



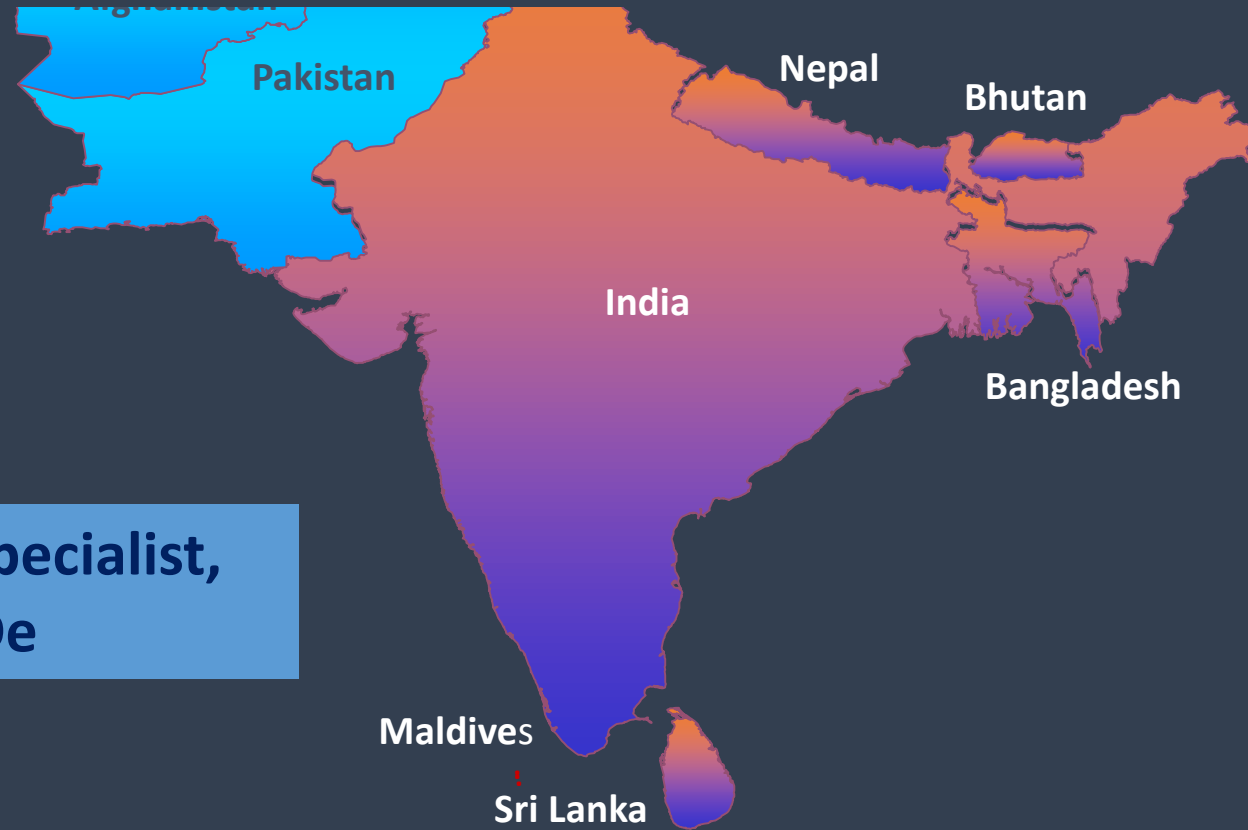
USAID
FROM THE AMERICAN PEOPLE

SARI/EI

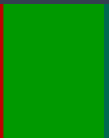


Integrated Research and
IRADe Action for Development

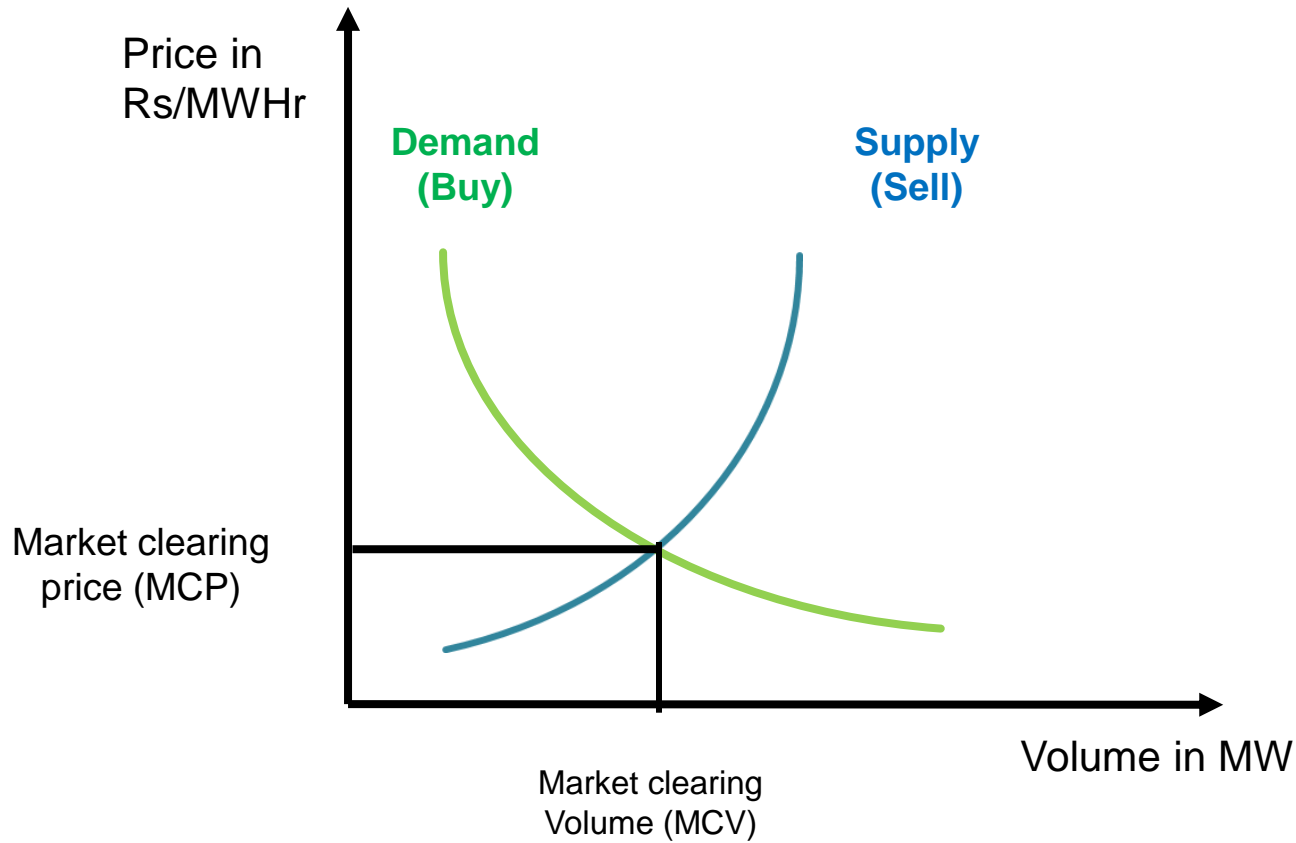
Stakeholder Consultation Meeting Basics of Power Exchange and SARPEX Mock Exercise



**S.K. Ray, Technical Specialist,
SARI/EI, IRADe**

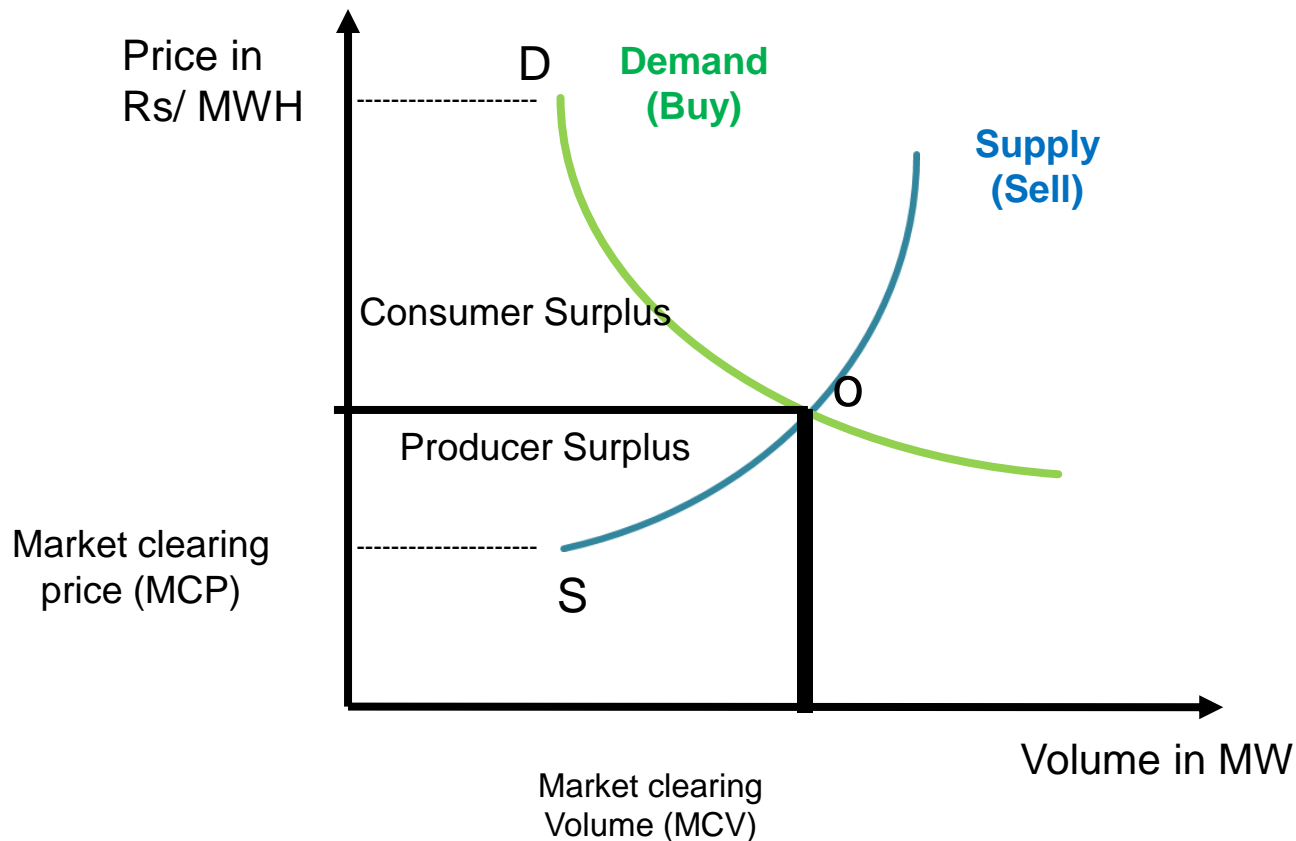


Basic Concept of Market Clearing price and volume in a close double sided auction



- 1) A curve is plotted for the Demand. All the points in the curve represent the Demand bid volume for that price.
- 2) A curve is plotted for the Supply. All the points in the curve represent the Supply bid volume for that price.
- 3) The point of intersection gives the Market clearing price (MCP) and the Market clearing volume (MCV)
- 4) All sellers willing to sell at MCP or at a lower price are cleared.
- 5) All the buyers willing to buy at MCP or at a higher price are cleared.
- 6) All trades are cleared at MCP irrespective of their bid price.

