[2] Master Plan on Optimization for Peaking Power Supply

Japan International Cooperation Agency (JICA)

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Contents

- **Part1**: Outline of Study
- **Part2**: Scenarios
- **Part3**: Results of Simulations
- **Part4**: Optimal Power Development Plan

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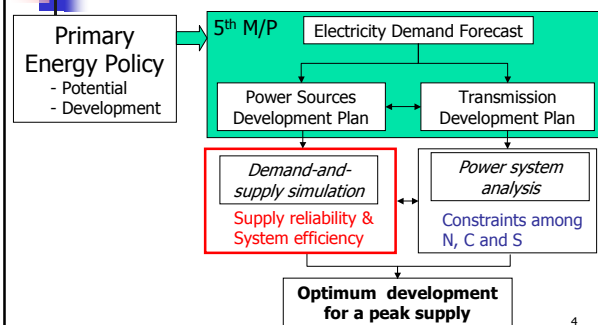## Part1 : Outline of Study

- Study Flow
- Methodology
  - System Reliability Analysis
  - Quantification of Annual Costs

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Study Flow

Primary Energy Policy
- Potential
- Development

5th M/P

Electricity Demand Forecast

Power Sources Development Plan — Transmission Development Plan

Demand-and-supply simulation
Supply reliability & System efficiency

Power system analysis
Constraints among N, C and S

Optimum development for a peak supply

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Power system analysis

To identify
- Constraints among North, Center and South through 500 kV T/L

Due to :
- Spec. of Transmission systems
- Stability
- Power supply reliability
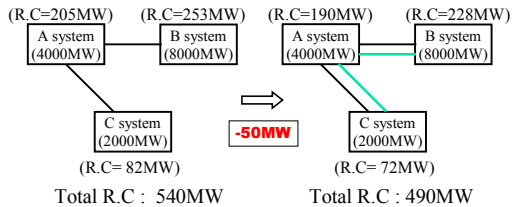
Reflecting to Supply-and-Demand Simulation

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Methodology

(Simulation Tools)

- System Reliability   RETICS
- Annual Costs
- Balance between   PDPAT II
  Demand and Supply

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System Reliability Analysis by RETICS

- To simulate how Reserve Capacity Required changes along with Interconnection Capacity on the Same Reliability

(R.C=205MW)   (R.C=253MW)   (R.C=190MW)   (R.C=228MW)

| A system (4000MW) | B system (8000MW) |

| C system (2000MW) |

-50MW

| A system (4000MW) | B system (8000MW) |

| C system (2000MW) |

(R.C= 82MW)   (R.C= 72MW)

Total R.C : 540MW   Total R.C : 490MW

Simulation of Supply & Demand Balance by PDPAT II (1)

- Computation of Annual Cost
  - Fixed Cost
    - Depreciation, Interest
    - O&M
  - Energy Cost
    - Fuel
    - Power Exchange

Simulation of Supply & Demand Balance by PDPAT II (2)

- Computation of Balance between Demand and Supply (Economic Dispatch)
  - Most Economical Energy Balance (Fuel Balance)
  - Optimal Power Balance
  - Reserve Margin
  - Fuel Consumption
- Computation of Power Exchange
  - Quantity & Frequency of Exchange
  - Economical Power Exchange

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- Part1: Outline of Study
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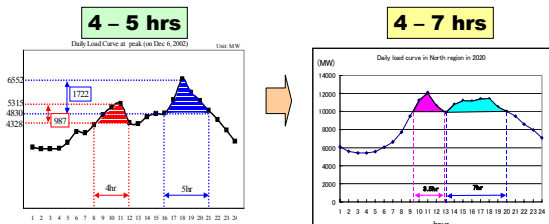
Part2 : Establishment of Scenarios

- Situations & Conditions
  - Load Curve, Limitation of Interconnection
- Screening Analysis
  - Selection of Economical Peak Suppliers
- System reliability analysis
  - Necessary Reserve margin

