添付資料 10-3-2

第 2 回ワークショッププレゼンテーション資料

THE 2nd WORKSHOP
ON THE MASTER PLAN STUDY

ON PUMPED STORAGE POWER PROJECT AND OPTIMIZATION FOR PEAKING POWER GENERATION

Venue: Fuji A, 2nd floor, Hotel NIKKO HANOI

7 August, Thursday

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POWER DEVELPOMENT & POWER NETWORK

- Outlines of power development plan focusing on peaking power supply
  - Optimization for peaking power generation
  - Power system analysis

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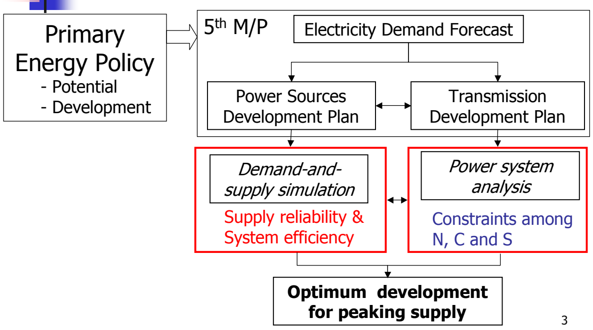
Study Flow



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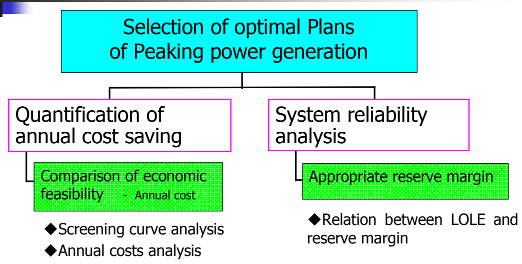
Outline of the study on Optimization for Peaking power generation



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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 Demand-and-supply simulation

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Optimization for Peaking power generation

- Quantification of annual cost saving
- System reliability analysis

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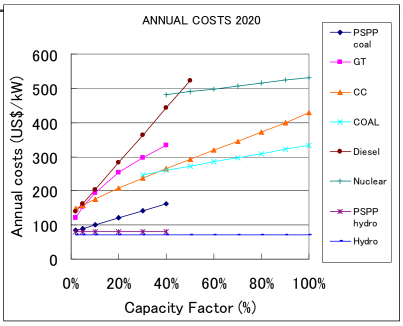
Quantification of annual cost saving

- **Step1:**
  Screening curve analysis
  - Which peaking power supply should be selected from economic aspect?

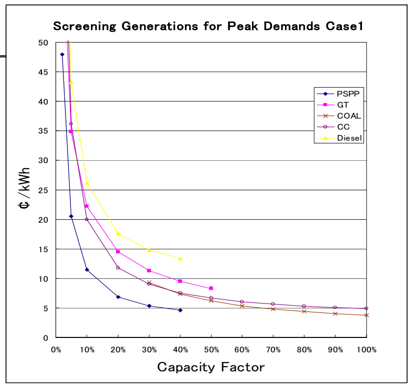
Conditions of screening

	Construction Cost	Life time	Annual O&M Cost Rate	Fuel cost	
PSPP	650 US$/kW	40	1.0%	Hydro 0 ¢ /kWh	Coal 2.4 ¢ /kWh
GT	400 US$/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	

Screening curve analysis (1)



Screening curve analysis (2)

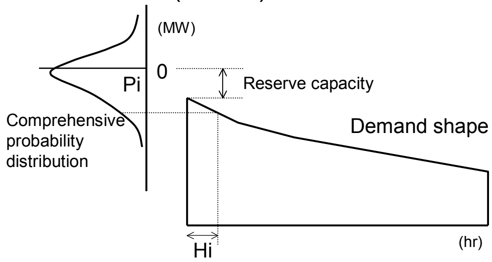


System reliability analysis

- Step2: Relation between LOLE and reserve margin
  - How much power supply does it need to meet the reliability criteria?
    - Reliability analysis (RETICS)

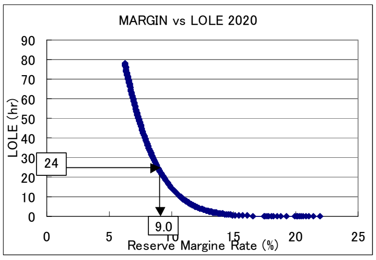
Relations between Reserve Capacity and LOLE

- LOLE＝Σ (Pi×Hi)



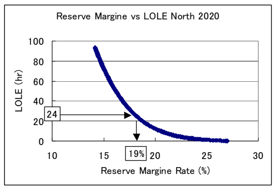
Reliability analysis (1)

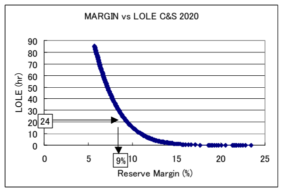
- Whole system



Reliability analysis (2)