Concept of Consumer Surplus and Producer surplus



- 1) Consumer Surplus. All the buyers whose bids were higher than MCP have been cleared. However they will get power at a price lesser than their bid price. Thus they get power at a price lesser than that they were willing to pay. This gain is called the consumer surplus and benefits all buyers on the curve OD.
- 2) Producer Surplus. All the sellers whose bids were lower than MCP have been cleared. However they will get power at a price higher than their bid price. Thus they get to sell their power at a price higher than that they were willing to accept. This gain is called the producer surplus and benefits all sellers on the curve OS.

Some Terminology relevant to the exercise

- Day ahead market: Bidding in the market is done on day n , for trades which are effective on day $n+1$.
- Unconstrained Market Price and volume (UMP & UMV) : The discovered market price and volume which do not take into account transmission constrains.
- Constrained Market Price and volume (CMP & CMV) : The discovered market price and volume discovered after taking into account the transmission constrains
- Modes of operation of pilot market:-
 - A. Sequential Mode or Residual Mode - The pilot market shall be run such that the Indian domestic exchanges are not in any manner influenced by the operation of the pilot market. The un-cleared bids of Indian Domestic exchanges shall be matched against the bids of the other nations in the pilot market platform.
 - B. Unified Mode - The pilot market shall be run such that all the bids including the bids from Indian participants are cleared simultaneously the pilot market platform

“THE GRID CONSTRAINTS & TRANSMISSION CAPACITY ALLOCATION PROCEDURES DON’T APPLY TO PILOT MARKET “

Brief about SARPEX Mock Exercise

- The exercise covers the period from April'2015 to March'2016.
- 71 days were selected in this one year period to cover all kind of demand situation and various other crucial factors as per the approved Sampling methodology.
- Core teams were nominated by Bangladesh, Bhutan and Nepal who will bid for all the dispatch periods of all these 71 days.
- Indian bids for these 71 days were extracted from information available in public domain.
- The mock trading platform was run to generate results for all these 71 days.
- The mock trading platform was run in two modes of operation, “Unified mode” and “ Sequential or Residual Mode” as explained further in this presentation.
- The market rules and design for running of the mock exercise were approved in the last TF-3 meeting for both the modes of operation.

Brief about SARPEX Mock Exercise .. Continued

- The transmission losses and charges have been factored in as in case of a regular day ahead market.
- The figures of transmission losses and charges used for Bangladesh, Bhutan and Nepal are mentioned further in this presentation.
- The result of the matching engine yields the unconstrained solution.
- The result for the 71 days were extrapolated to get the result for the entire year for both the modes of operation.
- The consumer and producer surplus, quantum of power sold/bought, sale/buy price etc. for each participating Nations and the entire region was worked out in both the modes .
- The impact of the regional trading platform on the domestic market was analyzed.
- Based on the above, a particular set of market rules and design is being recommended for SARPEX.

Average Transmission Charges and Losses Figures for BBN

| # | Country | Transmission Charges | Transmission Losses | Comments |
|---|----------------------------|----------------------|---------------------|--|
| | | (Rs/kWh) | (%) | |
| 1 | Bangladesh | 0.117 | 0.3% | The cross-border transmission network for India-Bangladesh has been included in the POC charges and transmission Withdrawal Charges and Losses are published for Bangladesh |
| 2 | Nepal | 0.301 | 4.1% | The cross-border transmission network for India-Nepal has not been included in POC and therefore the transmission charges of Bihar and Cross-border line are assumed for Nepal |
| | Bihar Withdrawal | 0.257 | 1.6% | |
| | Muzzafarpur Dhalkebar Line | 0.044 | 2.5% | |
| 3 | Bhutan | 0.089 | 1.1% | The cross-border transmission network for India-Bhutan has been included in the POC charges and transmission Injection Charges are published by NLDC for Bhutan |

The bids submitted by BBN were adjusted by the above transmission charges and losses to reflect the true cost of power purchased or sold on the Exchange

Approach and Methodology – UNIFIED MODE

SELECTION OF SAMPLE DAYS

A total of 71 days were selected from the period Apr'15 to Mar'16 basis:

- Average to Peak Load condition in all nations
- Unconstrained Market-clearing Price and Volume on Indian Exchange(s)
- Day and Month
- Effect and Public holidays/Special days observed in all the nations

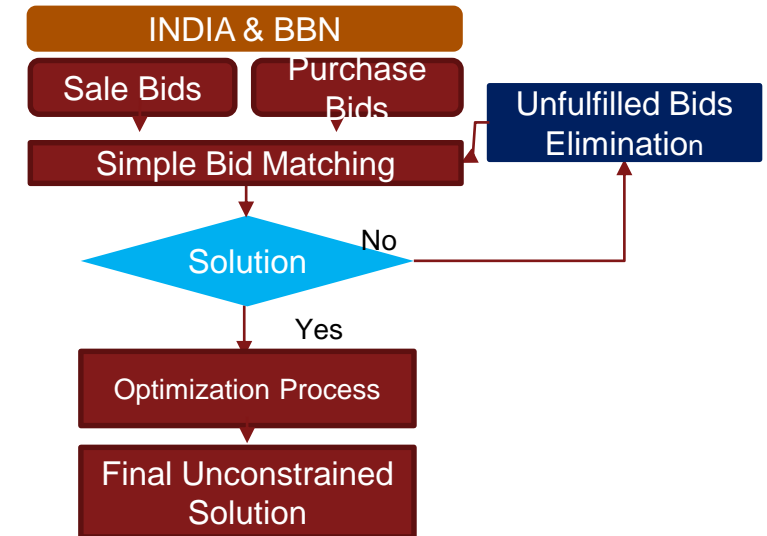
BIDDING

The 15-minute block level purchase/sale bids are submitted by Bhutan, Nepal and Bangladesh for all the selected days

The bids of Indian participants (both buyers and sellers) are extracted from the aggregate demand supply curves available publicly on the Indian Power Exchange(s)

MARKET CLEARING ALGORITHM IN UNIFIED MODE

UNIFIED MODE – 15 MINUTE DAM INTERVAL



Approach and Methodology – SEQUENTIAL/Sequential MODE

SELECTION OF SAMPLE DAYS

BIDDING

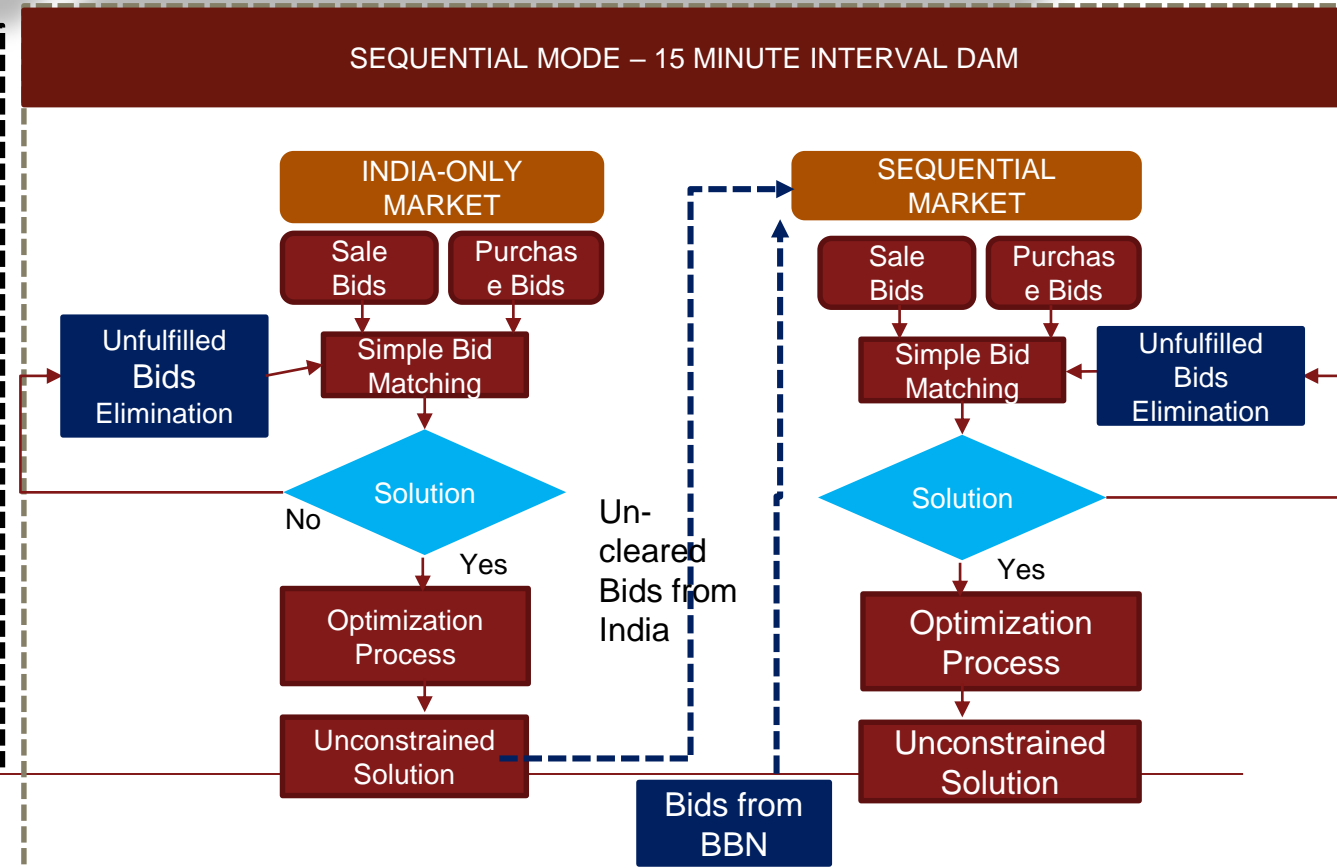
MARKET CLEARING ALGORITHM IN Sequential MODE