To establish Scenarios for
   Quantification of annual costs
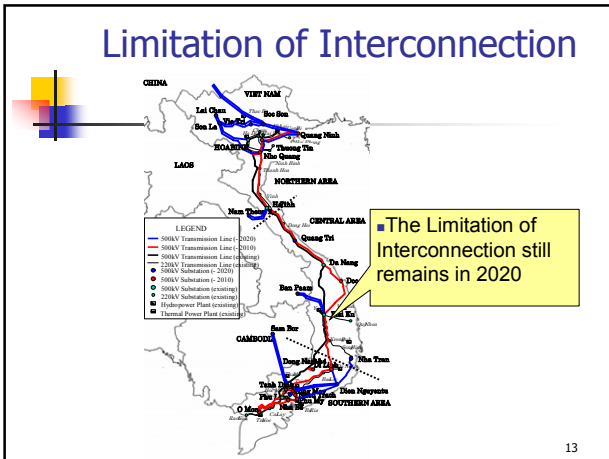by PDPAT II Simulation for divided systems

Load Curve Forecast

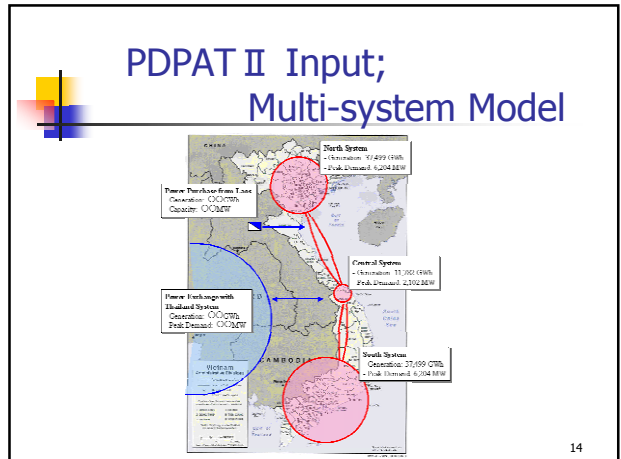- Peak shift affects the duration of peak demand

4 – 5 hrs   4 – 7 hrs

Limitation of Interconnection

LEGEND
500kV Transmission Line (~2020)
500kV Transmission Line (~2010)
500kV Transmission Line (existing)
220kV Transmission Line (existing)
500kV Substation (~ 2020)
500kV Substation (~ 2010)
500kV Substation (existing)
220kV Substation (existing)
Hydropower Plant (existing)
Thermal Power Plant (existing)

CHINA
VIET NAM
LAOS
NORTHERN AREA
CENTRAL AREA
CAMBODIA
SOUTHERN AREA

- The Limitation of Interconnection still remains in 2020

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PDPAT Ⅱ Input; Multi-system Model

North System
Power Purchase from Laos
Power Exchange with Thailand System
Central System
South System

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Screening analysis

- Which peaking power supply should be selected from economic aspect?

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Screening Analysis (conditions)

	Construction Cost	Life time	Annual O&M Cost Rate	Fuel Cost in 2020	
				Hydro 0 ¢ /kWh	Coal 2.4 ¢ /kWh
PSPP	650 US$/kW	40	1.0%		
GT	400 US$/kW	20	5.0%	3.9 ¢ /kWh	
CC	600 US$/kW	25	4.5%	2.4 ¢ /kWh	
Coal	938 US$/kW	30	3.5%	1.5 ¢ /kWh	
Diesel	800 US$/kW	15	3.0%	9.0 ¢ /kWh	

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Screening Analysis (1)

ANNUAL COSTS 2020

Annual costs (US$/kW)
Capacity Factor (%)

PSPP
GT
CC
COAL
Diesel
Nuclear

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Screening Analysis (2)

