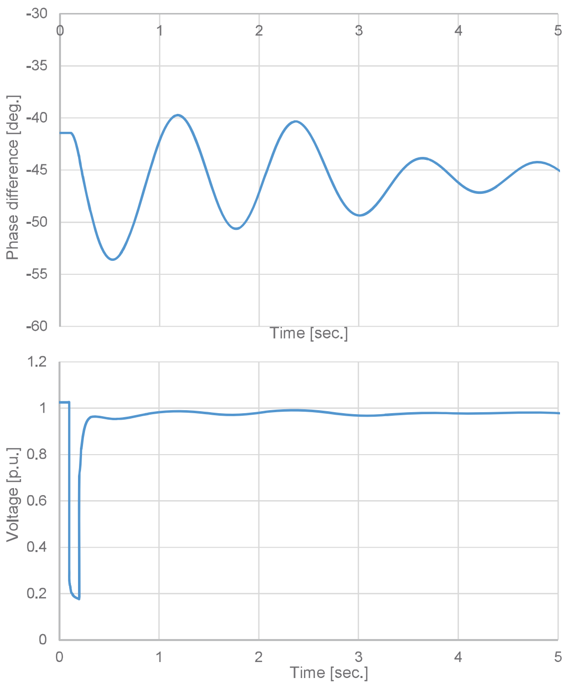
Basha – Chilas line fault (Basha side)
Reference phase : N. Jelum and Bunji



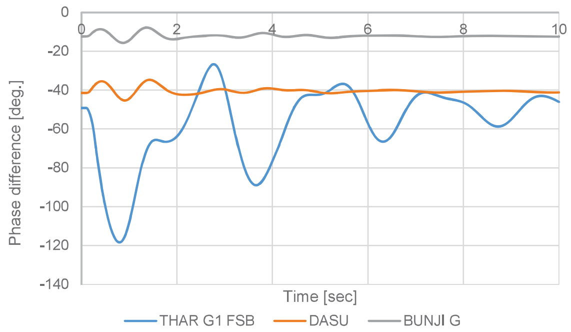
Bunji – Basha line fault (Bunji side)
Reference phase : N. Jelum and Bunji

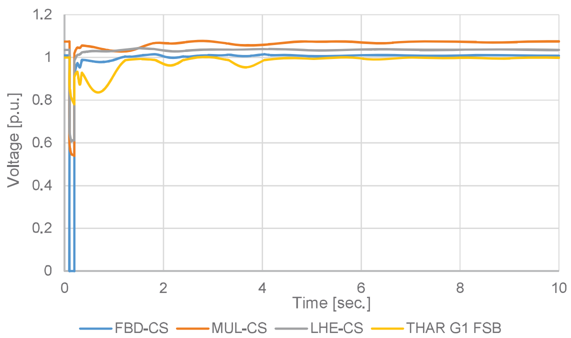


Basha – Mardan line fault (Basha side)
Reference phase : N. Jelum and Bunji

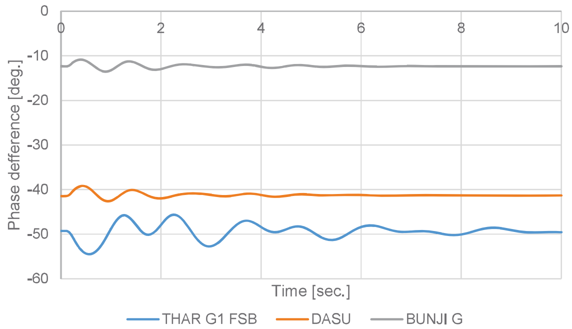


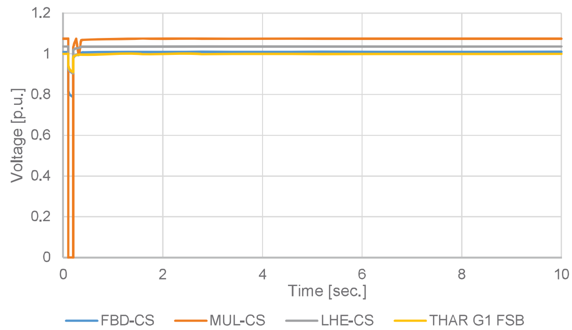
FBD CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



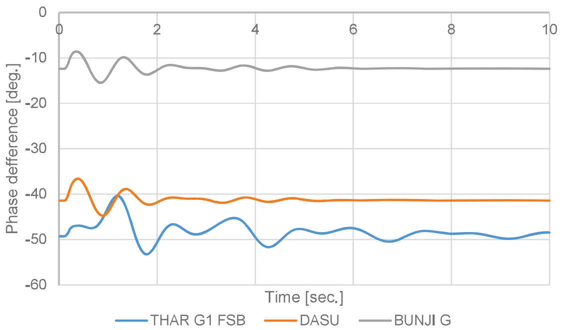


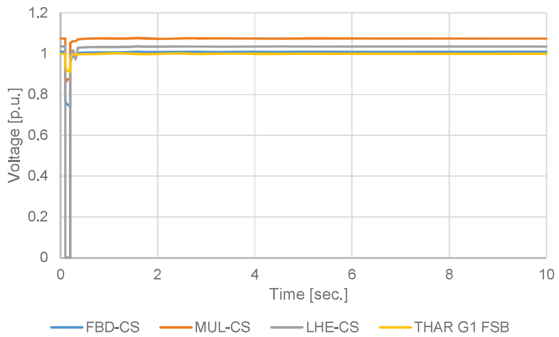
MUL CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



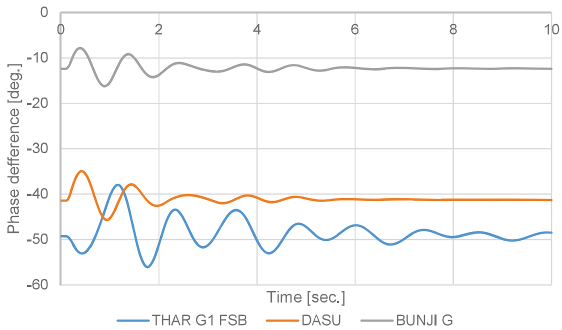


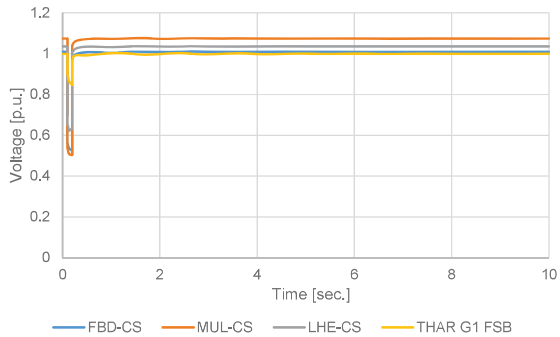
LHE CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



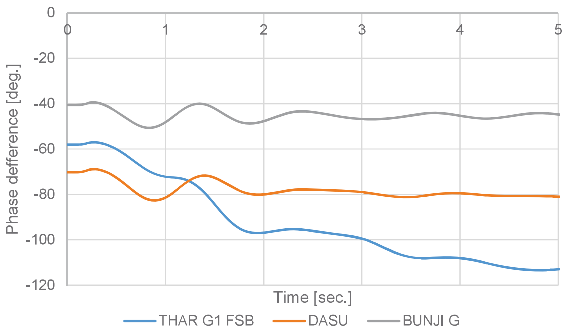


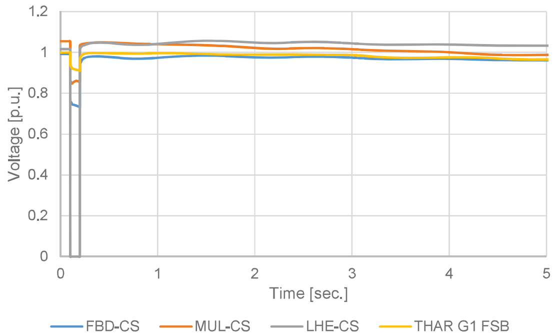
Sahiwal S/S Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



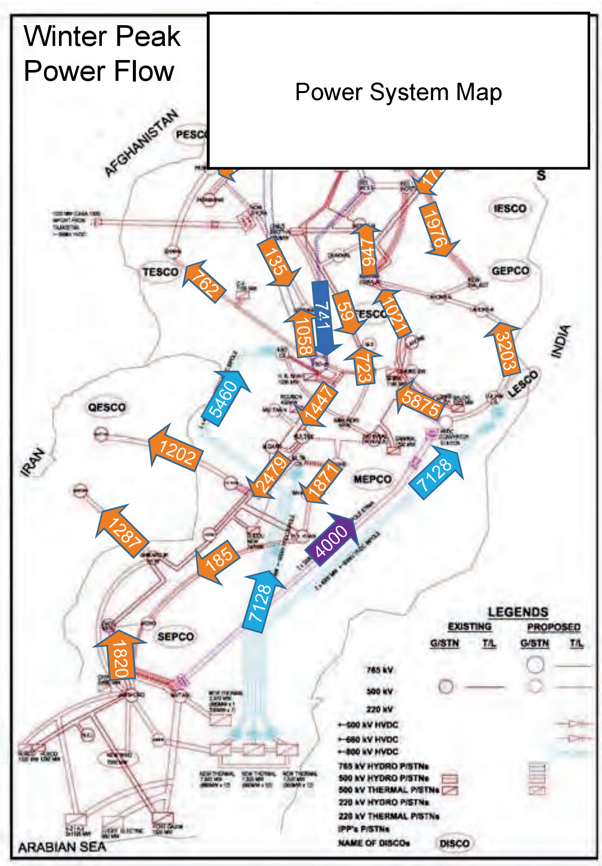


LHE CS Bus fault
Block time : 3.0 [sec] Block V : 0.65[p.u.]
Reference phase : N. Jelum

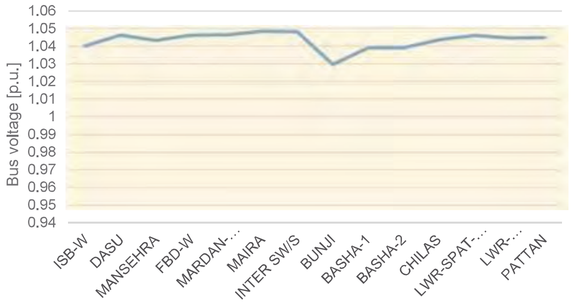




Winter Peak

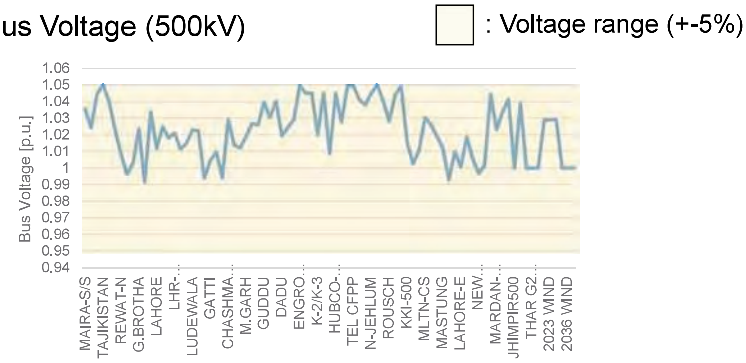

Winter Peak
Power Flow
Power System Map
AFGHANISTAN
PESCO
IESCO
TESCO
GEPCO
INDIA
LESCO
QESCO
IRAN
MEPCO
SEPCO
ARABIAN SEA
135
946
1976
762
741
59
1021
1058
723
3203
5460
1441
5875
1202
2479
1871
7128
4000
1287
185
7128
1820
LEGENDS
EXISTING
PROPOSED
G/STN
T/L
765 kV
500 kV
220 kV
NAME OF DISCOs
DISCO

Bus Voltage (765kV)

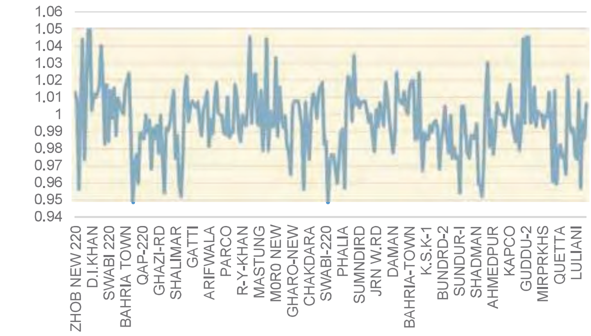


Bus Voltage (500kV)