A total of 71 days were selected from the period Apr'15 to Mar'16 basis:

- Average to Peak Load condition in all nations
- Unconstrained Market-clearing Price and Volume on Indian Exchange(s)
- Day and Month
- Effect and Public holidays/Special days observed in all the nations

The 15-minute block level purchase/sale bids are submitted by Bhutan, Nepal and Bangladesh for all the selected days

The bids of Indian participants (both buyers and sellers) are extracted from the aggregate demand supply curves available publicly on the Indian Power Exchange(s)

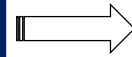


OPERATING TIMELINES FOR SARPEX

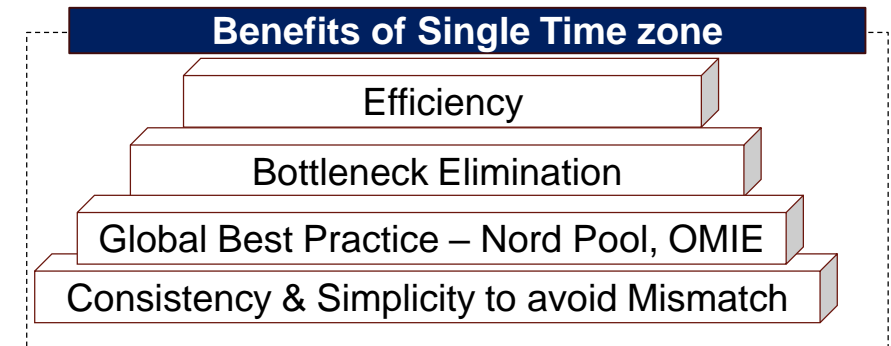
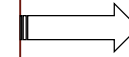
The choice between single and multi time zones needs to be made in keeping with the impact on Operating Timelines

Time zones observed in BBIN relative to UTC

| Country | Time zone (In Hours) | IST Deviation (In Minutes) |
|------------|----------------------|----------------------------|
| India | UTC + 5:30 | - |
| Bhutan | UTC + 6:00 | +30 minutes |
| Bangladesh | UTC + 6:00 | +30 minutes |
| Nepal | UTC + 5:45 | +15 minutes |



Mismatches in time-zones has implications on coordination of DAM operational activities.



A single reference time zone and operating timeline assumed for SARPEX mock exercise is IST

OPERATIONAL CHALLENGES DUE TO MULTIPLE TIME ZONES IN SARPEX

Electricity Dispatch at the “day boundary” for three consecutive days D-2, D-1 and D

| Slots | 41 | 48 | 49 | 71 | 95 | 96 | 1 | 2 | 41 | 49 | 95 | 96 | 1 | 2 | 41 | 49 | 95 | 96 |
|------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| India | 10:00 | 11:45 | 12:00 | 17:30 | 23:30 | 23:45 | 00:00 | 00:15 | 10:00 | 12:00 | 23:30 | 23:45 | 00:00 | 00:15 | 10:00 | 12:00 | 23:30 | 23:45 |
| Nepal | 10:15 | 12:00 | 12:15 | 17:45 | 23:45 | 00:00 | 00:15 | 00:30 | 10:15 | 12:15 | 23:45 | 00:00 | 00:15 | 00:30 | 10:15 | 12:15 | 23:45 | 00:00 |
| Bhutan | 10:30 | 12:15 | 12:30 | 18:00 | 00:00 | 00:15 | 00:30 | 00:45 | 10:30 | 12:30 | 00:00 | 00:15 | 00:30 | 00:45 | 10:30 | 12:30 | 00:00 | 00:15 |
| Bangladesh | 10:30 | 12:15 | 12:30 | 18:00 | 00:00 | 00:15 | 00:30 | 00:45 | 10:30 | 12:30 | 00:00 | 00:15 | 00:30 | 00:45 | 10:30 | 12:30 | 00:00 | 00:15 |

95 96
Coordination Issues

Day D-2
 Day D-1
 Day D

Dispatch periods at the “day boundary” i.e. Slot 95 and Slot 96 may lead to coordination issues. While these slots belong to Day “D-1” in India, they belong to Day “D” i.e. the next day in Bhutan, Bangladesh and Nepal

Web portal for SARPEX Mock Exercise Link

<http://mocksarpex.eu.ai>

Web Portal has, among other the following :-

- All documents related to SARPEX mock Exercise.
- Provision for submission of bids and viewing of results
- The access to the above is password protected.
- FAQ
- Various presentations related to SARPEX Mock Exercise
- Details of Stakeholder Consultations.
- Details of past and planned events
- Contact details.
- A link for submission of queries.



Selected Days for Pilot Market Exercise

A total of 71 days were selected as the sample for Mock Exercise

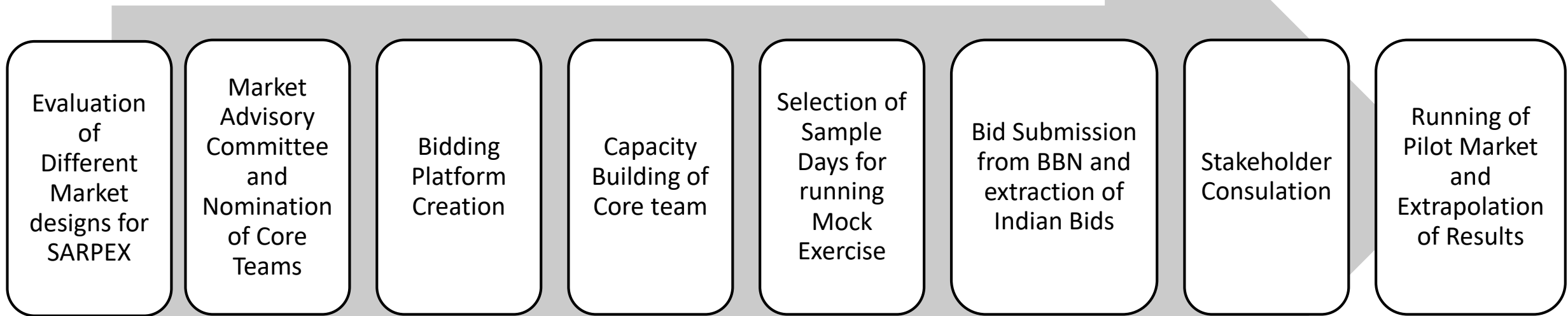
Selection of the days was based on the following criterion:

Average to Peak Load condition in all nations, Unconstrained Market-clearing Price and Volume on Indian Exchange(s), Day and Month Effect and Public holidays/Special days observed in all the nations

| APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER |
|-----------------------------|---------------------------|------------------------------|-----------------------------|------------------------------|-------------------------------|
| Sunday, April 5, 2015 | Wednesday, May 13, 2015 | Thursday, June 11, 2015 | Thursday, July 2, 2015 | Saturday, August 8, 2015 | Sunday, September 13, 2015 |
| Saturday, April 11, 2015 | Friday, May 15, 2015 | Sunday, June 14, 2015 | Saturday, July 11, 2015 | Sunday, August 9, 2015 | Sunday, September 20, 2015 |
| Monday, April 13, 2015 | Saturday, May 16, 2015 | Monday, June 15, 2015 | Monday, July 13, 2015 | Tuesday, August 11, 2015 | Tuesday, September 22, 2015 |
| Sunday, April 19, 2015 | Tuesday, May 19, 2015 | Sunday, June 21, 2015 | Thursday, July 16, 2015 | Wednesday, August 19, 2015 | Wednesday, September 23, 2015 |
| Wednesday, April 29, 2015 | | Friday, June 26, 2015 | Sunday, July 26, 2015 | Thursday, August 20, 2015 | Monday, September 28, 2015 |
| | | Saturday, June 27, 2015 | Monday, July 27, 2015 | Saturday, August 22, 2015 | |
| | | Tuesday, June 30, 2015 | | Sunday, August 23, 2015 | |
| | | | | Wednesday, August 26, 2015 | |
| | | | | Sunday, August 30, 2015 | |
| OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH |
| Tuesday, October 13, 2015 | Friday, November 27, 2015 | Thursday, December 10, 2015 | Wednesday, January 6, 2016 | Sunday, February 7, 2016 | Saturday, March 5, 2016 |
| Wednesday, October 14, 2015 | | Monday, December 14, 2015 | Friday, January 8, 2016 | Monday, February 8, 2016 | Tuesday, March 8, 2016 |
| Saturday, October 17, 2015 | | Tuesday, December 15, 2015 | Saturday, January 9, 2016 | Thursday, February 11, 2016 | Monday, March 14, 2016 |
| Thursday, October 22, 2015 | | Sunday, December 20, 2015 | Monday, January 11, 2016 | Sunday, February 14, 2016 | Saturday, March 19, 2016 |
| | | Wednesday, December 23, 2015 | Thursday, January 14, 2016 | Wednesday, February 24, 2016 | Monday, March 21, 2016 |
| | | Thursday, December 24, 2015 | Tuesday, January 19, 2016 | | Monday, March 28, 2016 |
| | | Tuesday, December 29, 2015 | Wednesday, January 20, 2016 | | Tuesday, March 29, 2016 |
| | | Wednesday, December 30, 2015 | Thursday, January 21, 2016 | | Thursday, March 31, 2016 |
| | | | Friday, January 29, 2016 | | |