Screening Generations for Peak Demands

¢ /kWh
Capacity Rate

PSPP
GT
COAL
CC
Diesel

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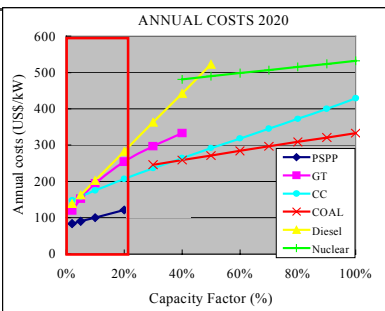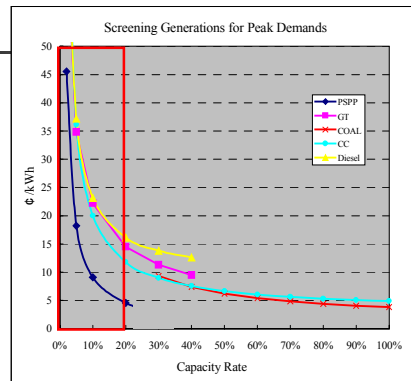
Reliability analysis by RETICS (1)

- Divided systems

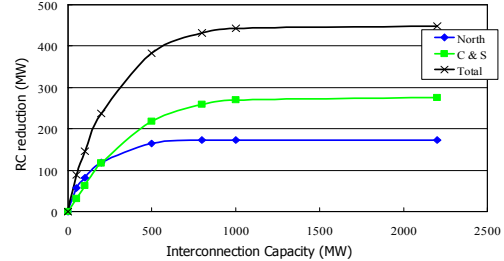Reserve Margine vs LOLE North 2020

MARGIN vs LOLE C&S 2020
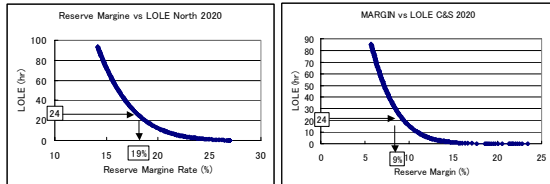
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Reliability analysis by RETICS (2)

- Reduction of Reserve Capacity

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Reserve Margin of Revised 5th M/P

	Installed capacity (MW)	Reserve margin	LOLE	Annual costs mil,.US$/yr
Whole system	42,162	19.3%	0.08	9,515
North	16,290	10.9%	86.46	2,925
C&S	25,872	20.2%	0.03	6,699
Total	42,162			9,624

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Required Reserve Margin (MP load profile)

	Installed capacity (MW)	Reserve margin	LOLE (hrs)	Annual costs (mil.US$/yr)
①Whole system	39,793 -2,369	9.7%	24.6	9,400 -115
②Divided system				
(North)	16,225 -65	14.2%	23.4	3,083 +158
(C&S)	24,538 -1,334	7.9%	23.3	6,555 -144
Total	40,763 -1,399			9,638 +14

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Establishment of scenarios

	PSPP	GT
Target years	2015, 2020	2015, 2020
Power system	Whole, North, C&S	Whole, South
Installed capacity	0 - 10%	0 - 10%
Capacity of interconnection	800, 1300, 2200MW	800, 1300, 2200MW
Son La construction	2,400 or 0	2,400 or 0
Demand forecast	MP load curve, Peak Shift	MP load curve, Peak Shift
Power Purchase from Neighbor Countries	Laos, None, All	Laos, None, All
Soaring fuel prices	Base×2	Base×2

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Part3 : Simulation of Supply & Demand Balance by PDPAT II

- Results in 2015 for optimal peak supply
  - Effects of Son La
- Results in 2020 for optimal peak supply
  - Effects of peak shift
  - Effects of interconnection
  - Effects of system limitations
- Optimal composition
  - Effects of limitations of fuel consumption
- Optimal operating hours for PSPP

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Effects of Son La

- Effects peak supply installation
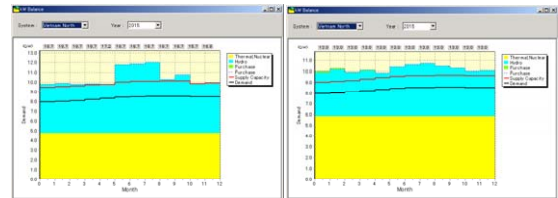
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Results in 2020