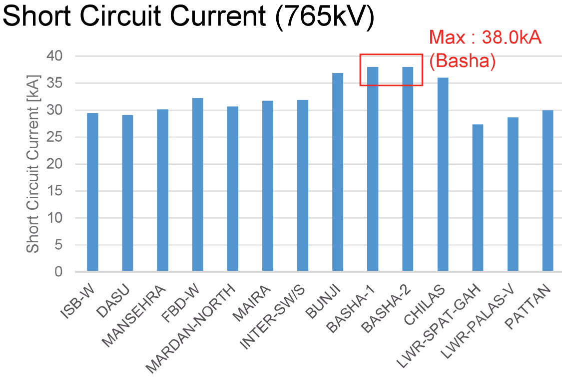
: Voltage range (+-5%)



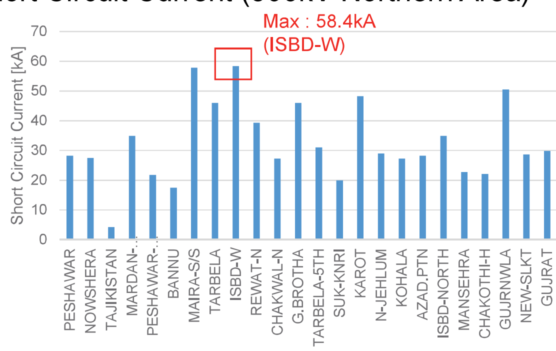
Bus Voltage (220kV)



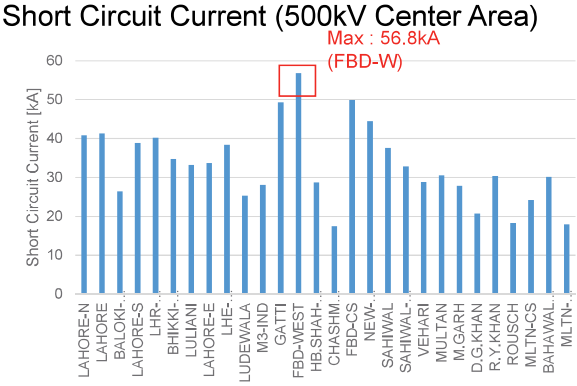
Short Circuit Current (765kV)



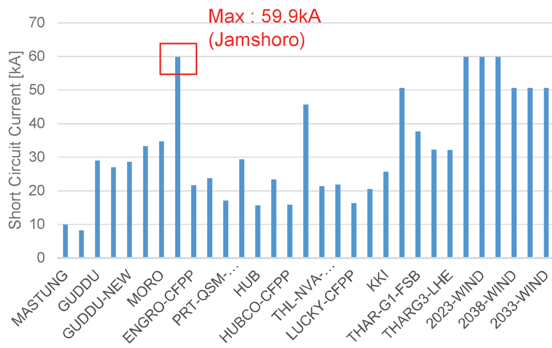
Short Circuit Current (500kV Northern Area)



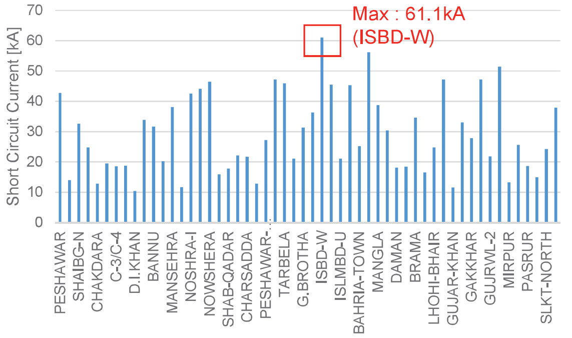
Short Circuit Current (500kV Center Area)



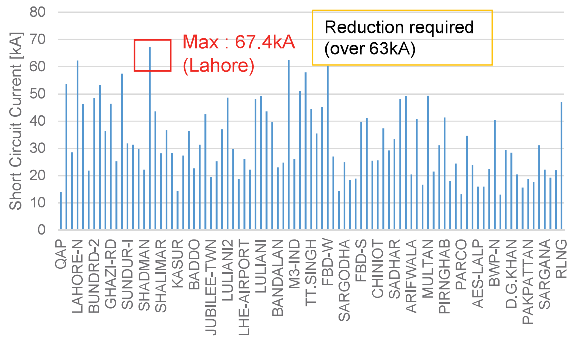
Short Circuit Current (500kV Southern Area)



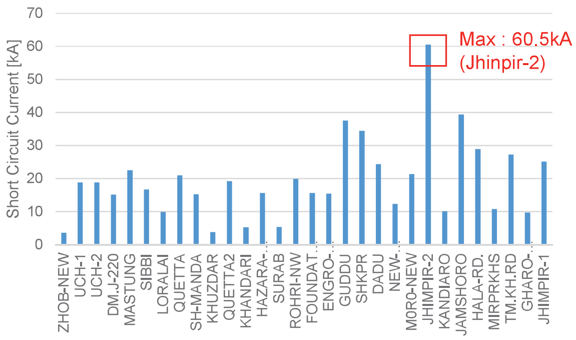
Short Circuit Current (220kV Northern Area)



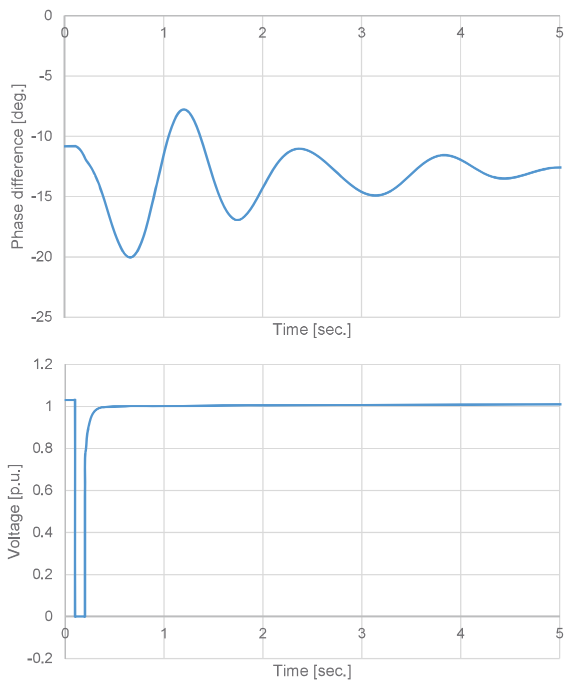
Short Circuit Current (220kV Center Area)



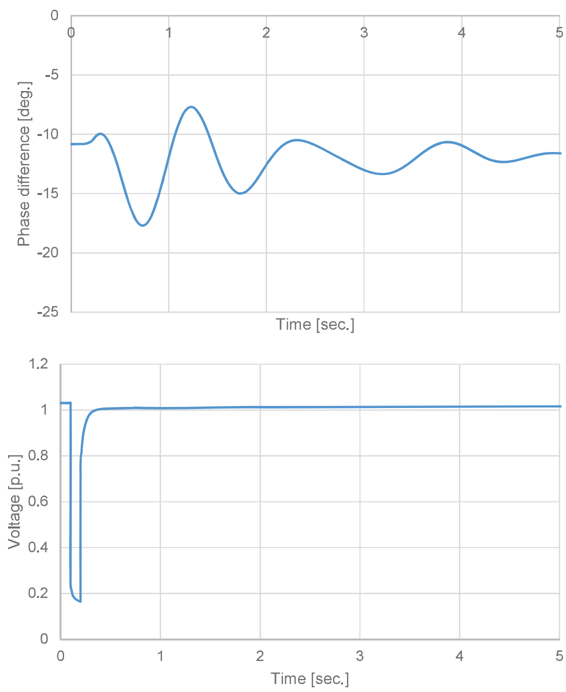
Short Circuit Current (220kV Southern Area)



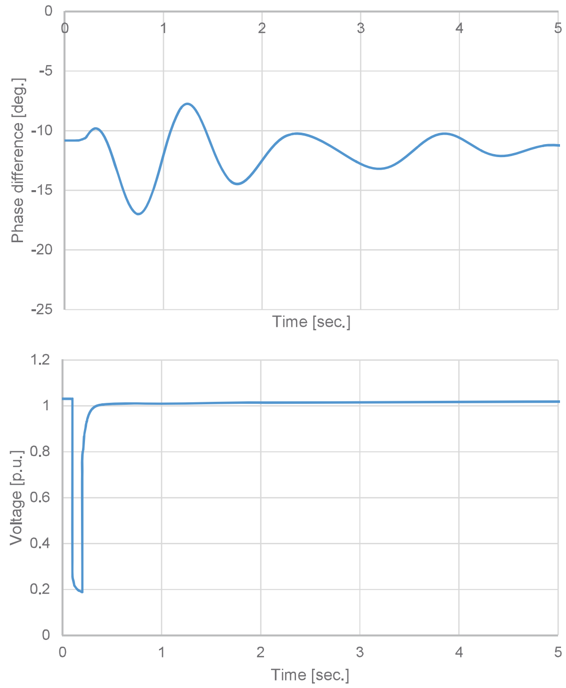
Bunji – Chilas line fault (Bunji side)
Reference phase : N. Jelum and Bunji



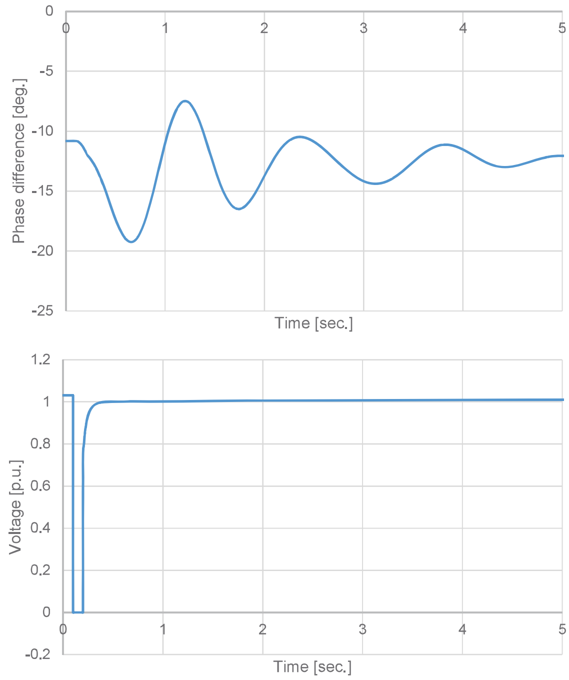
Chilas – Inter SW/S line fault (Chilas side)
Reference phase : N. Jelum and Bunji



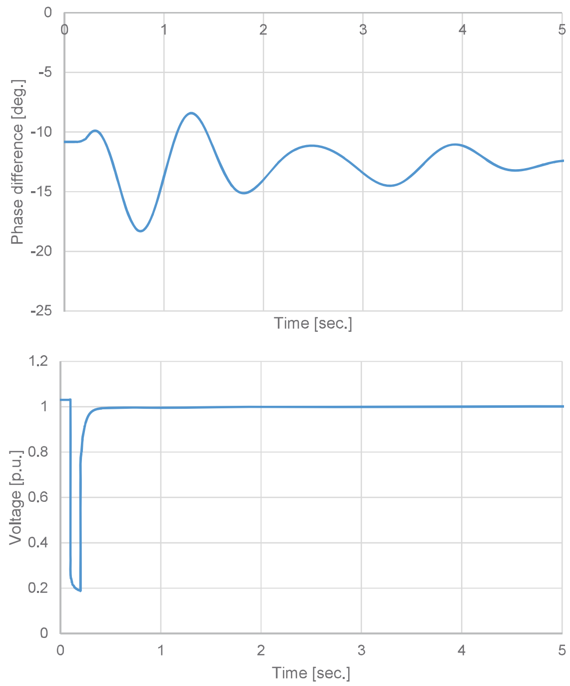
Basha – Chilas line fault (Basha side)
Reference phase : N. Jelum and Bunji



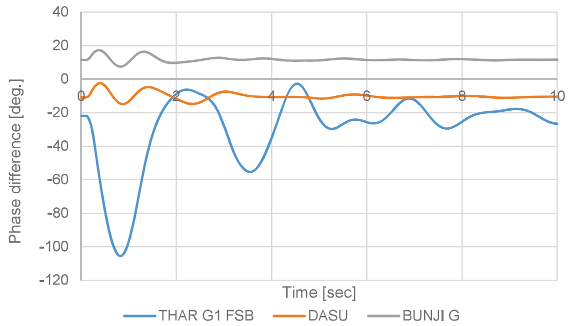
Bunji – Basha line fault (Bunji side)
Reference phase : N. Jelum and Bunji