Key Processes for conducting SARPEX Mock Exercise

Processes for conducting SARPEX- Mock Exercise



Key Completed activities

2.1 Market Advisory Committee for deciding the Market Rules and Design for SARPEX

Market Advisory Committee

| Name | Country | Designation | Organisation |
|-------------------------|--------------|---------------------|--------------------------|
| Mr Anil Razdan | India | Ex- Secretary Power | Ministry of Power |
| Mr. Hans-Arild Bredesen | Norway | CEO | Nord Pool Consulting |
| Mr Peter Jogersen | Denmark | Vice President | Energinet, Denmark |
| Mr Musara Beta | South Africa | Chief Analysts | South African Power Pool |

Mentors

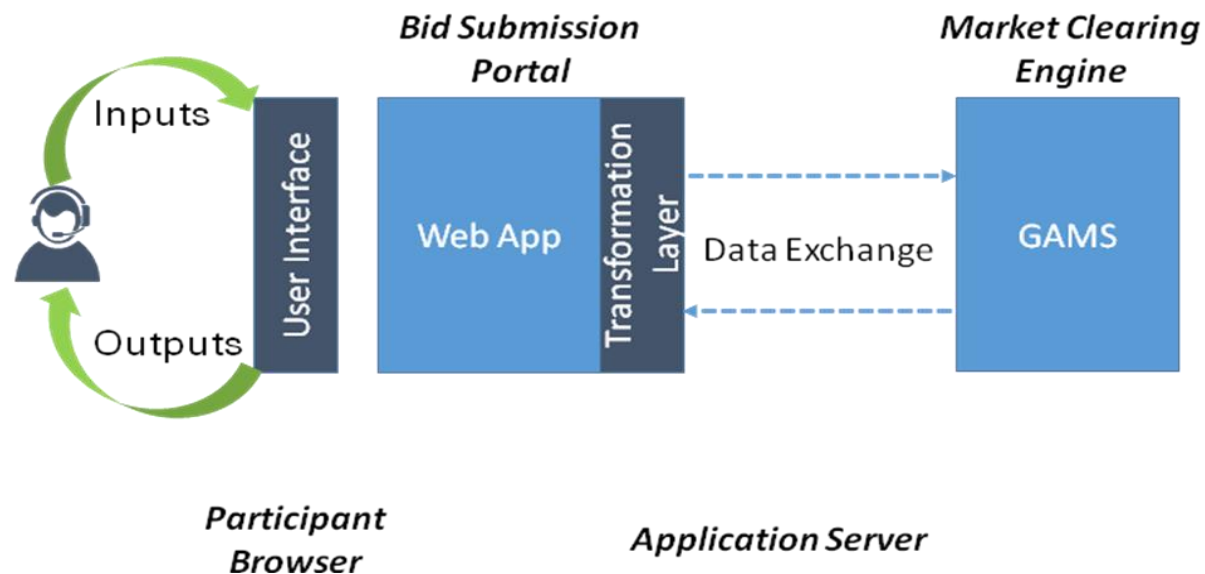
| Name | Country | Designation | Organisation |
|------------------|---------|--------------------|--------------|
| Dr. Kirit Parikh | India | Chairman | IRADe |
| Dr. Jyoti Parikh | India | Executive Director | IRADe |

2.2 Nomination of Core Team and TF-3 Members

| Core Team Member - BBN for SARPEX | | | | |
|--|--------------------------|------------|---|---|
| S.No | Name | Country | Designation | Organisation |
| 1 | Mr. Karma Namgyel | Bhutan | Chief Engineer, Department of Hydropower and Power Systems | Ministry of Economic Affairs |
| 2 | Mr. Denkar | Bhutan | Engineer, Department of Hydropower and Power Systems | Ministry of Economic Affairs |
| 3 | Mr. Ugyen Chopel | Bhutan | Engineer, Department of Hydropower and Power Systems | Ministry of Economic Affairs |
| 4 | Mr. Nima Tshering | Bhutan | Bhutan Power System Operator (BPSO) | Bhutan Power Corporation (BPC) |
| 5 | Mohammad Hossain, | Bangladesh | Director General | Power Cell |
| 6 | Shiekh Faezul Amin - | Bangladesh | JS (Dev) | Power Division |
| 7 | Golam Kibria | Bangladesh | Director IPP 1 | BPDB |
| 8 | Md. Nuruzzaman | Bangladesh | SE (Plg) | PGCB |
| 9 | Mr. Anil Rajbhandary | Nepal | Director | Nepal Electricity Authority |
| 10 | Mr. Nutan Prakash Sharma | Nepal | Senior Divisional Engineer | DoED, NEA |
| 11 | Mr. Narendra Shrestha | Nepal | Assistant Manager | Load Dispatch Center, NEA |
| 12 | Mr. Tej Krishna Shrestha | Nepal | Assistant Manager | Power Trade Department, NEA |
| Task Force-3 Members- South Asian Countries | | | | |
| S.No | Name | Country | Designation | Organisation |
| 1 | Mr. Md. Mizanur Rahman | Bangladesh | Member | Bangladesh Energy Regulatory Commission |
| 2 | Mr. Abid Latif Lodhi | Pakistan | CEO | Central Power Purchasing Agency (Guarantee) Limited |
| 3 | Mr. Sonam P. Wangdi | Bhutan | Director General- Department of hydropower and power system | Ministry of economic affairs |
| 4 | Mr. Harish Saran | India | Executive Director (Marketing) | Power trading Corporation India Limited |
| 5 | Mr. Rajesh K Mediratta | India | Director – Business Development | Indian Energy Exchange Limited |
| 7 | Mr.K.L.R.C. Wijayasinghe | Sri Lanka | Director (Power & Energy) | Ministry of Power & Energy |

3. Bidding Platform Creation – SARPEX Web Portal

- The portal is powered by a front-end web application which interacts with Market Clearing Engine at the back-end and allows users to see the results on the Web Portal.
- The web portal has been created to mimick the trade in the DAM on a Regional Power Exchange
- Link <http://mocksarpex.eu.ai>



4. Capacity building of the Core Team

- After the nomination of core teams, the members from various participating nations were trained on the various skills required for placing a bid on the Pilot Exchange through a detailed 2-day workshop from 7th to 9th February 2017, held in Delhi. This was the first Capacity Building Workshop
- In the workshop, lecture notes/ study material/ videos/ were arranged to train the core teams of the member nations on various aspects relating to trade on Power exchanges.
- Tests were also conducted at the end of the workshop to ensure learning. The portal is powered by a front-end web application which interacts with Market Clearing Engine at the back-end and allows users to see the results on the Web Portal.
- Another capacity building workshop was done on 4th and 5th October 2017 to discuss the preliminary results of the SARPEX Mock Exercise and identify any discrepancy in the input data or the results

5. Selection of Sample Days for conducting SARPEX Mock Exercise

The following variables were identified to be crucial in determining a sample that covers all probable demand-supply scenario on SARPEX

| S. No | Data | General data/ Country Specific | | | | |
|-------|---|--------------------------------|--------|-------|------------|---------|
| | | India | Bhutan | Nepal | Bangladesh | Generic |
| 1 | Average to Peak Load | ✓ | ✓ | ✓ | ✓ | |
| 2 | Unconstrained Market Clearing Price on the Exchange | ✓ | | | | |
| 3 | Relative Demand Supply Gap on the Exchange | ✓ | | | | |
| 4 | Day of the Month | | | | | ✓ |
| 5 | Month of the Year | | | | | ✓ |
| 6 | Special Day/Holiday | ✓ | ✓ | ✓ | ✓ | |

Using the above variables, all the days from FY'16 were divided into distinct clusters, using Hierarchical clustering technique

After clustering, random days from each cluster were chosen, depending upon the overall size of the cluster

In effect, a sample of 71 days, that is representative of the entire year (FY'16) was chosen for the study



6.1. Bid Submission from BBN

The bids of the selected days from were uploaded by the core team members on SARPEX Web Portal

BIDS SUBMISSION - SARPEX

Submit your bids on this page in predefined excel formats provided by the administrator.

[View previously bid dates - Click here!](#)

Submit Bids Here!

- Step1:** Choose Date, Month and Year you want to submit the bid file for.
- Step2:** Upload the Bids file in xlsx format.
- Step3:** Confirm the bids submission and wait for success message.