- PSPP in N system shows benefits

Scenario		PSPP in N		PSPP in S		GT in S	
Demand	Interconnection	%	US$ mil/Yr	%	US$ mil/Yr	%	US$ mil/Yr
Peak shift	Whole system	0	9,621	0	9,621	0	9,621
	0MW	3.5	9,875	0	9,956	0	9,973
	800MW	3.5	9,650	0	9,727	0	9,729
	1,300MW	3.5	9,618	0.6	9,663	0	9,667
	2,200MW	2.4	9,598	1.8	9,588	0	9,622
IE	Whole system	0	9,400	0	9,400	1.2	9,397
	0MW	1.2	9,546	0	9,592	0	9,592
	800MW	1.2	9,307	0	9,341	0	9,341
	1,300MW	1.2	9,260	0	9,276	0	9,276
	2,200MW	0	9,233	0	9,233	0	9,233

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PSPP in N system PS demand (1)

- N system has benefits.
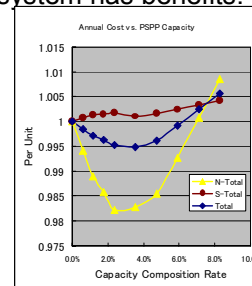
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Simulation results (1)

- Before PSPP installation, N system
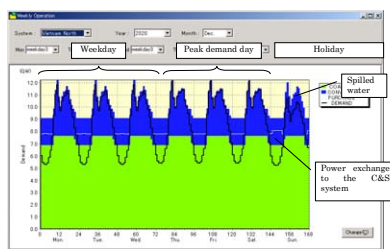
Dec. 2020 N system

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Simulation results (2)
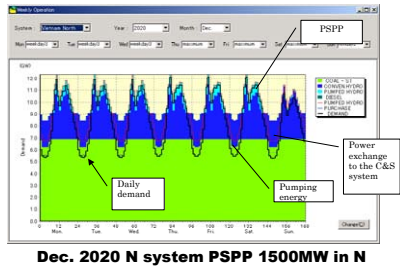
- Before PSPP installation, C&S system
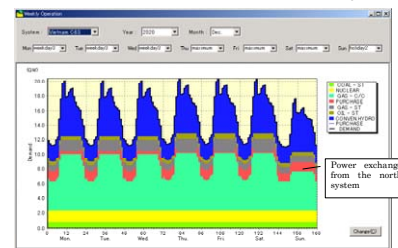
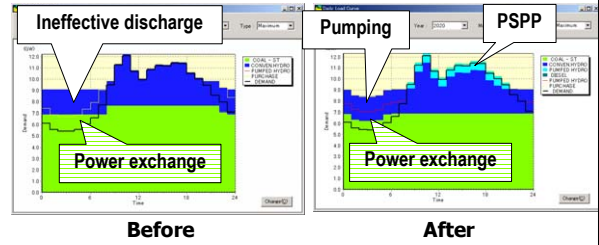**Dec. 2020 C&S system**

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Simulation results (3)
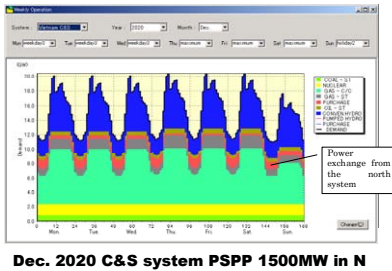
- After PSPP installation, N system

Dec. 2020 N system PSPP 1500MW in N

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Effects of PSPP in 2020

- Utilization of off-peak surplus supply

Before   **After**

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Simulation results (4)

- After PSPP installation, C&S system

Dec. 2020 C&S system PSPP 1500MW in N

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PSPP in N system PS demand (1)