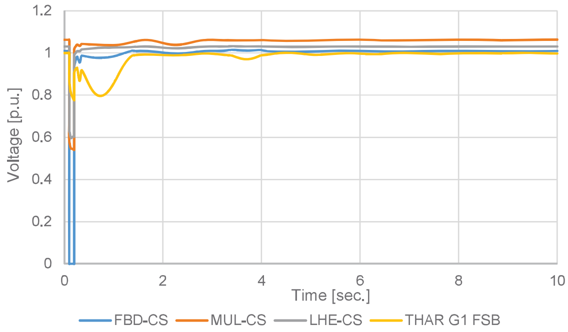


Basha – Mardan line fault (Basha side)
Reference phase : N. Jelum and Bunji

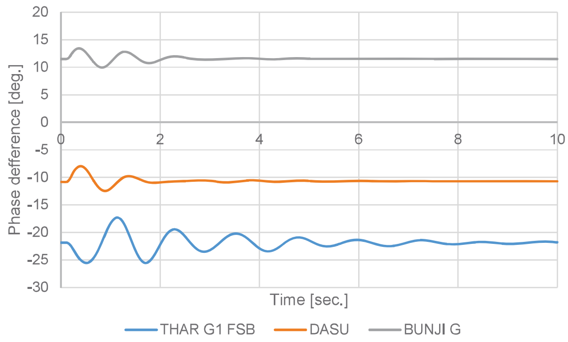


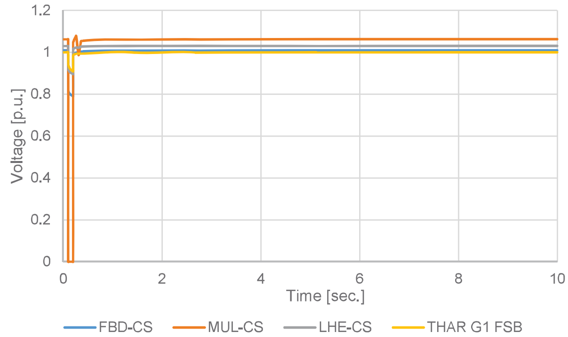
FBD CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



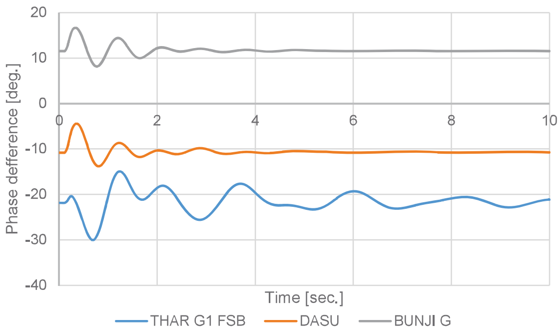


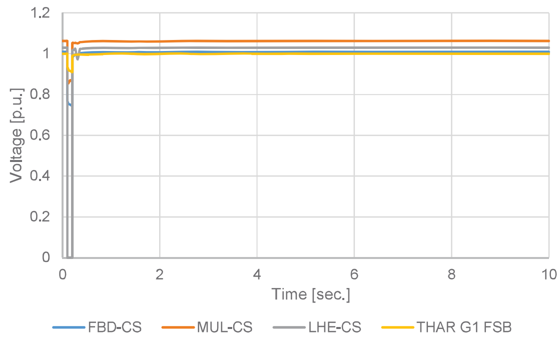
MUL CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



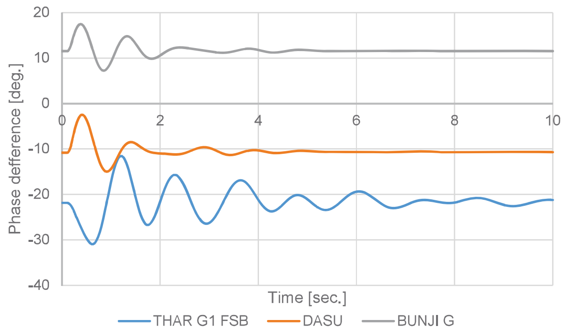


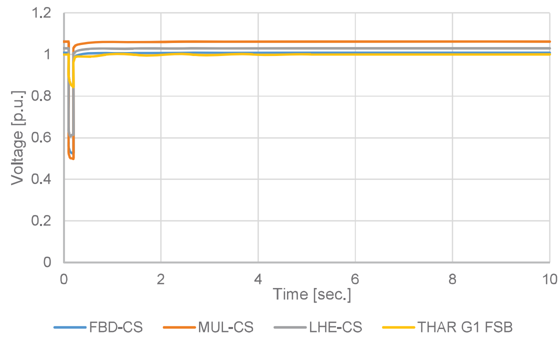
LHE CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



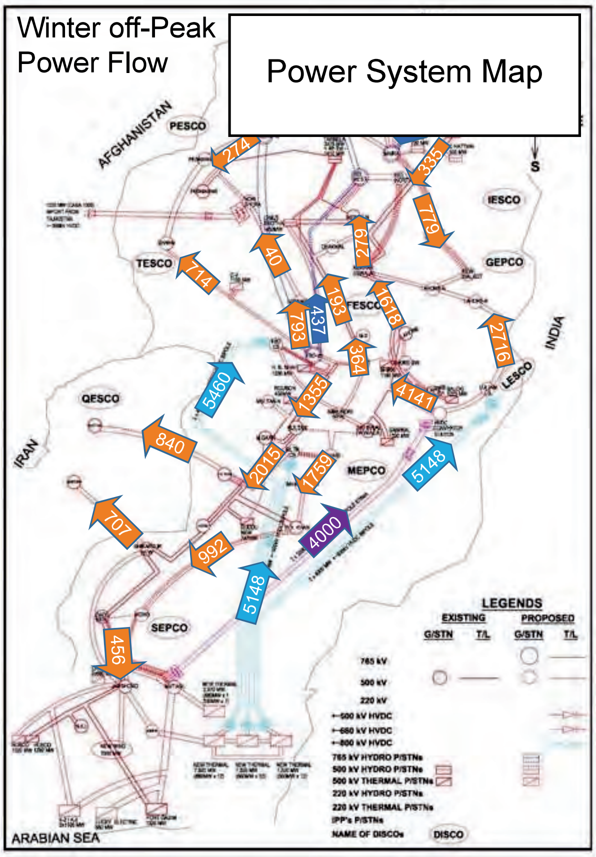


Sahiwal S/S Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum

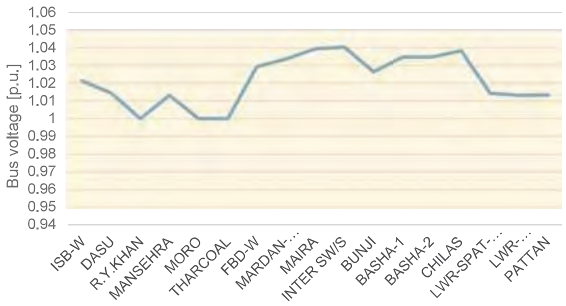




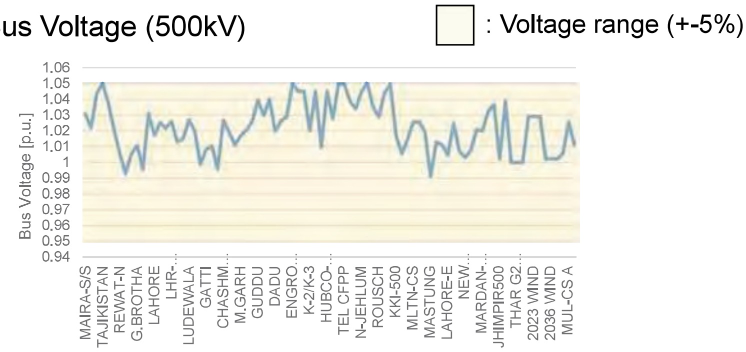
Winter off-Peak



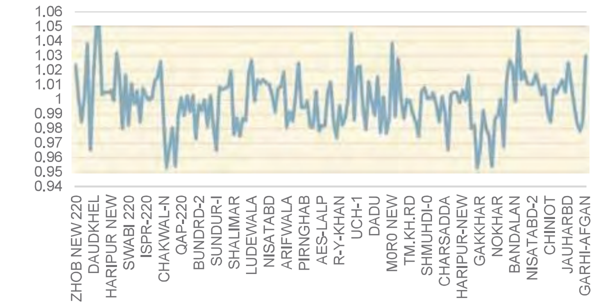
Bus Voltage (765kV)



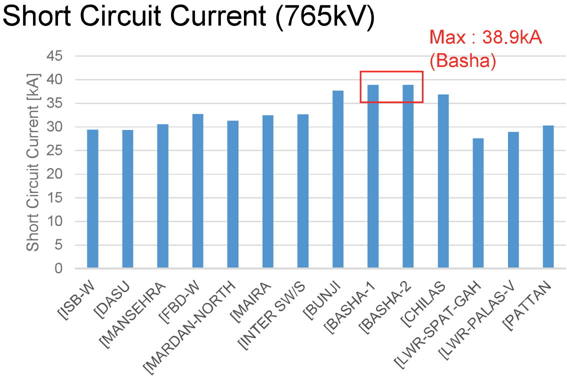
Bus Voltage (500kV)



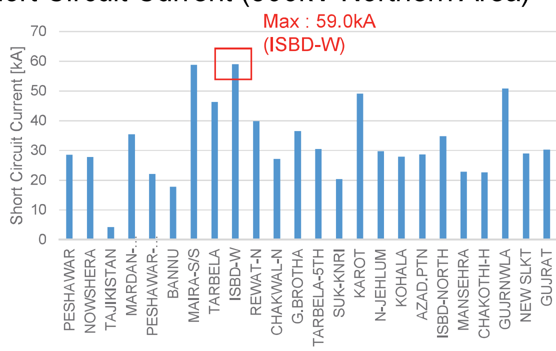
Bus Voltage (220kV)



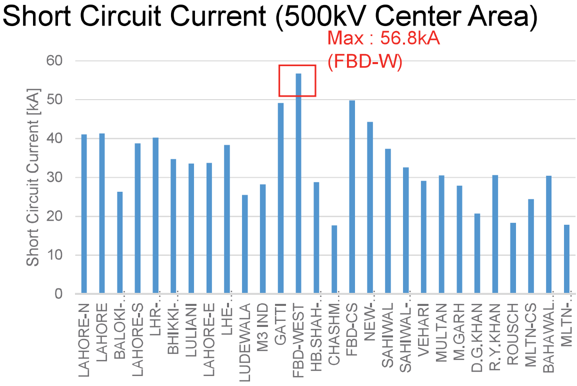
Short Circuit Current (765kV)



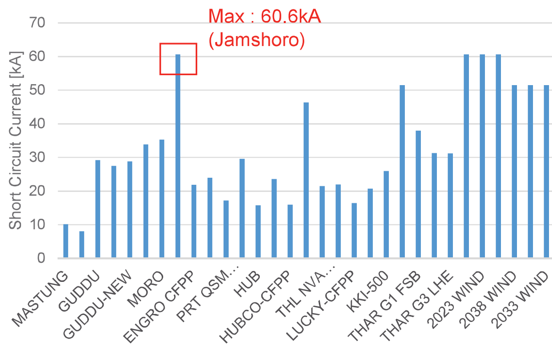
Short Circuit Current (500kV Northern Area)



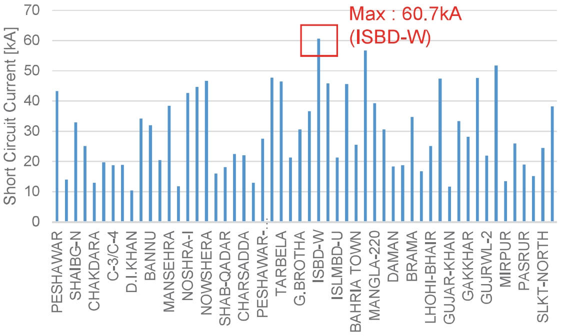
Short Circuit Current (500kV Center Area)