Select day:

Select month:

Select year:

**** UPLOAD EXCEL FILE CONTAINING BIDS ****

No file chosen

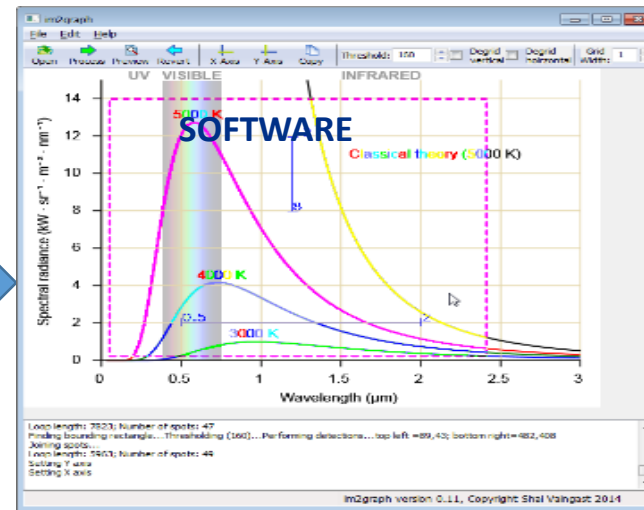
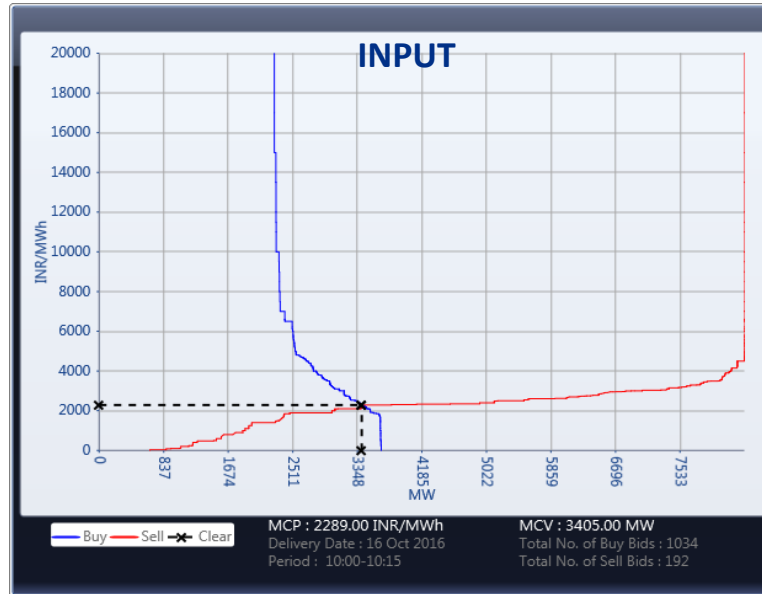
* Please ensure that data is entered properly in the excel template before submission!

CONFIRM BIDS SUBMISSION

6.2. Extraction of Indian Bids

- The bids of the Indian participants were extracted from the images of the aggregate demand-supply curves/charts available on IEX website using an “image-processing software” called “im2graph”
- The charts were fed into the software and the range for X-Y coordinates were specified and software then identified the scanned images (pixels) and converted them into discrete data-points

Process of Image Scanning and Data Extraction



OUTPUT

| Buy | Sell |
|------------------|------------------|
| X, Y_0 | X, Y_0 |
| 2237.49, 17529.8 | 670.754, 29.9401 |
| 2253.3, 13303.6 | 686.536, 29.9401 |
| 2269.11, 10803.6 | 702.319, 29.9401 |
| 2300.74, 9077.38 | 718.101, 29.9401 |
| 2316.55, 7529.76 | 733.884, 29.9401 |
| 2332.36, 7053.57 | 749.666, 29.9401 |
| 2348.17, 7053.57 | 765.448, 29.9401 |
| 2363.99, 7053.57 | 781.231, 29.9401 |
| 2379.8, 6875 | 797.013, 29.9401 |
| 2395.61, 6517.86 | 812.796, 29.9401 |
| 2411.42, 6517.86 | 828.578, 29.9401 |
| 2427.24, 6517.86 | 844.361, 29.9401 |
| 2443.05, 6517.86 | 860.143, 29.9401 |
| 2458.86, 6517.86 | 875.926, 89.8204 |
| 2474.67, 6398.81 | 891.708, 89.8204 |
| 2490.49, 5982.14 | 907.49, 89.8204 |
| 2506.3, 5208.33 | 923.273, 89.8204 |
| 2522.11, 5029.76 | 939.055, 89.8204 |
| 2569.55, 4791.67 | 954.838, 89.8204 |
| 2585.36, 4732.14 | 970.62, 89.8204 |

7. Stakeholder Consultation

Nepal

- The Stakeholder Consultation on SARPEX Mock Exercise for covering various aspects of SARPEX exercise objective power exchange operation and participation in the context of the SARPEX mock exercise was held on 11th and 12th April 2017.
- Mr. Dinesh Kumar Ghimire, Joint Secretary, Ministry of Energy, Nepal delivered the key note address and mentioned about the Nepal's long term plan for mitigating energy deficit.
- More than 30 participants from various organization has participated in the Workshop.
- The one to one meeting has been conducted in Ministry of Energy, Nepal Electricity Authority (NEA) and Load Dispatch Centre etc. to discuss the concept of SARPEX and its relevance for Nepal.

Bhutan

- The stakeholder consultation on SARPEX Mock Exercise for Bhutan Stakeholders covering various aspects of SARPEX exercise objective, power exchange operation and participation in the context of the SARPEX mock exercise was held on 29th-30th July 2017.
- Keynote address has been delivered by Mr. Sonam P Wangdi Director General, DHPS, MoEA Bhutan and more than 20 participants from different organization has participated in the Workshop.
- The one to one meeting has been conducted in the Ministry of Economic Affairs (MoEA) with Mr Dasho Yeshi Wangdi and others, Druk Green Power Corporation (DGPC), Bhutan Power Corporation (BPC), Druk Holding & Investment etc.

India

- **Central Electricity Authority:** “South Asian Regional Power Exchange (SARPEX) Mock Exercise One-to-one meetings with Central Electricity Authority (CEA) with Principal Chief Engineer, Chief Engineer and Director etc. and later on with Member Power System who is the Designated Authority as per the MoP India Notification for Cross Border Electricity Trade.
- **POSOCO:** The SARPEX mock exercise stakeholder consultation was held at POSOCO on 20th July’2017. The same was attended by CEO POSOCO and other high level officers. Mr Soonee, earlier CEO POSOCO and current Advisor, has always given his valuable suggestions in this matter right from the inception stage.
- **Central Electricity Regulatory Commission:**
Submission followed by supplementary submissions to CERC draft notification were presented to CERC. The same are also available on CERC website.

Bangladesh

- The stakeholder consultation on SARPEX Mock Exercise for Bangladesh Stakeholders covering various aspects of SARPEX exercise objective, power exchange operation and participation in the context of the SARPEX mock exercise was held on 10th August 2017.
- Keynote address has been delivered by Mr. Sher Khan, USAID Bangladesh and Mizanur Rahman, Member Bangladesh Electricity Regulatory Commission (BERC) has delivered key note address.
- More than 40 participants from different organization has participated in the Workshop. This included the ministry, BPDP, PGCB, BERC, DPDC etc.
- One to one meeting were held on 9th August and 10th August with Mr Ahmad Kaikaus Secretary Power, Mr Masum Al- Beroni MD , PGCB and his team, Mr Bikas Dewan MD DPDC and Mr Mizanul Rehman Member BERC.



USAID
FROM THE AMERICAN PEOPLE

SARI/EI

IRADe Integrated Research and
Action for Development





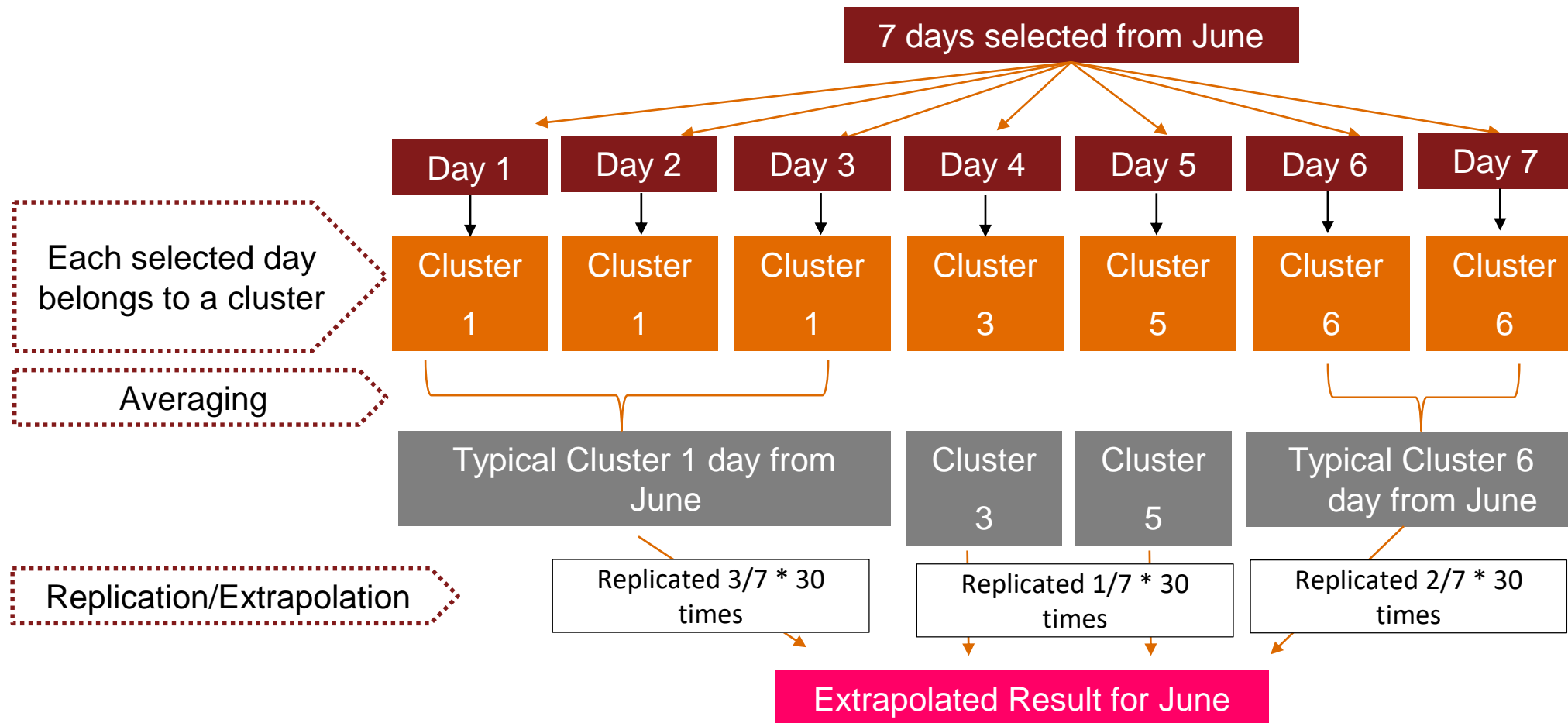
8.1. Running of Pilot Market Exercise

- Bid Aggregation - The bids obtained from all nations were aggregated using the Step-wise Approach, which is one of the common methods of aggregation.
- Matching Engine for Price Discovery – The MCP and MCV for each dispatch period and for each selected day was determined using the Uniform Pricing Mechanism.
- The other key features around which the market simulations were done are summarized in the table below

| Design Aspect | Assumption for SARPEX |
|---------------------------|-----------------------|
| Market Type | Energy |
| Auction Type | First Price Auction |
| Bidding Format | Double Sided |
| Market clearing Algorithm | Step-wise |
| Pricing Rules | Uniform |
| Matching Rules | Single |
| Time Zone | IST |
| Currency | INR |



8.2. Extrapolation of Market Results



SARPEX Web Portal and its Applications



USAID
FROM THE AMERICAN PEOPLE

SARI/EI



SARPEX Web Portal -Home Page

SARPEX : MOCK EXERCISE - ABOUT

ABOUT SARPEX : MOCK EXERCISE

THE CONCEPT

ABOUT US

MEET THE PEOPLE

SARPEX CONCEPT

The proposed South Asian Regional Power Exchange (SARPEX) aims to provide the following benefits:

- Cross Border Electricity Trade (CBET) that maximizes the social welfare and efficiency through market determined prices.
- Deficit/Surplus power can be bought/sold on a real time basis to optimise resource allocation.