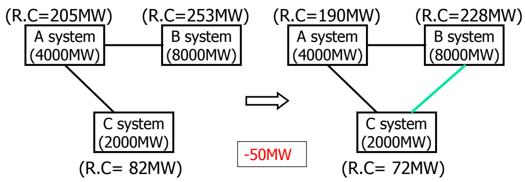
- Divided systems





Reduction in reserve capacity

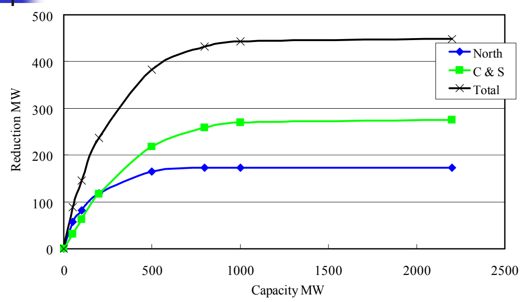
- To maintain a desired LOLE value for each system and ascertain how the reserve capacity changes with or without an interconnection



Total R.C : 540MW

Total R.C : 490MW

Reduction in Reserve Capacity



Quantification of annual cost saving

- **Step3:** Annual costs analysis
  - How much annual cost does it need to operation?
    - Simulation concerning with daily operation (PDPAT II)

Function of PDPAT II

- Computation of Annual Cost
  - Capacity Cost
    - Depreciation
    - Maintenance
  - Energy Cost
    - Fuel
    - Power Exchange

Function of PDPAT II

- 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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Input Data for PDPAT II

- Demand Data
  - Every Hour Data throughout a Year
- Power Development Plan
- Facility Data
  - Capacity
  - Generation Cost and its Breakdown (Construction, Fuel, O&M Cost *etc.*)
  - Forced & Scheduled Outage Rate
  - Operation Condition

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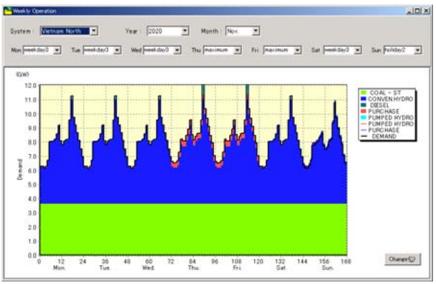
Demand-and-Supply Simulation (1)

- Weekly operation N system



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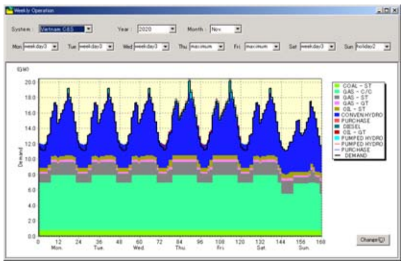
Demand-and-Supply Simulation (2)

- Weekly operation of C&S system



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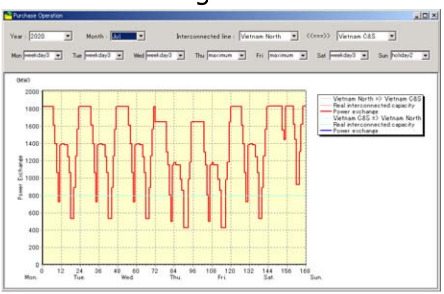
Demand-and-Supply Simulation (3)

- Power exchange



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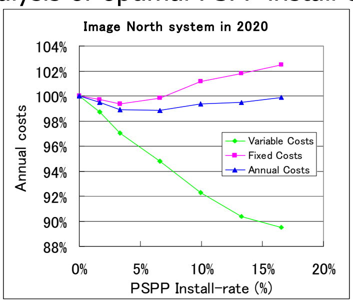
Optimal Composition

- Analysis of optimal PSPP install capacity



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Power network of Vietnam in year 2020

- Outline of power network
- Series capacitors
- Impacts on power network by PSPP

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Outline of power network

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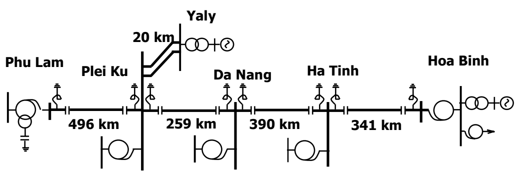
Existing 500 kV system

- Single circuit from north to south
- Series capacitors and shunt reactors installed



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500 kV system Y2020

- Doubled with north-south 500 kV circuits
- Constructed in a net-shaped structure of north and south
- Extended to the power station areas in Laos and Cambodia

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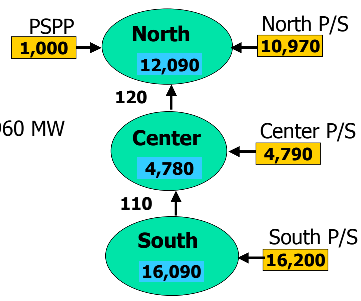
Sample power flow at peak in 2020