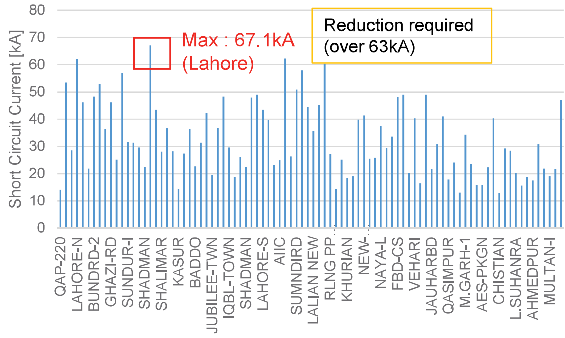
Short Circuit Current (500kV Southern Area)



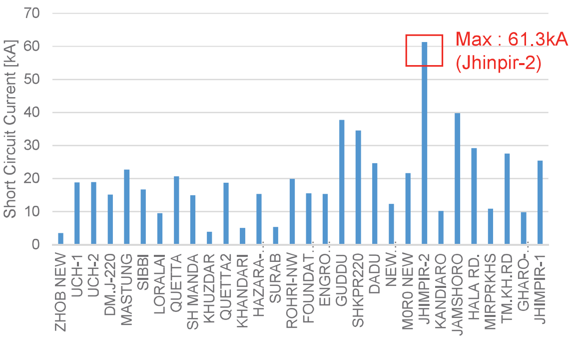
Short Circuit Current (220kV Northern Area)



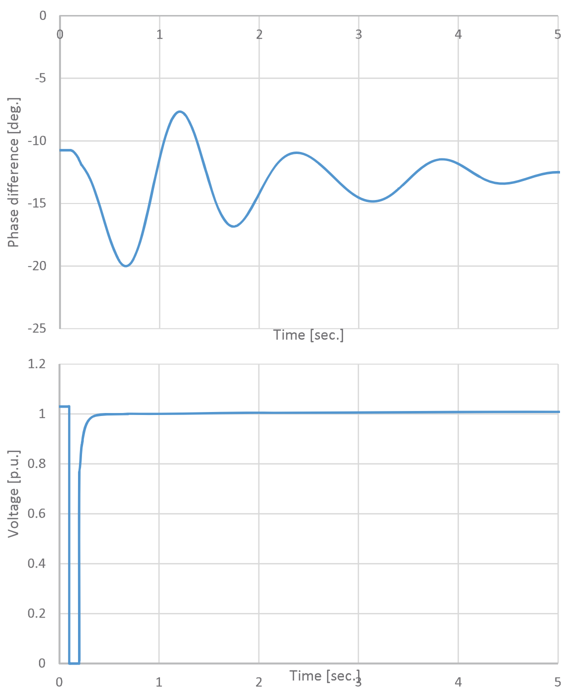
Short Circuit Current (220kV Center Area)



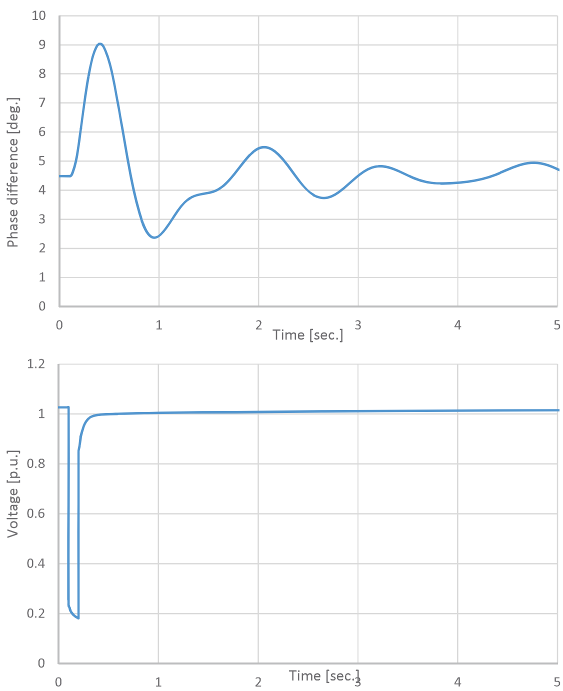
Short Circuit Current (220kV Southern Area)



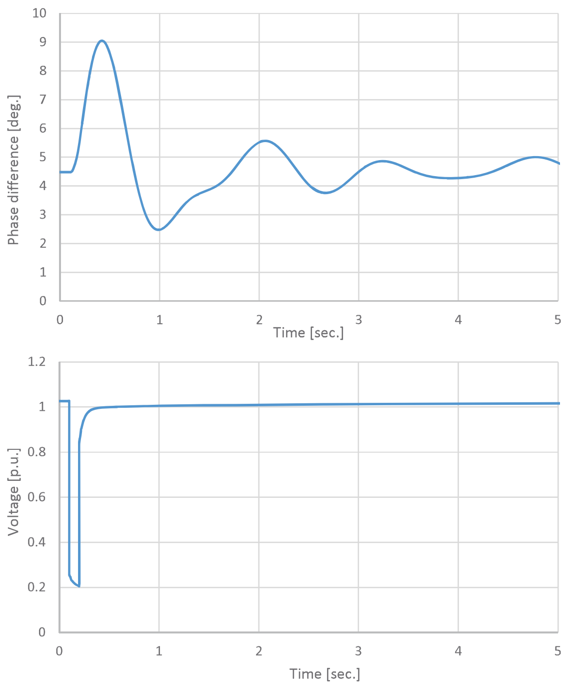
Bunji – Chilas line fault (Bunji side)
Reference phase : N. Jelum and Bunji



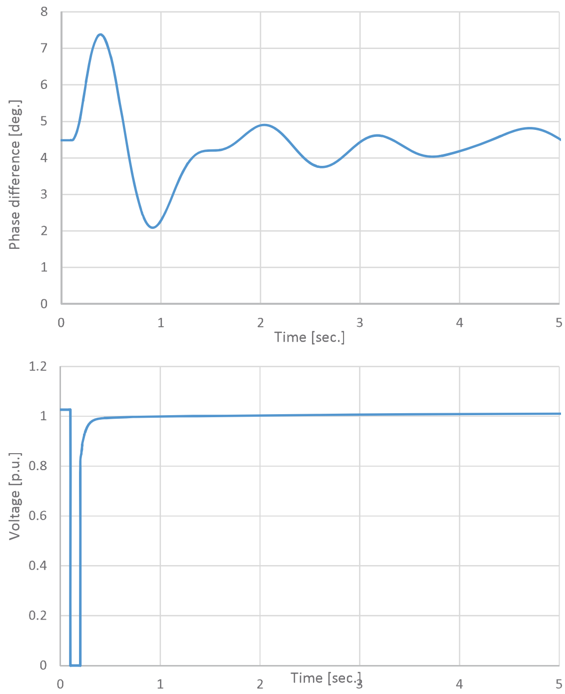
Chilas – Inter SW/S line fault (Chilas side)
Reference phase : N. Jelum and Bunji



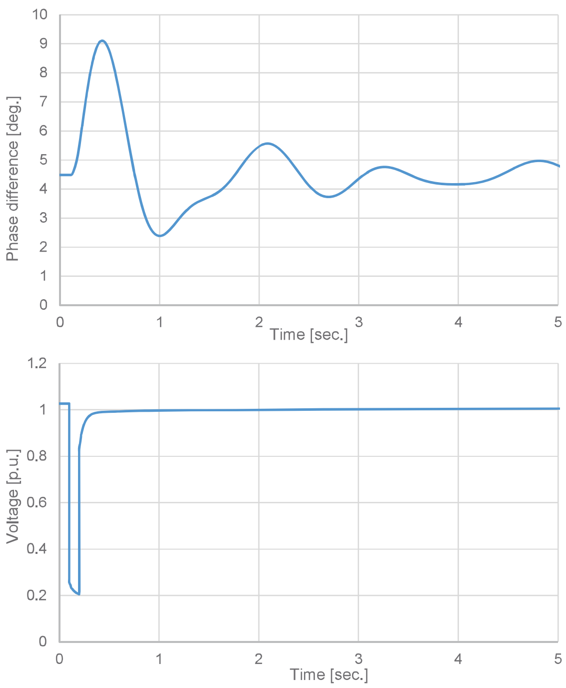
Basha – Chilas line fault (Basha side)
Reference phase : N. Jelum and Bunji



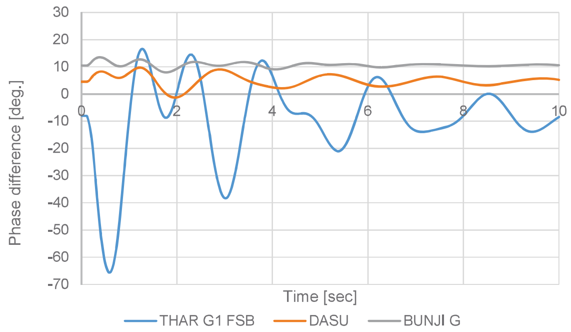
Bunji – Basha line fault (Bunji side)
Reference phase : N. Jelum and Bunji

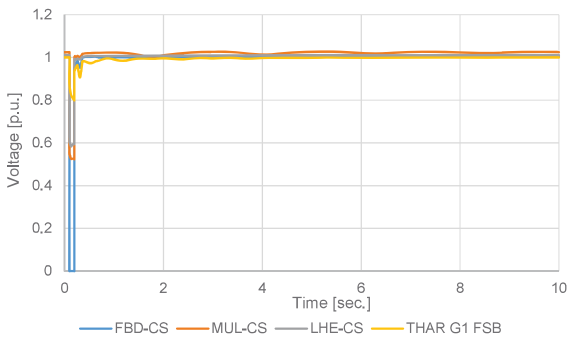


Basha – Mardan line fault (Basha side)
Reference phase : N. Jelum and Bunji

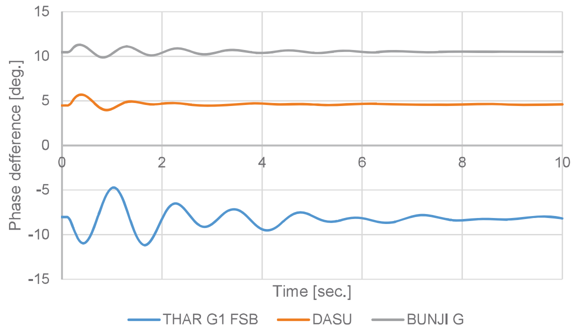


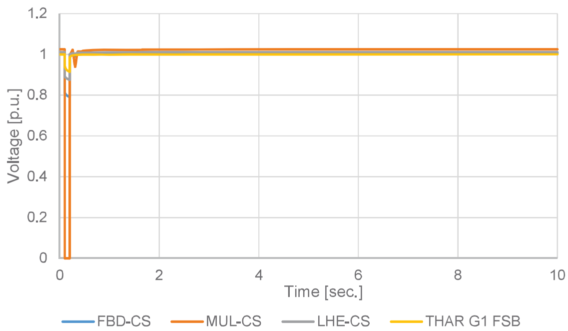
FBD CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



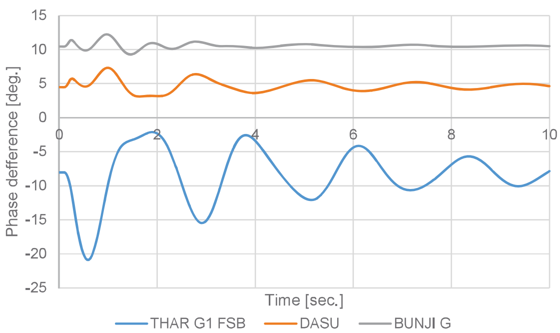


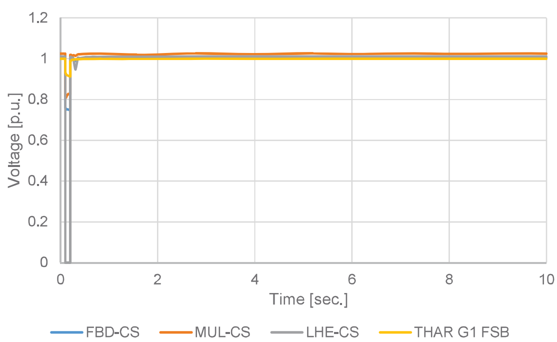
MUL CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum



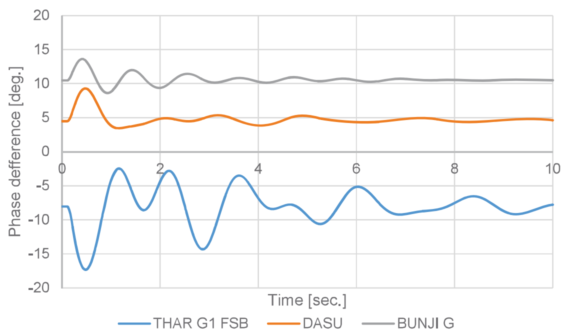


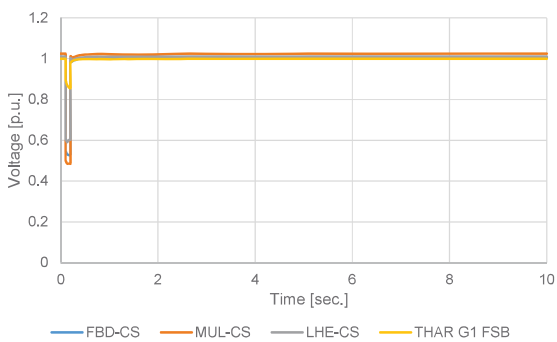
LHE CS Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum





Sahiwal S/S Bus fault
Block time : 0.1 [sec] Block V : 0.65 [p.u.]
Reference phase : N. Jelum





Classification & Outcome for Pre Feasibility Study & Feasibility Study

1. Definition

Type	Definition
Pre Feasibility Study	**BRIEF STUDY** to confirm feasible project or not before starting F/S. In case, "Not feasible" are become clear, F/S must stop.
Feasibility Study	**CAREFUL STUDY** of how a planned activity, how much cost and income based on Pre F/S

2. Outcome Documents

Type	Definition
Pre Feasibility Study	Following documents are enough to determine the project feasibility. 1. Simplified SLD : No details required, confirm BoQ purpose 2. BoQ for Main Equipment : No BOP materials, estimation purpose 3. Simplified Project Schedule : No details, imaging overall schedule 4. Ambient Condition : To confirm "no special" condition are required. 5. Substation Plan : To confirm necessary area of substation. 6. Tentative T/L route (by Google Earth) : 7. Rough Cost Estimation
Feasibility Study	8. Detailed SLD for main circuit and BOP 9. BoQ for all equipment 10. Project Schedule (draft) 11. Substation Layout (Plane / Section) 12. T/L route (Investigated) 13. ESIA

EC

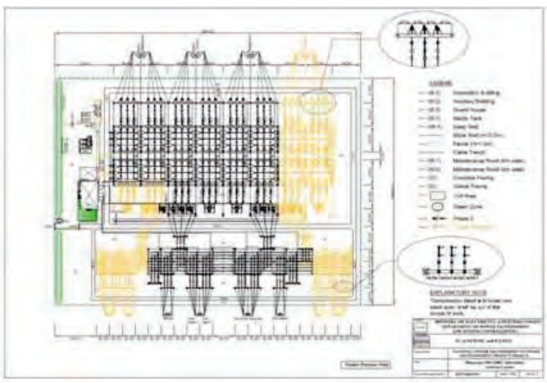
Classification & Outcome for Pre Feasibility Study & Feasibility Study

1. Substation Plan at Pre F/S

Allocation of substation equipment to confirm proper land space or Not.

2. Substation Layout at F/S

Accurate drawing are applied by detailed engineering.



NEWJEC

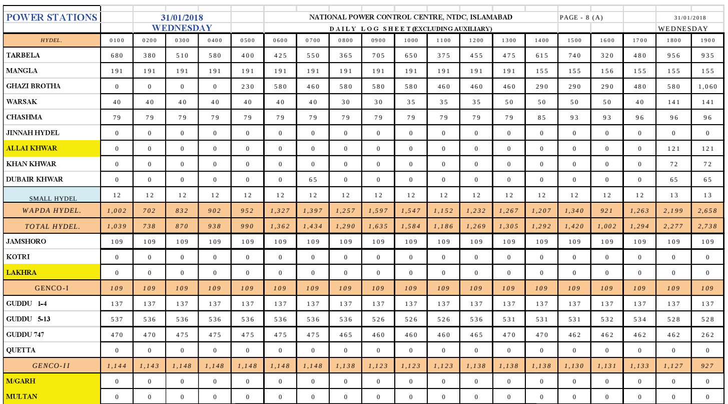
The Project for the Study of Upgrading National Power System Expansion Plan

Considerations on the Generation Operation of NPCC in 2018

October, 2019

Japan International Cooperation Agency
NEWJEC Inc.

1. Outline of the Received Data



POWER STATIONS — 31/01/2018 WEDNESDAY — NATIONAL POWER CONTROL CENTRE, NTDC, ISLAMABAD — DAILY LOG SHEET (EXCLUDING AUXILIARY) — PAGE - 8 (A) — 31/01/2018 WEDNESDAY

HYDEL.	0100	0200	0300	0400	0500	0600	0700	0800	0900
TARBELA	680	380	510	580	400	425	550	365	705
MANGLA	191	191	191	191	191	191	191	191	191
GHAZI BROTHA	0	0	0	0	230	580	460	580	580
WARSAK	40	40	40	40	40	40	40	30	30
CHASHMA	79	79	79	79	79	79	79	79	79
JINNAH HYDEL	0	0	0	0	0	0	0	0	0
ALLAI KHWAR	0	0	0	0	0	0	0	0	0
KHAN KHWAR	0	0	0	0	0	0	0	0	0
DUBAIR KHWAR	0	0	0	0	0	0	65	0	0
SMALL HYDEL	12	12	12	12	12	12	12	12	12
WAPDA HYDEL.	1,002	702	832	902	952	1,327	1,397	1,257	1,597
TOTAL HYDEL.	1,039	738	870	938	990	1,362	1,434	1,290	1,635
JAMSHORO	109	109	109	109	109	109	109	109	109
KOTRI	0	0	0	0	0	0	0	0	0
LAKHRA	0	0	0	0	0	0	0	0	0
GENCO-I	109	109	109	109	109	109	109	109	109
GUDDU 1-4	137	137	137	137	137	137	137	137	137
GUDDU 5-13	537	536	536	536	536	536	536	536	526
GUDDU 747	470	470	475	475	475	475	475	465	460
QUETTA	0	0	0	0	0	0	0	0	0
GENCO-II	1,144	1,143	1,148	1,148	1,148	1,148	1,148	1,138	1,123
M/GARH	0	0	0	0	0	0	0	0	0
MULTAN	0	0	0	0	0	0	0	0	0

HYDEL.	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900
TARBELA	650	375	455	475	615	740	320	480	956	935
MANGLA	191	191	191	191	155	155	156	155	155	155
GHAZI BROTHA	580	460	460	460	290	290	290	480	580	1,060
WARSAK	35	35	35	50	50	50	50	40	141	141
CHASHMA	79	79	79	79	85	93	93	96	96	96
JINNAH HYDEL	0	0	0	0	0	0	0	0	0	0
ALLAI KHWAR	0	0	0	0	0	0	0	0	121	121
KHAN KHWAR	0	0	0	0	0	0	0	0	72	72
DUBAIR KHWAR	0	0	0	0	0	0	0	0	65	65
SMALL HYDEL	12	12	12	12	12	12	12	12	13	13
WAPDA HYDEL.	1,547	1,152	1,232	1,267	1,207	1,340	921	1,263	2,199	2,658
TOTAL HYDEL.	1,584	1,186	1,269	1,305	1,292	1,420	1,002	1,294	2,277	2,738
JAMSHORO	109	109	109	109	109	109	109	109	109	109
KOTRI	0	0	0	0	0	0	0	0	0	0
LAKHRA	0	0	0	0	0	0	0	0	0	0
GENCO-I	109	109	109	109	109	109	109	109	109	109
GUDDU 1-4	137	137	137	137	137	137	137	137	137	137
GUDDU 5-13	526	526	536	531	531	531	532	534	528	528
GUDDU 747	460	460	465	470	470	462	462	462	462	262
QUETTA	0	0	0	0	0	0	0	0	0	0
GENCO-II	1,123	1,123	1,138	1,138	1,138	1,130	1,131	1,133	1,127	927
M/GARH	0	0	0	0	0	0	0	0	0	0
MULTAN	0	0	0	0	0	0	0	0	0	0

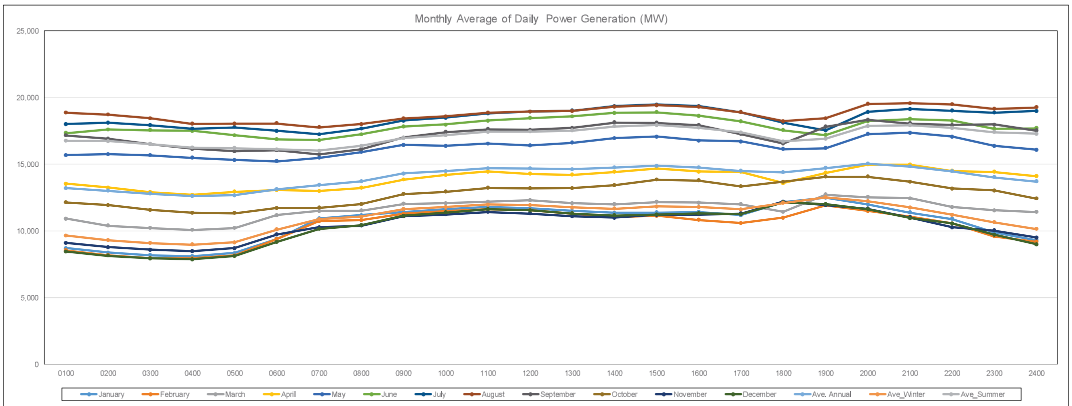
Original Data

電源		形式	地点数	出力(MW)
Hydro	1	ROR	6	581.0
	2	Reservoir	8	2,907.0
	3	Irrigation	4	6,131.0
Thermal	4	Oil	21	6,436.6
	5	Natural Gas	9	4,209.0
	6	RLNG	14	7,415.0
	7	Domestic Coal	1	150.0
	8	Imported Coal	2	2,640.0
Renewable	9	Solar	5	500.0
	10	Wind	23	1,184.5
	11	Bio	7	306.0
Nuclear	12	Nuclear	5	1,330.0
Others	20	Others	2	-

Type of Sources, Number and Capacity

Item	Outline
Data Source	NPCC（National Power Control Center）
Period	January 1st to December 31th
Contents	Hourly Record of Generation (kWh) per plants
Remarks	- Although records of KE system are not included, transmitted amount to KE is recorded. - It is not load demand but sum of power generation amount and regulation load management is assumed to be the total actual demand. - Actual performance of generation is utilized for the PSSE input.