Further, the Ministry of Power (MoP), India recently launched its cross-border power trade guidelines allowing South Asian Countries (SAC) to participate on the Indian Power Exchanges for Term Ahead and Intra Day Contracts/Contingency contracts subject to certain conditions. This makes the concept of SARPEX much more of a reality



USAID
FROM THE AMERICAN PEOPLE

SARI/EI



SARPEX Web Portal – Login Page

SARPEX : MOCK EXERCISE [HOME](#)

[LOG IN](#) ▾

Log In

E-mail

sarpex.bhutan.bids@gmail.com

Password

.....

Remember me (for 30 days)

LOG IN

SARPEX Web Portal – Bid Submission Page

SARPEX : MOCK EXERCISE HOME REPORTS CONTACT

WELCOME BHUTAN -

BIDS SUBMISSION - SARPEX

Submit your bids on this page in predefined excel formats provided by the administrator.

[View previously bid dates - Click here!](#)

Submit Bids Here!

Step1: Choose Date, Month and Year you want to submit the bid file for.

Step2: Upload the Bids file in xlsx format.

Step3: Confirm the bids submission and wait for success message.

Users can choose a date for which they are uploading the bids

Select day:

Select month:

Select year:

**** UPLOAD EXCEL FILE CONTAINING BIDS ****

Choose File No file chosen

* Please ensure that data is entered properly in the excel template before submission!

Users can upload their bids by clicking here and choosing the excel file containing bids

CONFIRM BIDS SUBMISSION



SARPEX Web Portal – Results Page

BIDS SUBMISSION RESULTS - SARPEX

The results of your bids submission are displayed on this webpage.
The default date is today. Please choose a different date for viewing corresponding results.

CHOOSE A DATE TO VIEW RESULTS

Select day: Select month: Select year:

Users can choose a date and see results for the corresponding date

Showing bids submission results for date: 15-04-2015

UNIFIED MODE RESULTS

Results are shown for unified and Sequential Mode

SARPEX Web Portal – Archived Reports Page

VIEW ARCHIVED REPORTS - SARPEX

You can view the previously uploaded bids by you and the reports associated with those bids on this page!
Please choose a date to see the reports.

CHOOSE A DATE TO VIEW REPORTS

Select day:

Select month:

Select year:

SHOW REPORTS

VIEW/DOWNLOAD PREVIOUSLY ARCHIVED BIDS & RESULTS

Click on the following links to see the reports of the corresponding date on the link.

[30-01-2017/Results/Reports](#)

[27-01-2017/Results/Reports](#)

[29-01-2017/Results/Reports](#)

[26-01-2017/Results/Reports](#)

[28-01-2017/Results/Reports](#)

[25-01-2017/Results/Reports](#)

Users can choose a date and see reports for the corresponding date

SARPEX Web Portal – Contact Administrator Page

SARPEX : MOCK EXERCISE [HOME](#) WELCOME BHUTAN

CONTACT APPLICATION ADMINISTRATOR

For queries regarding

1. Bids Submission Issues
2. Results Display Issues
3. Data Discrepancy

Please use the contact form below to send a message to the application administrator.
Your issues will be resolved at the earliest.

Write a message to administrator for issues!

Fill the fields below and click on 'SEND MESSAGE TO ADMIN' button the send the message to application administrator.

QUERY/MESSAGE SUBJECT

QUERY/MESSAGE BODY

Message/Query:

SEND MESSAGE TO ADMIN

Users can contact app administrator for issues.

Copyright © 2017 KPMD Powered by KPMD

Quantification of Transmission Charges and Losses

Key Assumptions and Participants for SARPEX Mock Exercise

1

Determination of Unconstrained Market Clearing Price and Volume

The impact of transmission constraints in cross border lines as well as in the countries own national grid are not considered in the mock exercise because:

- Difficulty of ensuring coordination with the related load dispatch centres of various nations
- The results of mock exercise are expected to give an indication of the direction and quantum of power flows between India and the neighbouring countries

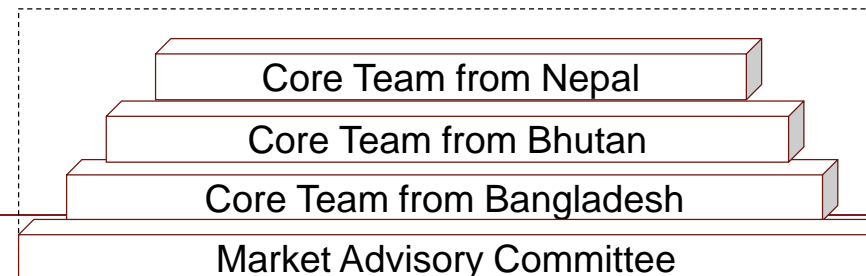
2

Quantification of Transmission Charges and Losses

The transmission charges and losses as currently applicable under the bilateral trade with BBN were adjusted in the bids submitted by BBN to account for the true cost of power procurement/sale.

The transmission charges and losses component was already incorporated by the Indian Participants while submitting their purchase and sell bids on Indian Exchange(s)

Key Participants



Average Transmission Charges and Losses Figures for BBN

| # | Country | Transmission Charges | Transmission Losses | Comments |
|---|----------------------------|----------------------|---------------------|--|
| | | (Rs/kWh) | (%) | |
| 1 | Bangladesh | 0.117 | 0.3% | The cross-border transmission network for India-Bangladesh has been included in the POC charges and transmission Withdrawal Charges and Losses are published for Bangladesh |
| 2 | Nepal | 0.301 | 4.1% | The cross-border transmission network for India-Nepal has not been included in POC and therefore the transmission charges of Bihar and Cross-border line are assumed for Nepal |
| | Bihar Withdrawal | 0.257 | 1.6% | |
| | Muzzafarpur Dhalkebar Line | 0.044 | 2.5% | |
| 3 | Bhutan | 0.089 | 1.1% | The cross-border transmission network for India-Bhutan has been included in the POC charges and transmission Injection Charges are published by NLDC for Bhutan |

The bids submitted by BBN were adjusted by the above transmission charges and losses to reflect the true cost of power purchased or sold on the Exchange

Extrapolated Results for BBIN

Representation of Results



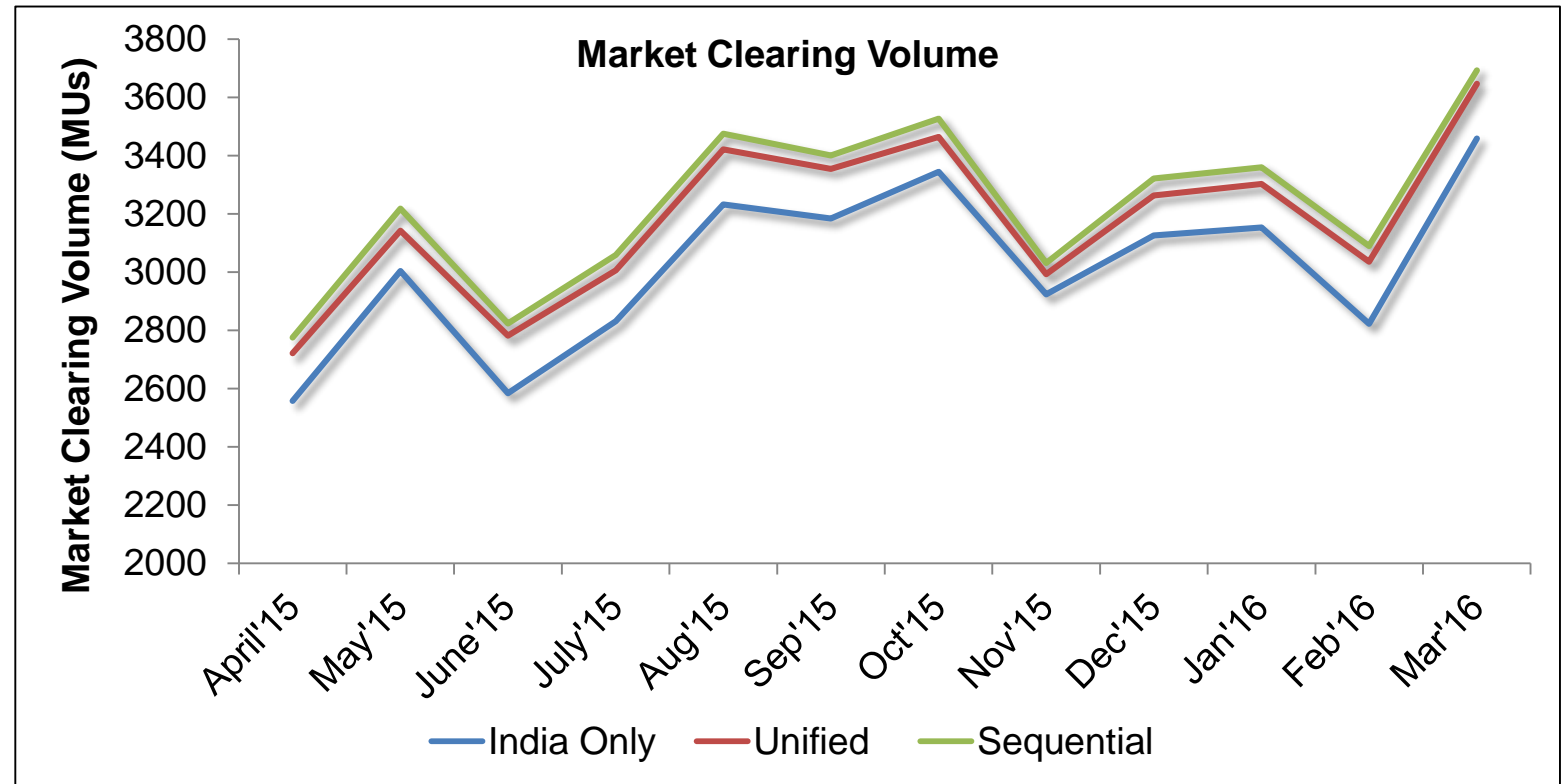
Total Surplus in the 3 Modes for FY'16

| Surplus (Rs Billion) | |
|----------------------|--------|
| India Only | 313.53 |
| Unified | 323.63 |
| Sequential | 323.24 |