Generation : 32,960 MW



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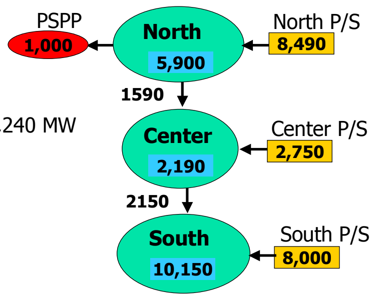
Sample power flow at off peak in 2020

Generation : 18,240 MW



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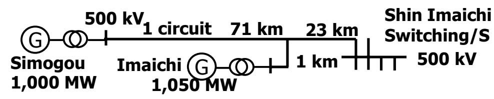
Power flow at off peak in 2020

- Fully output Coal P/S in north
- Less output Gas P/S in south

- More power exchange from north to south than peak

1,000 MW PSPP to network

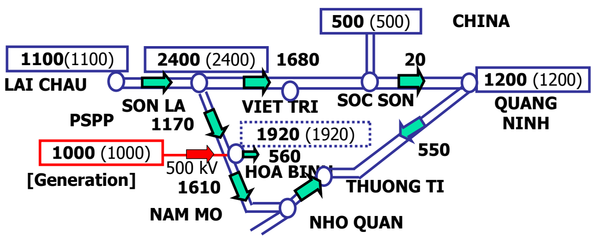
- Example of TEPCO



- 500 kV
  - Stable and more cost effective than 220 kV
- One circuit
  - Tokyo and Tohoku system : 50,000 MW (planning stage)
  - 8 % power/Hz
  - Dropping out of 1 circuit makes allowable frequency changes.

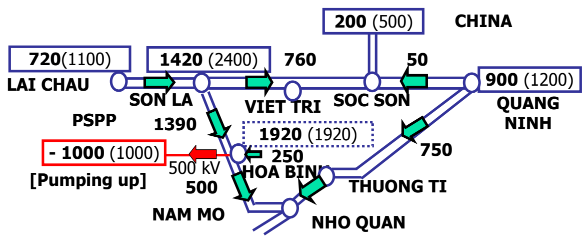
Example of PSPP operation at peak

- Full outputting at peak demand



Example of PSPP operation at off peak

- Pumping up at off peak demand



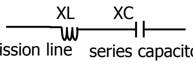
Series capacitors

Series capacitors and SSR

- Series capacitors compensate large line reactance.
- However, there is a possibility of causing SSR (subsynchronous resonance).

SSR

- Zero reactance of transmission lines and series capacitors for a lower frequency than 50 Hz.



reactance : XL – XC = 0 for a lower frequency

- Series resonance or negative damping torque
- Possibility of causing shaft torsional vibration of turbine generators with long shafts.

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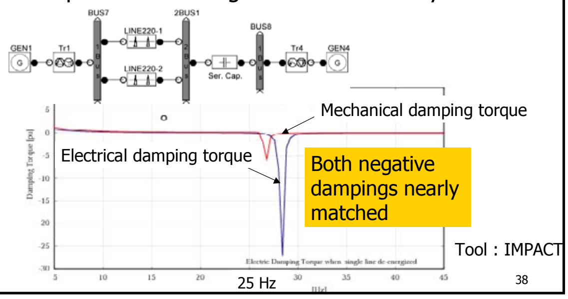
Example of SSR

- Simple model with generator 3 mass system



Tool : IMPACT

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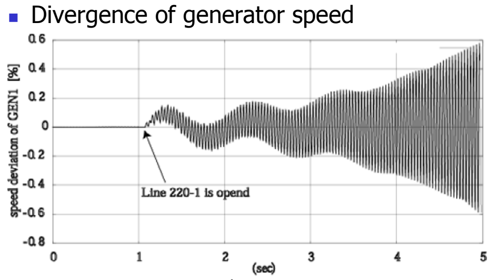
Example of SSR

- Divergence of generator speed



Tool : ATP-EMTP

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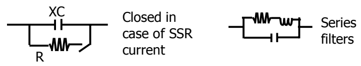
Countermeasures against SSR

- Not installing series capacitors
- Reinforcing transmission lines without series capacitors
- Series capacitor with some filters



- Relays for generator tripping
- Auto network switching in case of SSR
- Applying shafts avoiding resonance
- Applying thyristor controlled devices
- Precise and cautious studies will be required on applying series capacitor.

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Impacts on power network by PSPP

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Study flow

- PDP scenarios with PSPP
  - Economical operation
  - Largest power flow case
  - PSPP development scenarios
- Studies of impacts on power network by PSPP
  - Checking system performance
  - Giving information for comparison between scenarios

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Checking system performance

- Power flow
  - Power flow analysis and loss comparison
    - Loss ratio to total demand will be about 2-3% in Y2020.
- Stability
  - In case of a fault at each 500 kV circuit
- Voltage
  - Differences in required reactive power in network
- Fault current
  - Confirmation of fault current at respective buses
    - Some 220 kV buses in south areas will exceeds 45 kA

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Thank you

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