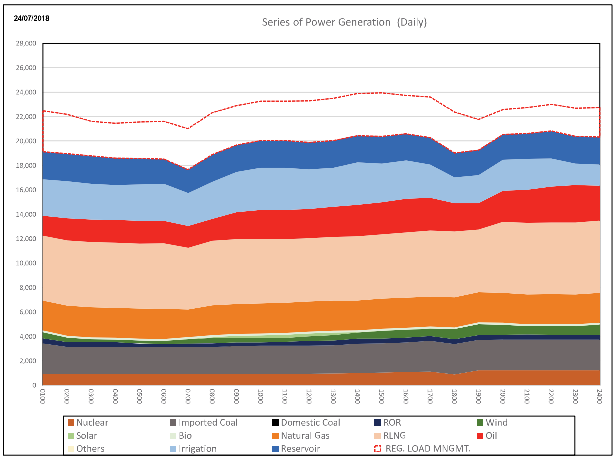
2. Generation Record (Monthly Average x 24 hours)

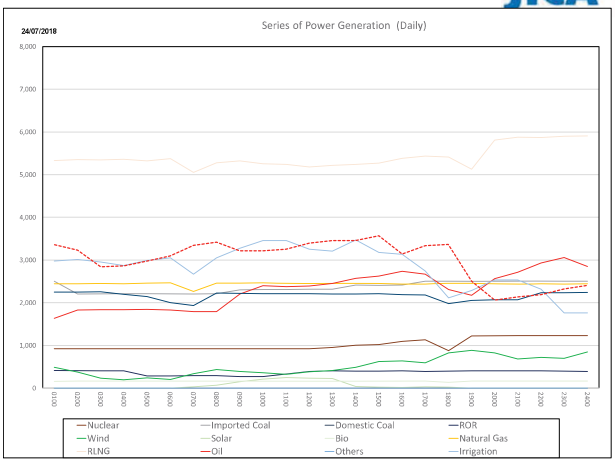


Month	0100	0200	0300	0400	0500	0600	0700	0800	0900	1000	1100	1200	1300	1400	1500	1600	1700	1800	1900	2000	2100	2200	2300	2400	Total (MWh)	Peak (MW)	(Time)	Off-Peak (MW)	(Time)
January	8,710	8,374	8,185	8,106	8,340	9,410	10,942	11,171	11,418	11,606	11,788	11,680	11,499	11,354	11,373	11,414	11,175	12,168	12,490	12,002	11,366	10,901	9,929	9,296	254,698	12,490	19	8,106	4
February	8,542	8,184	7,954	7,932	8,158	9,402	10,741	10,820	11,290	11,473	11,618	11,555	11,300	11,055	11,142	10,828	10,594	10,996	11,923	11,507	11,059	10,554	9,592	9,192	247,413	11,923	19	7,932	4
March	10,920	10,400	10,220	10,070	10,208	11,182	11,499	11,514	12,027	12,089	12,198	12,309	12,091	12,001	12,167	12,129	11,999	11,433	12,723	12,531	12,454	11,797	11,547	11,404	278,911	12,723	19	10,070	4
April	13,536	13,253	12,897	12,705	12,946	13,058	12,992	13,227	13,843	14,184	14,451	14,289	14,215	14,429	14,691	14,438	14,429	13,574	14,363	14,969	14,972	14,493	14,429	14,107	334,490	14,972	21	12,705	4
May	15,676	15,761	15,666	15,473	15,309	15,229	15,476	15,919	16,436	16,379	16,555	16,402	16,612	16,949	17,059	16,766	16,699	16,131	16,205	17,258	17,358	17,067	16,363	16,083	390,829	17,358	21	15,229	6
June	17,342	17,601	17,561	17,495	17,175	16,865	16,807	17,243	17,830	17,978	18,255	18,453	18,583	18,837	18,903	18,622	18,212	17,548	17,188	18,218	18,391	18,254	17,657	17,700	428,720	18,903	15	16,807	7
July	18,008	18,109	17,908	17,655	17,766	17,501	17,248	17,668	18,269	18,485	18,807	18,959	19,005	19,345	19,463	19,352	18,891	18,122	17,533	18,911	19,130	19,013	18,856	18,983	442,987	19,463	15	17,248	7
August	18,854	18,709	18,446	18,026	18,037	18,057	17,767	18,007	18,421	18,590	18,857	18,943	18,994	19,313	19,415	19,295	18,894	18,217	18,441	19,507	19,576	19,487	19,146	19,257	450,257	19,576	21	17,767	7
Septembe	17,145	16,926	16,499	16,152	15,978	16,043	15,743	16,127	16,988	17,401	17,634	17,571	17,722	18,140	18,097	17,907	17,258	16,558	17,799	18,327	18,066	17,934	17,979	17,520	413,517	18,327	20	15,743	7
October	12,145	11,941	11,575	11,360	11,334	11,727	11,742	12,020	12,763	12,933	13,235	13,191	13,216	13,420	13,844	13,780	13,335	13,689	14,059	14,060	13,689	13,180	13,030	12,424	307,692	14,060	20	11,334	5
November	9,105	8,775	8,588	8,481	8,712	9,736	10,269	10,397	11,097	11,221	11,403	11,302	11,096	10,986	11,206	11,230	11,307	12,197	11,934	11,658	11,004	10,268	10,037	9,496	251,506	12,197	18	8,481	4
December	8,455	8,141	7,936	7,861	8,115	9,184	10,145	10,439	11,146	11,382	11,628	11,545	11,299	11,164	11,237	11,326	11,251	12,141	12,005	11,632	10,952	10,551	9,715	9,001	248,251	12,141	18	7,861	4
Ave. Annu	13,203	13,014	12,786	12,610	12,673	13,116	13,448	13,713	14,294	14,477	14,702	14,683	14,636	14,749	14,883	14,757	14,504	14,398	14,722	15,048	14,835	14,458	14,023	13,705	337,439	15,048	20	12,610	4
Ave_Winte	9,646	9,302	9,076	8,968	9,145	10,107	10,890	11,060	11,623	11,784	11,978	11,930	11,750	11,663	11,828	11,785	11,610	12,104	12,523	12,232	11,754	11,208	10,642	10,136	264,745	12,523	19	8,968	4
Ave_Sumr	16,760	16,726	16,496	16,251	16,202	16,125	16,006	16,365	16,964	17,170	17,426	17,436	17,522	17,835	17,938	17,730	17,397	16,692	16,922	17,865	17,916	17,708	17,405	17,275	410,133	17,938	15	16,006	7

- Maximum daily peak of monthly average is shown in August, Peak ;19,576MW at 21:00 and Off-peak;17,767MW at 07:00.
- Minimum daily peak of monthly average is shown in February, Peak ;11,923MW at 19:00 and Off-peak;7,932 MW at 04:00.
- Daily difference between peak and off-peak is relatively smaller. The ratio of peak/off-peak is 89.2%. Meanwhile, difference is more clearly shown in winter season with the ration 66.5%. In general, difference is tended to be shown in summer season when the demand of air conditioners in daytime is high but it is not shown in the records. It is assumed that peak demand in summer season is not satisfied due to the regulation load management.

3. Generation Record（Generation Maximum ×24 hour）



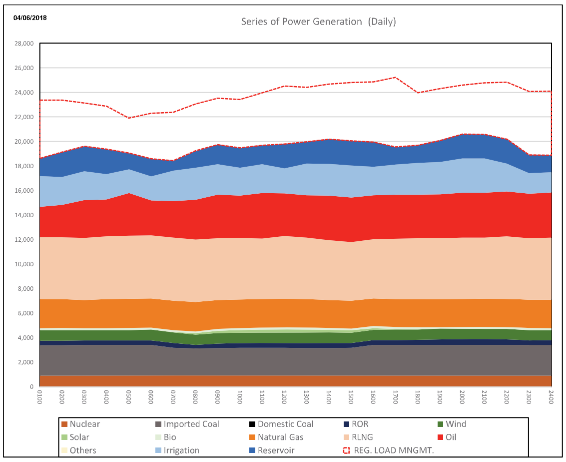


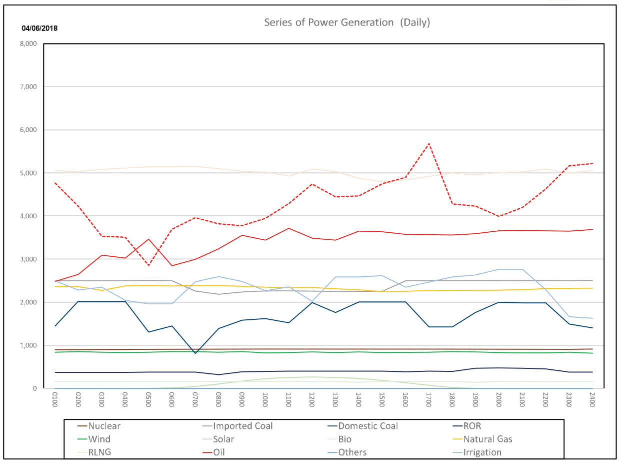
Generation Maximum (July 24th)

Generation	**Peak**	**20,811MW(22:00)**
	Off-peak	**17,664MW(07:00)**
Demand	**Peak**	**24,490MW(15:00)**
	Off-peak	**21,008MW(07:00)**

- Annual maximum generation was recorded in July 24th at 22:00, 20,811MW. However, maximum demand of the day is 24,490MW at 15:00 and there is the gap of 3,679MW. Operation of power generation is mainly regulated by the hydropower and oil thermal power on July 24th, others Natural Gas, RLNG, Import Coal and Nuclear is operated to be responsible for the base load.
- All power plants generated electricity within the available capacity but expensive oil power plants are limited to operate.

4. Generation Record（Maximum Demand × 24hour）





Generation Maximum (June 4th)

Generation	Peak	20,596MW(20:00)
	Off-peak	18,432MW(07:00)
Demand	Peak	26,741MW(17:00)
	Off-peak	21,894MW(05:00)

- Maximum peak demand in 2018 was recorded on June 4th at 17:00 with 26,741MW. Peak of generation was 20,596MW at 20:00. The gap between supply and demand was 6,145MW. Output of hydropower pants was low on this day and oil power plants supplemented this gap. Natural Gas, RLNG, Coal and Nuclear plants are operated as base load.

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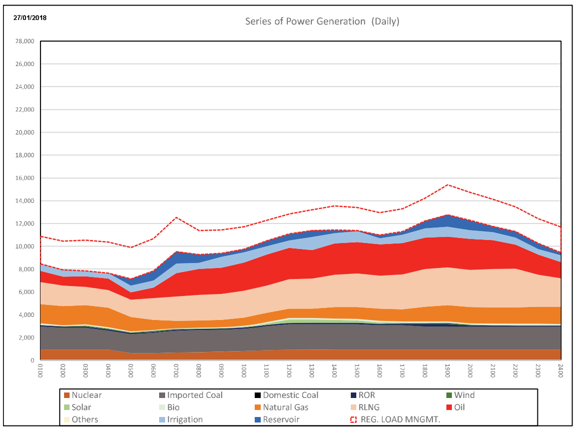
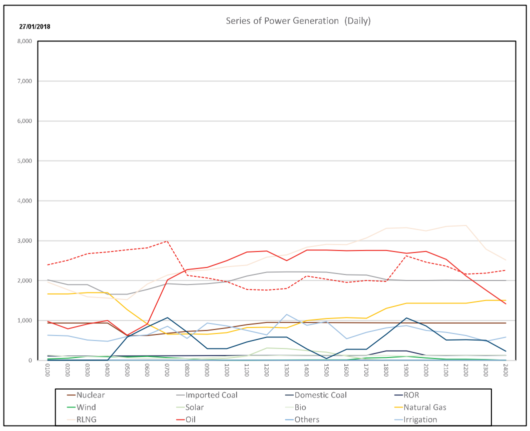
5. Generation Record (Generation and Demand Minimum x 24 hour)





Generation Minimum (January 27th)

Generation	Peak	12,777MW(19:00)
	Off-peak	7,147MW(05:00)
Demand	Peak	15,397MW(19:00)
	Off-peak	9,913MW(05:00)

- Minimum peak generation in 2018 was recorded on January 27th at 19:00 with 12,777MW. However, there was still the gap between demand and generation. Minimum peak demand is recorded on January 26th, almost same value..