The two modes of Operation for SARPEX are practically the same. The difference of 0.12%, as observed, is negligible given that the Mock Exercise only simulates the possible behavior of all bidders in the DAM on SARPEX through inputs that are accurate to a reasonable degree of accuracy

Total Market Clearing Volume in the 3 Modes for FY'16

| | Total Market Clearing Volume (in MUs) |
|------------|---------------------------------------|
| India-Only | 36219 |
| Unified | 38127 (1908*) |
| Sequential | 38768 (2549*) |

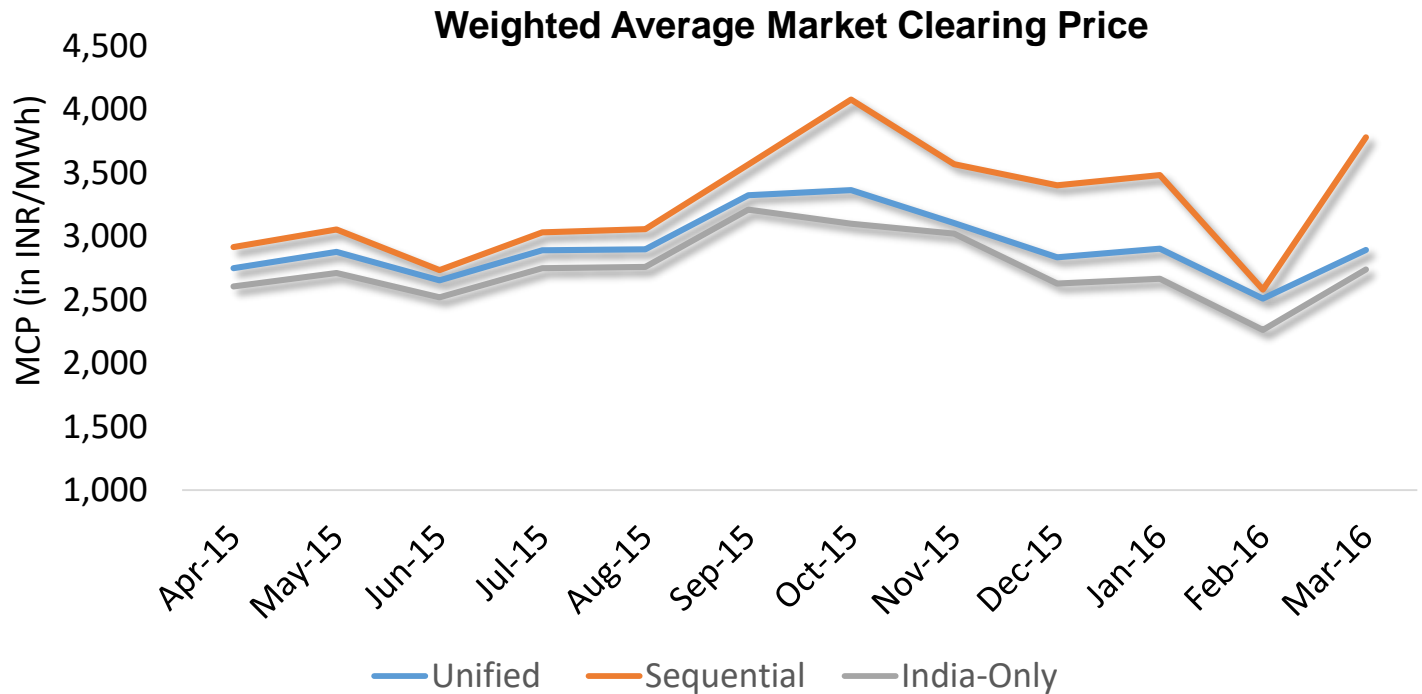


The figures for Unified and Sequential Mode include the existing DAM operations in India, referred as India-Only Mode

** The figures for in the bracket represent the change in MCV over India-Only Mode. The MCV in case of sequential mode is significantly higher*

Weighted Average Market Clearing Price in the 3 Modes for FY'16

| | Weighted Average Market Clearing Price (in Rs/MWh) |
|------------|--|
| India-Only | 2745 |
| Unified | 2910 |
| Sequential | 3269 |



The market clearing volume for the respective mode is used as weight for computing the above figures

Monthly Weighted Average Market Clearing Price on SARPEX for FY'16

| Month | Weighted Average MCP (in Rs/MWh) | | |
|----------------|-------------------------------------|-----------------|--------------|
| | Unified Mode | Sequential Mode | India-Only |
| April | 2,751 | 2,916 | 2,606 |
| May | 2,878 | 3,056 | 2,712 |
| June | 2,655 | 2,735 | 2,520 |
| July | 2,892 | 3,032 | 2,750 |
| August | 2,898 | 3,059 | 2,760 |
| September | 3,324 | 3,567 | 3,211 |
| October | 3,367 | 4,079 | 3,101 |
| November | 3,106 | 3,571 | 3,024 |
| December | 2,836 | 3,403 | 2,630 |
| January | 2,903 | 3,484 | 2,667 |
| February | 2,510 | 2,581 | 2,262 |
| March | 2,751 | 3,783 | 2,740 |
| Average | 2,910 | 3,269 | 2,745 |

The monthly market clearing volume for the respective mode is used as weight for computing the above figures.

Comparison of Monthly Weighted Average MCP across 3 Modes

| Month | Increment in Weighted Average MCP (in Rs/MWh, % Increment) | | |
|----------------|--|--|---|
| | Increment in Weighted Average MCP Unified Mode over India-Only (% Increment) | Increment in Weighted Average MCP Sequential Mode over India-Only Mode (% Increment) | Increment in Weighted Average Sequential Mode over Unified Mode (% Increment) |
| April | 145 (6%) | 310 (12%) | 165 (6%) |
| May | 166 (6%) | 344 (13%) | 179 (6%) |
| June | 135 (5%) | 215 (9%) | 80 (3%) |
| July | 142 (5%) | 281 (10%) | 139 (5%) |
| August | 138 (5%) | 299 (11%) | 161 (6%) |
| September | 113 (4%) | 356 (11%) | 243 (7%) |
| October | 265 (9%) | 978 (32%) | 713 (21%) |
| November | 82 (3%) | 547 (18%) | 465 (15%) |
| December | 206 (8%) | 772 (29%) | 567 (20%) |
| January | 236 (9%) | 817 (31%) | 581 (20%) |
| February | 248 (11%) | 319 (14%) | 71 (3%) |
| March | 155 (6%) | 1,043 (38%) | 888 (31%) |
| Average | 169 (6%) | 523 (19%) | 354 (12%) |

The MCP in Unified and Sequential Mode increases in the winter months when supply from Bhutan is relatively very low

Distribution of Prices in Unified and Sequential Mode

| Month | Mode | <2000 | 2000-2500 | 2500- 3000 | 3000- 3500 | 3500- 4000 | 4000- 4500 | 4500- 5000 | >5000 |
|--------|------------|-------|-----------|------------|------------|------------|------------|------------|-------|
| April | Unified | 4% | 33% | 32% | 24% | 6% | 1% | 0% | 0% |
| | Sequential | 6% | 28% | 24% | 33% | 6% | 1% | 0% | 2% |
| May | Unified | 1% | 28% | 33% | 24% | 12% | 2% | 0% | 0% |
| | Sequential | 1% | 23% | 22% | 28% | 20% | 5% | 0% | 1% |
| June | Unified | 2% | 53% | 26% | 10% | 4% | 4% | 1% | 0% |
| | Sequential | 1% | 49% | 29% | 9% | 6% | 4% | 1% | 1% |
| July | Unified | 1% | 28% | 40% | 19% | 5% | 6% | 1% | 0% |
| | Sequential | 0% | 25% | 39% | 19% | 7% | 4% | 1% | 5% |
| August | Unified | 2% | 31% | 29% | 21% | 5% | 8% | 2% | 2% |
| | Sequential | 2% | 28% | 27% | 21% | 8% | 6% | 2% | 6% |
| Sep | Unified | 0% | 5% | 25% | 42% | 13% | 10% | 5% | 0% |
| | Sequential | 0% | 5% | 30% | 33% | 8% | 6% | 3% | 15% |
| Oct | Unified | 4% | 4% | 21% | 38% | 20% | 6% | 4% | 3% |
| | Sequential | 5% | 3% | 17% | 41% | 10% | 2% | 2% | 20% |
| Nov | Unified | 11% | 12% | 19% | 44% | 5% | 4% | 5% | 0% |
| | Sequential | 8% | 15% | 15% | 22% | 28% | 1% | 0% | 11% |
| Dec | Unified | 21% | 18% | 18% | 19% | 16% | 4% | 4% | 0% |
| | Sequential | 18% | 21% | 14% | 15% | 14% | 3% | 1% | 14% |
| Jan | Unified | 20% | 10% | 24% | 20% | 16% | 9% | 1% | 0% |
| | Sequential | 17% | 13% | 20% | 13% | 14% | 8% | 4% | 11% |
| Feb | Unified | 15% | 26% | 53% | 6% | 0% | 0% | 0% | 0% |
| | Sequential | 14% | 23% | 52% | 10% | 1% | 0% | 0% | 0% |
| Mar | Unified | 0% | 18% | 53% | 15% | 8% | 4% | 2% | 0% |
| | Sequential | 0% | 14% | 53% | 7% | 7% | 2% | 0% | 18% |