- N system has benefits.
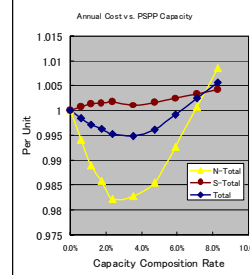
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PSPP in S system PS demand (1)
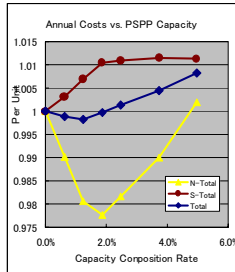
- No benefit
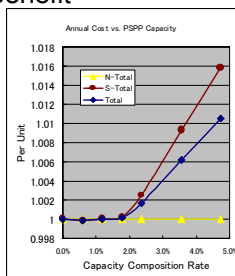
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PSPP in C&S system PS demand (2)

- Increasing Oil consumption

PSPP in C&S 250MW in Dec. 2020   PSPP in C&S 2000MW in Dec. 2020
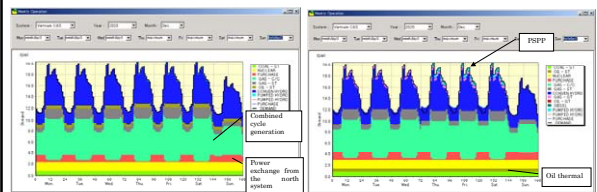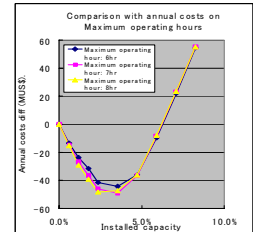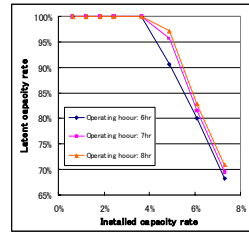
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PSPP in N system, MP load profile

- Benefits from PSPP installation with IC 1300MW

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Optimal Peak Duration Time of PSPP

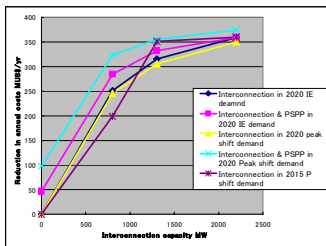- 7-hour is appropriate in Vietnam system.

Latent capacity   **Annual costs**

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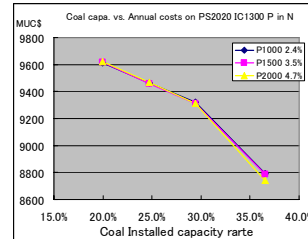## Effects of Interconnection

- Around 1300MW, benefits decelerate

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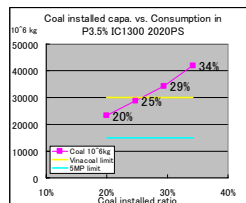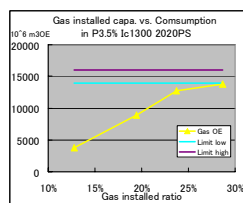## Effects of Coal TPP installation in the South

- PS demand, 2020 case

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Consideration of Fuel limitation

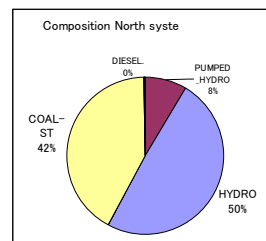- Coal limits at 25%, Gas not to constrain

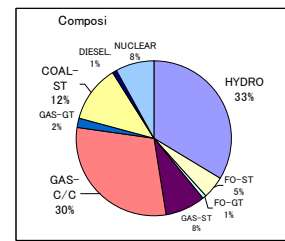**Coal limitation**   **Gas limitation**

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Optimal Composition

- Peak shift case, 2020 case

N system   **C&S system**

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Part 4 : Optimal power development plan in 2020 (Composition)

Peak shift case

MP load profile

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Image of power development pattern from 2010 to 2020 (Peak shift case)

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Thank you

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