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第 1 回ビデオ会議

The Project for the Study of Upgrading National Power System Expansion Plan in The Islamic Republic of Pakistan

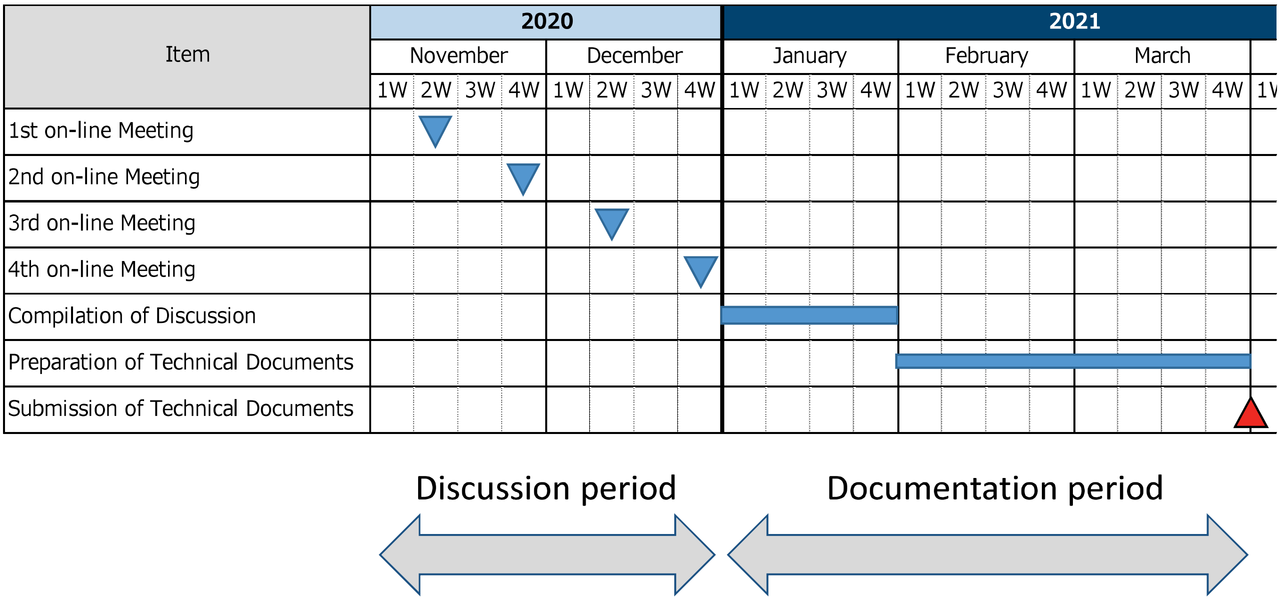
Video conference

November, 2020

CONTENTS

1. Outline of action plan

- Project period: until March 2021
- Meeting: Online meeting (1st , 2nd , 3rd , 4th)
- Completion of Technical Documents: End of March 2021



2. Progress of the Project

Period	Action
February 2019	Holding kick-off meeting
June 2019	Submission of Interim Report based on IGCEP2040(Draft)
July 2019	Provision of PSS/E software to NTDC
July 2019	Discussed and agreed to change the reference to be based on (IGCEP2047)
May 2020	Sharing of IGCEP2047(Draft) with consultant
	Implementation of the study of long term power system expansion plan and pre-feasibility study based on IGCEP2047(Draft)
October 2020	Preparing technical documents based on the study result
November 2020	Sharing of technical documents as Training Material (Draft) with NTDC

3. Overview of the Technical Document

1. Present Status of Power System Facilities
2. Review of Power Demand Forecast
3. Review of IGCEP
4. Review of Existing Power System Expansion Plans
5. Formulation of National Power System Expansion Plan
6. Preparing a Power System Development Plan
7. Strategic Environmental Assessment
8. Outlook for Power Cost in the Power System Expansion Plan
9. Pre-F/S of Priority Projects

4. Key subjects for discussion

Revised 24/11/2020

	Subject	Content
1	Concept of bulk power system	UHV backbone system which connects northern and southern power generation to the central demand area
	Renewable Energy	How to deal with RE in the power system expansion plan
2	Pre Feasibility study	3 projects are proposed based on NTDC's priority list
2.5	Economic and Financial Analysis	Estimates of wheeling cost based on long term power system expansion plan
3	Strategic Environmental Assessment	Result of SEA in the power system expansion plan
	T/L corridor (North)	Result of transmission line corridor study based on GIS data in north (large hydropower plant to grid) and in south (large coal-fired power plant to central grid)
	T/L corridor (South)	
4	HVDC	Modeling of HVDC system which is a key technology of UHV backbone system
	Wrap-up	Additional discussion of the subjects if necessary

5. Schedule of on-line discussion

Revised 24/11/2020

Date	Day	Time	Meeting
25 November	Wed.	10 – 12	The 1st on-line meeting
9 December	Wed.	10 – 12	The 2nd on-line meeting
11 December	Fri.	10 – 11	The 2.5th on-line meeting
16 December	Wed.	10 – 12	The 3rd on-line meeting
23 December	Wed.	10 – 12	The 4th on-line meeting

- ✓ Reference materials to explain subjects in each meeting is shared before the meeting
- ✓ Tools for on-line meeting

6. Request for the comments on the Technical Document

Revised 24/11/2020

Request: Comments on the Technical Documents

Deadline: 23rd December 2020 (4th discussion)

The Project for the Study of Upgrading National Power System Expansion Plan

Overviews for the NPSEP

November 18, 2020

Japan International Cooperation Agency
NEWJEC Inc.

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CONTENTS

1. EXISTING POWER SYSTEM
2. APPROACHES FOR THE FORMULATION OF THE NPSEP2047
3. UNDERSTANDINGS OF IGCEP2047 DRAFT
4. BASIC CONCEPT FOR THE NPSEP2047
5. OUTLINE OF THE POWER SYSTEM IN 2047

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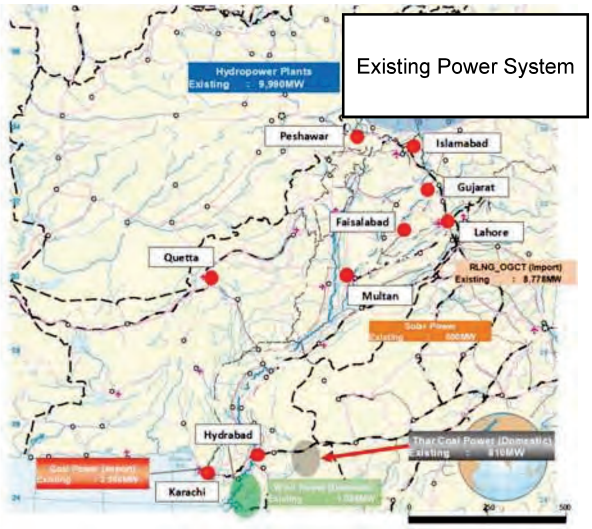
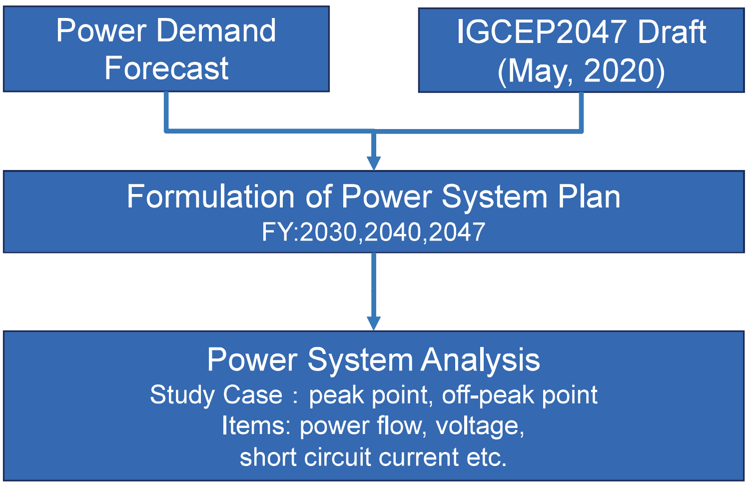
1. Existing Power System



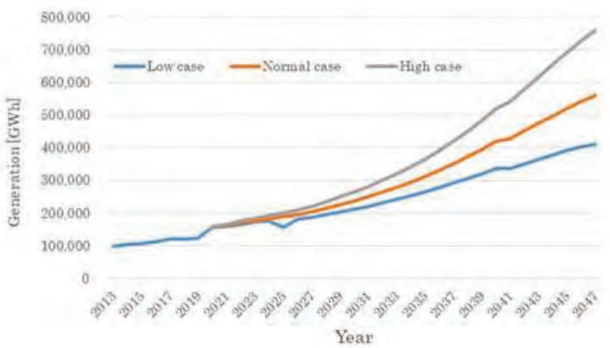
- The distance between northern capital city Islamabad and southern city Karachi is about 1,150 km, and the northern and southern area are connected by 500kV transmission lines which are the backbone of 500kV power system.
- Northern hydro power plants (Tarbela hydro power plant 4,888MW, etc.) and southern thermal power plant (Port Qasim coal thermal power plant 1,320MW, etc.) are connected to 500kV power system, the generation power is transmitted to the main consumption area, Lahore located in northern-middle area.
- Un even distribution of generation sources and concentration of the power demand is the one of unique characteristic.

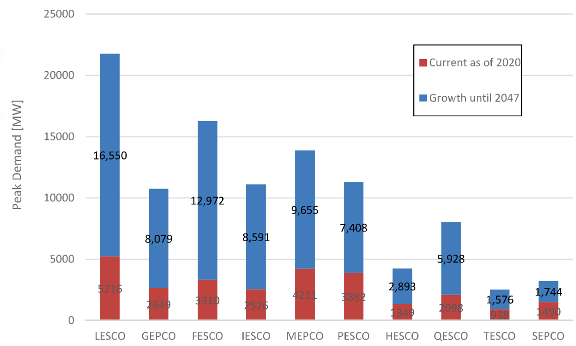
2. Approaches for the NPSEP2047



- Study years are 2030, 2040 and 2047. Rain season, dry season, peak point, off-peak point are studied for each year.
- In the interim report 2, the results of peak point in rainy season and off-peak point in winter season are detailed.

3. Understandings of IGCEP2047
(1) Concentration of the Power Demand in the Central Area





- In terms of electricity demand in the NTDC's jurisdiction, the Punjab province, which is located in the middle of the country, accounts for 62.6 GW out of the total demand of 103.0 GW, with LESCO, FESCO, MEPCO and GEPCO. If the jurisdiction of PESCO and IESCO is included in this, the total demand reaches 85.0 GW.
- These jurisdictions include Lahore, Faisalabad, Multan, Gujarat, Peshawar, Islamabad and other large cities, which pose a challenge to the efficient transmission of power from the power plants to the demand areas and the supply of power in the metropolitan areas.

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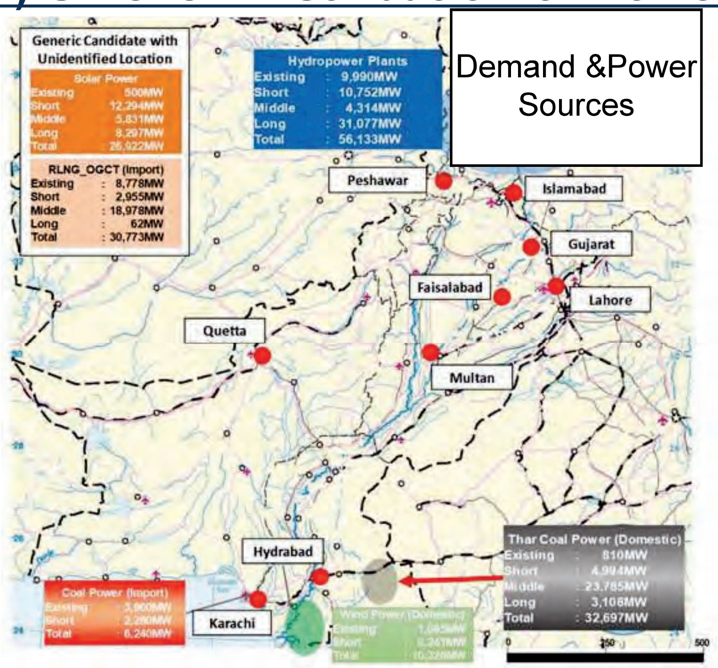
3. Understandings of IGCEP2047
(2) Un even Distribution of Power Sources



- The most important features of the power generation development plan in Pakistan are the development of abundant hydropower reserves in the north and coal-fired development in the Thar coalfield, the fourth largest reserve in the world, in the south.
- By 2047, hydro development will amount to 46 GW, with most of it located in the northern mountainous region The construction of these northern hydropower-to-demand transmission lines is envisaged to be a major development in an alpine region unlike any other in the world.
- Domestic coal-fired power development in the southern Thar coalfield is planned at 32 GW. In addition, the wind corridor in Sindh is envisaged to be developed at around 9 GW.