Country Specific Findings

Surplus accrued to each nation (including the surplus of Indian DAM) on SARPEX for FY'16

| | Regional Surplus (Rs Billion) | Surplus Gain to Bangladesh (Rs Billion) | Surplus Gain to Nepal (Rs Billion) | Surplus Gain to Bhutan (Rs Billion) | Surplus Gain to India (Rs Billion) |
|-------------------|--------------------------------------|--|---|--|---|
| Unified | 323.63 | 8.85 | 0.7 | 0.3 | 313.78 |
| Sequential | 323.24 | 8.23 | 0.63 | 0.42 | 313.96 |

Additional Surplus accrued to each nation on SARPEX (over the surplus of Indian DAM) for FY'16

| | Regional Surplus (Rs Billion) | Surplus Gain to Bangladesh (Rs Billion) | Surplus Gain to Nepal (Rs Billion) | Surplus Gain to Bhutan (Rs Billion) | Surplus Gain to India (Rs Billion) |
|------------|-------------------------------|---|------------------------------------|-------------------------------------|------------------------------------|
| Unified | 10.1 | 8.85 | 0.7 | 0.3 | 0.25 |
| Sequential | 9.71 | 8.23 | 0.63 | 0.42 | 0.43 |

Volumes (unconstrained) bought by each nation on SARPEX for FY'16

| | India (in MUs) | Bangladesh (in MUs) | Nepal (in MUs) | Bhutan (in MUs) |
|-------------------|------------------|---------------------|----------------|-----------------|
| India-Only | 36219 | - | - | - |
| Unified | 35396 (-822*) | 2011 | 719 | 0.09 |
| Sequential | 36219 (0*) | 1920 | 630 | 0.04 |

The figures for Unified and Sequential Mode include the existing DAM operations in India.

** The figure in the bracket represents the change in purchase volume over India-Only Mode*

Volumes (unconstrained) sold by each nation on SARPEX for FY'16

| | India (in MUs) | Bangladesh (in MUs) | Nepal (in MUs) | Bhutan (in MUs) |
|-------------------|------------------|---------------------|----------------|-----------------|
| India-Only | 36219 | - | - | - |
| Unified | 37715 (1496*) | - | 10 | 412 |
| Sequential | 38342 (2123*) | - | 10 | 427 |

The figures for Unified and Sequential Mode include the existing DAM operations in India.

** The figure in the bracket represents the change in purchase volume over India-Only Mode*

Weighted Average Buy Price for each nation

| | India (in Rs/MWh) | Bangladesh (in Rs/MWh) | Nepal (in Rs/MWh) | Bhutan (in Rs/MWh) |
|------------|-------------------|------------------------|-------------------|--------------------|
| India-Only | 2745 | - | - | - |
| Unified | 2919 | 2938 | 2893 | 3751 |
| Sequential | 2745 | 3099 | 2881 | 3438 |

- *The prices represent the Unconstrained MCP , weights have been computed using the cleared buy volume of each nation*
 - *Bhutan is predominant seller on the Exchange*

Weighted Average Sell price for each nation

| | India (in Rs/MWh) | Bangladesh (in Rs/MWh) | Nepal (in Rs/MWh) | Bhutan (in Rs/MWh) |
|------------|-------------------|------------------------|-------------------|--------------------|
| India-Only | 2745 | - | - | - |
| Unified | 2918 | - | 2000 | 2983 |
| Sequential | 2965 (2768*) | - | 3000 | 3339 |

The prices in the sequential mode represents the weighted average price accrued to sellers from the sale of power in the residual market

** The figure in the bracket represent the weighted average price to Indian sellers from the sale of power in domestic as well as residual market*

Total Cost incurred by buyers from each nation in FY'16

| | India (in Rs Billion) | Bangladesh (in Rs Billion) | Nepal (in Rs Billion) | Bhutan (in Rs Billion) |
|------------|-----------------------|----------------------------|-----------------------|------------------------|
| India-Only | 99.4 | - | - | - |
| Unified | 103.32 | 5.90 | 2.08 | 0.0003 |
| Sequential | 99.4 | 5.95 | 1.81 | 0.0001 |

The figures for Unified and Sequential Mode include the existing DAM operations in India.

Total Revenue earned by sellers from each nation in FY'16

| | India (in Rs Billion) | Bangladesh (in Rs Billion) | Nepal (in Rs Billion) | Bhutan (in Rs Billion) |
|------------|-----------------------|----------------------------|-----------------------|------------------------|
| India-Only | 99.4 | - | - | - |
| Unified | 110.05 | - | 0.02 | 1.22 |
| Sequential | 105.71 | - | 0.03 | 1.42 |

The figures for Sequential Mode include the revenue from the sale of power in domestic (India Only) and residual market (BBN)

Recommended Market Rules and Design for SARPEX

It was agreed upon in the previous TF-3 Meeting that the following market rules and design is recommended for SARPEX

| Design Aspect | Assumption for SARPEX |
|---------------------------|-----------------------|
| Market Type | Energy |
| Auction Type | First Price Auction |
| Bidding Format | Double Sided |
| Market clearing Algorithm | Step-wise |
| Pricing Rules | Uniform |
| Matching Rules | Single |
| Time Zone | IST |
| Currency | INR |

Key Takeaways from SARPEX Mock Exercise...(1/2)

- ❖ All nations gain significantly from the trade in the DAM on SARPEX. Total (Regional Surplus is higher in Unified Mode (INR 323.63 Billion) by INR 0.39 Billion in comparison to the Sequential Mode (INR 323.24 Billion) for FY'16
- ❖ The difference of 0.12% in the regional surplus between the two modes is insignificant in comparison to the gain accrued to each nation and the overall regional surplus
- ❖ The two modes of Operation for SARPEX are practically the same. given that the Mock Exercise only simulates the possible behavior of all bidders in the DAM on SARPEX through inputs that are accurate to a reasonable degree of accuracy
- ❖ The revenue accrued to each nation from the trade is accounts to INR 8.85 Billion, 0.7 Billion, 0.3 Billion and 0.25 Billion for Bangladesh, Nepal, Bhutan and India respectively in Unified Mode for FY'16
- ❖ The revenue accrued to each nation in the Sequential Mode accounts to INR 8.23 Billion, 0.63 Billion, 0.42 Billion and INR 0.43 Billion for Bangladesh, Nepal, Bhutan and India respectively for FY'16
- ❖ Clearly, the DAM on a regional exchange is desirable and improves the socio-economic welfare of all participating nations

Key Takeaways from SARPEX Mock Exercise...(2/2)

- ❖ In Unified Mode, the volumes bought by Bangladesh, Nepal, Bhutan and India in FY'16 is 2011 MUs, 719 MUs, 0.09 MUs and 35396 MUs respectively. The corresponding figure for each nation is 1920 MUs, 630 MUs, 0.04 MUs and 36219 MUs in Sequential Mode (*These figures include the volumes from India DAM*)
- ❖ The volumes sold by Nepal, Bhutan and India in Unified Mode for FY'16 is 10 MUs, 412 MUs and 37715 MUs respectively. The corresponding figure for each nation is 100 MUs, 427 MUs and 38342 MUs in Sequential Mode (*These figures include the volumes from India DAM*)
- ❖ Over India-Only Mode, the purchase volume for India declines by 822 MUs in Unified Mode and remains unchanged in Sequential Mode. On the other hand, the sell quantum increases by 1496 MUs and 2123 MUs in Unified and Sequential Mode respectively
- ❖ The weighted average market clearing price is INR 2910/MWh and INR 3269/MWh in Unified and Residual Mode respectively. The price in the latter mode is higher by an average of 12% for FY'16. In both the modes, the price is below INR 4000/MWh in more than 80% of the cases
- ❖ The monthly trends of price observed in both the modes exactly mimics the trends on Indian Exchanges as India plays the role of a dominant player in the SA regional market

Discussion on Results

- ❖ The SARPEX Mock Exercise Project finds that based on the demand-supply and transmission conditions that prevailed in BBIN in FY'16, the DAM operation of SARPEX would benefit all the participating nations, resulting in the overall regional surplus of INR 323 Billion in a year, in both the modes
- ❖ The Surplus Gain in a year to BBIN is far higher than the YTC of the transmission line indicating that relatively small investments in transmission lines may yield surprisingly huge dividends in terms of increased economic gains and social welfare.
- ❖ With regards to the mode of operation for SARPEX, in Sequential Mode, all nations are better off without adversely impacting any nation from its current state.
- ❖ For Bhutan, Bangladesh and Nepal, the access to DAM on SARPEX, regardless of the mode of operation, not only helps in management of day-ahead contingencies in demand and supply; these countries also reap benefits of being able to buy/sell power at a price less than/greater to their marginal willingness. Thus the choice of mode of operation for SARPEX doesn't have a big bearing for BBIN
- ❖ For India, the consumer surplus falls in Unified Mode as the new market entrants with higher willingness to pay disturb the existing market equilibrium for Indian buyers. However, this problem is completely nullified in the Sequential Mode as by the virtue of its design, it doesn't impact the existing DAM for Indian participants.
- ❖ As more volumes are brought into the DAM on SARPEX with strengthening of inter-country transmission, the regional surplus in the Sequential Mode would increase. Therefore, it serves as a good starting point for the development of day-ahead cross border trade between these countries.

THANK YOU

For more details please contact:-

1) S. K. Ray Technical Specialist, IRADe skray@irade.org ,+91 9971792136