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3. Understandings of IGCEP2047
(3) Un even Distribution of Power Sources

Two characteristics of the overall concept of the grid development plan are;

- *Uneven distribution of power sources, namely, northern hydropower and southern coal-fired power and wind power*
- *Concentration of the power demand in the central area.*

- These characteristics are the already-existing problems, but these will become more apparent until 2047.
- In the case of a more compact grid configuration, gas-fired plants powered by natural gas or RLNG are envisioned to supply electricity to the vicinity of the demand areas, but this will lead to an increased reliance on a relatively more expensive imported fossil fuel. Hydroelectric power and domestic coal-fired power are superior in terms of energy self-sufficiency and economic efficiency, and are planned to be developed as main power sources in IGCEP 2047, although environmental impacts need to be fully considered.
- Therefore, how to realize the connection between huge power sources and power demand area is the most important topic for the National Power System Expansion Plan

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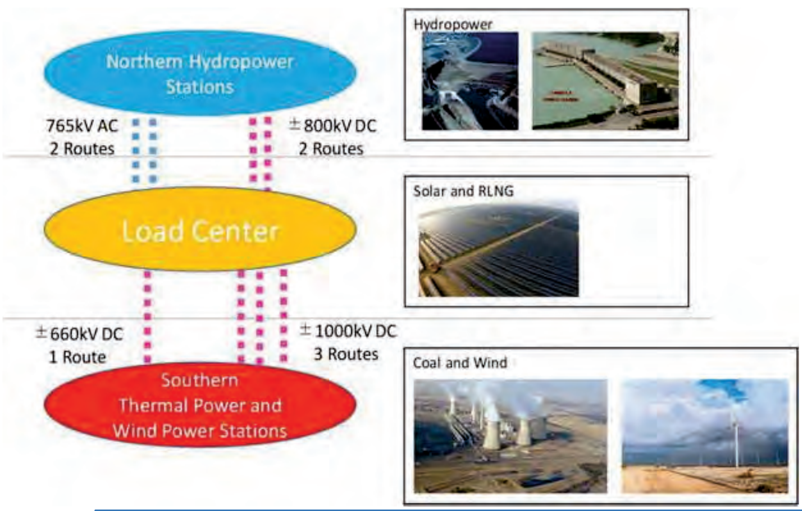
4. Basic Concept for the NPSEP2047



Item	Feature
Simple and reliable power system	A simple grid structure with a longitudinal traverse from north to central demand area and south to central demand area, making grid operation easy Critical urban demand is firmly supported by UHV transmission from northern and southern sources to achieve a high level of reliability. Back-up is ensured even in the event of a failure, such as a disruption of the northern or southern route due to weather conditions
Incremental upgrade by DC transmission system	The general advantage of DC transmission is the flexible ability to add converters when transmission capacity shall be increased. Power development projects, including those for northern hydropower and southern thermal power plants, are subject to unexpected delays and changes in plans, whereas DC transmission is flexible and can be ramped up incrementally. It is economically advantageous.

Concept of "the Large Scale Power Sources and UHV Transmission Lines"

- Considering the focal characteristics in power demand and power generation from IGCEP2047 Draft, ***"the Large Scale Power Sources and UHV Transmission Lines"*** is proposed for the basic concept of the National Power System Expansion Plan.

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5. Outline of the Power System in 2047

UHV Transmission Lines

(Northern Hydro)

- Two routes of 765kV AC transmission lines (Manshera SS-Islamabad West SS and Mardan North-Faisalabad West)
- Two routes of ±800 kV DC transmission lines (Chilas CS-New Sialkot CS)

(Southern Thermal Power, Renewable Energy)

- One ±660 kV DC transmission line route

(Matiari CS-Lahore South CS)

- 3 routes of ±1000kV DC transmission lines (Thar CSs-Luliani CS, Faisalabad CS and Multan CS)

- In addition to the UHV transmission system, the construction of a grid that allows for the decentralized deployment of solar and RLNG-fired power near the demand areas, as the bulk power system by 2047 is also planned.
- In large cities, we will construct highly reliable 500kV power systems based on a circular structure to achieve high power supply reliability.
- The power supply in rural areas such as TESCO and QESCO will be strengthened through the construction and enhancement of new 500 kV/220 kV systems, where demand is expected to grow.

The Project for the Study of
Upgrading National Power System
Expansion Plan

Introduction of Renewable Energy

November 18, 2020

Japan International Cooperation Agency
NEWJEC Inc.

CONTENTS

1. ARE Policy 2019

The Renewable Energy Policy 2019 is being prepared as a component of the overall plan, the long-term integrated energy plan of Pakistan that is currently under development. It envisions the development of an efficient, sustainable, secure, affordable, competitive and environment friendly power system, while promoting indigenization of energy resources and development of local manufacturing capabilities in such technologies.

The main objectives of the Power Policy are:

- *To provide the least cost power generation while keeping other constraints in mind*
- *To ensure fast track and transparent development of power projects*
- *To encourage and ensure utilization of indigenous resources*
- *To be attuned to safeguarding the environment by increasing "green" energy*
- *To encourage private sector investment through attractive rates of return*

Specific targets are being set under this policy and may be amended from time to time. Presently, the GOP has set **the target of at least 20% renewable energy generation by capacity by year 2025 and at least 30% by 2030**.

In order to achieve these targets, the GOP will procure a larger percentage of new capacity from ARE policy 2019, keeping in mind the constraints of base load versus variable generation requirements and the hybrid solutions of ARET that are nearing base load capacity factors

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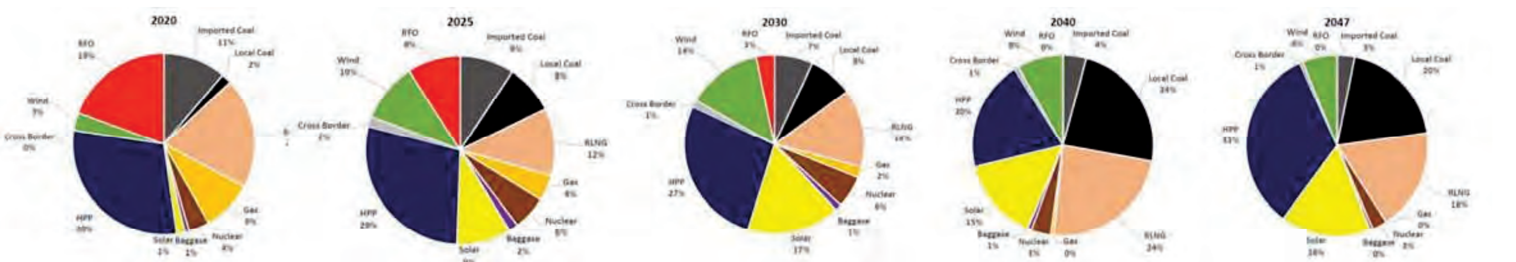
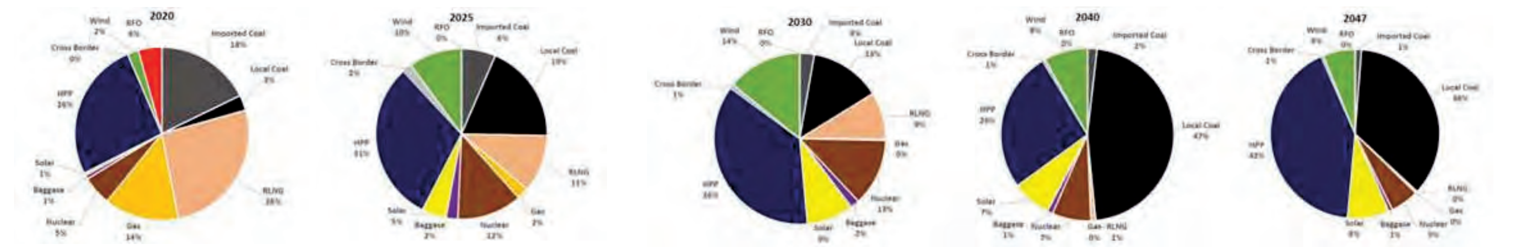
2. Capacity Addition of RE until 2047

Installed Capacity (MW)



RE 5% (W :3%, S :1% and B :1%) | RE 21% (W :10%, S :9% and B :2%) | RE 32% (W :14%, S :17% and B :1%) | RE 24% (W :8%, S :15% and B :1%) | RE 22% (W :6%, S :16% and B :0%)

Annual Power Generation (GWh)



RE 4% (W :2%, S :1% and B :1%) | RE 17% (W :10%, S :5% and B :2%) | RE 26% (W :14%, S :9% and B :2%) | RE 16% (W :8%, S :7% and B :1%) | RE 15% (W :6%, S :8% and B :1%)

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2. Capacity Addition of RE until 2047

Capacity Addition (MW)

Sources	2020 - 2030		2031 - 2040		2041 - 2047		Subtotal	
Hydro	10,752.0	25.7%	4,314.0	8.7%	31,077.0	74.4%	46,143.0	34.6%
Oil	-4,728.4	-20.8%	-1,618.3	-3.3%	0.0	0.0%	-6,346.7	-4.8%
Natural Gas	-954.0	-4.2%	-1,614.0	-3.2%	-747.0	-1.8%	-3,315.0	-2.5%
R-LNG	2,955.0	13.0%	18,978.0	38.2%	62.0	0.1%	21,995.0	16.5%
Local Coal	4,994.0	22.0%	23,785.0	47.9%	3,108.0	7.4%	31,887.0	23.9%
Import Coal	2,280.0	10.0%	0.0	0.0%	0.0	0.0%	2,280.0	1.7%
Nuclear	3,300.0	14.5%	0.0	0.0%	0.0	0.0%	3,300.0	2.5%
Baggasse	653.5	2.9%	0.0	0.0%	0.0	0.0%	653.5	0.5%
Wind	9,241.3	40.7%	0.0	0.0%	0.0	0.0%	9,241.3	6.9%
Solar	12,293.9	54.2%	5,831.0	11.7%	8,297.0	19.9%	26,421.9	19.8%
Interconnection	1,000.0	4.4%	0.0	0.0%	0.0	0.0%	1,000.0	0.8%
Total	***41,787.3***		***49,675.7***		***41,797.0***		***133,260.0***	

- Vast amount of RE will be introduced during 2020 to 2030 in order to achieve the target of ARE Policy 2019.
- 9.2GW of wind, 12.3GW of solar and 0.6GW of Baggasse will be newly installed in this period.
- After that, solar will be the main resource for the capacity addition of RE. 5.8GW during 2031 – 2040 and 8.3GW during 2041 – 2047 will be introduced respectively.
- Although huge amount of RE is planned to be installed, identified projects listed in IGCEP2047 are limited. Wind is 0.9 GW and solar is 0.4 GW.
- Most of new RE projects are proposed as "Generic Candidate" which were defined as unidentified projects with only installed capacity. Their exact location has not been mentioned in the IGCEP2047 draft.

3. Wind Power

- There is a very high potential for wind power in Sindh and Barochistan. Development of Sindh Wind Corridor has been in progress around Jhimpir and Gharo and some new projects are also being planned. According to AEDB, the wind corridor in Sindh is spread over an area of 9,700 km^2 and is expected to have **a total potential of 43 GW**.
- The wind potential of Barochistan province is scattered in Haran in the west and Washap around the Iranian border. The potential is very high and is expected to be developed as a wind corridor similar to Sindh. On the other hand, the bulk power system is not connected to this area. It seems that it is possible to connect these areas to the 500kV substations such as Shikarpur, Dadu and Quetta, but the development plan has not been prepared as of this moment.
- Considering the above the situation, the NPSEP shall be formulated based on the assumption that **8.3 GW Generic Candidates of wind power plants will be developed at Sindh Wind Corridor**.

4. Solar Power

- From the aspect of solar radiation, Barochistan and Sindh have rich potential. On the other hand, GHI in the northern area such as Islambad and Peshawar is 1,727 – 1,844 kWh/m2/year which is also equivalent to the capacity factor of 20.4%. Such a solar radiation level is envisaged to yield a competitive generation cost when compared to gas or other thermal fuels. And, **<u>it is possible to develop solar power plants throughout Pakistan</u>**.
- Introduction of solar power plants by 2047 is expected to reach 26.5GW. Identified projects are only 0.4GW and Generic Candidates are 26.1GW. **<u>How to allocate this huge capacity is an important topic.</u>**
- While location of wind power is based on the potential, the solar plants can be distributed owing to their flexibility when it comes to site selection. On the other hand, selection of solar power plants for IPPs tends to focus on land use and radiation, in other words, the economic efficiency. And it may lead to the concentrated development of solar power projects in the hotspots, which will have negative impact on the power system operation.
- Basic approaches for the introduction of solar power in NPSEP are **<u>"Decentralization" and "Harmonization".</u>**

4. Solar Power

- Following steps are practically proposed for the consideration of location and capacity of solar power plants in NPSEP.
  - ***<u>Committed projects in IGCEP2047 are listed.</u>***
  - ***<u>Development Plan in promising potential area located near the demand area. And potential area, which have vast land such as Bahawalpur in southern Multan and Hyderabad Thall in western Faisalabad, are considered.</u>***
  - ***<u>Remaining capacity shall be distributed based on the demand of 220kV substation.</u>***
- As for ii), there are some promising areas with large solar potential and vast land near the demand area. Interconnection to the bulk power system is expected to be easier and large scale development of a "Solar Park" is expected in these areas. It is consistent with "Decentralization" and "Harmonization of the power system".