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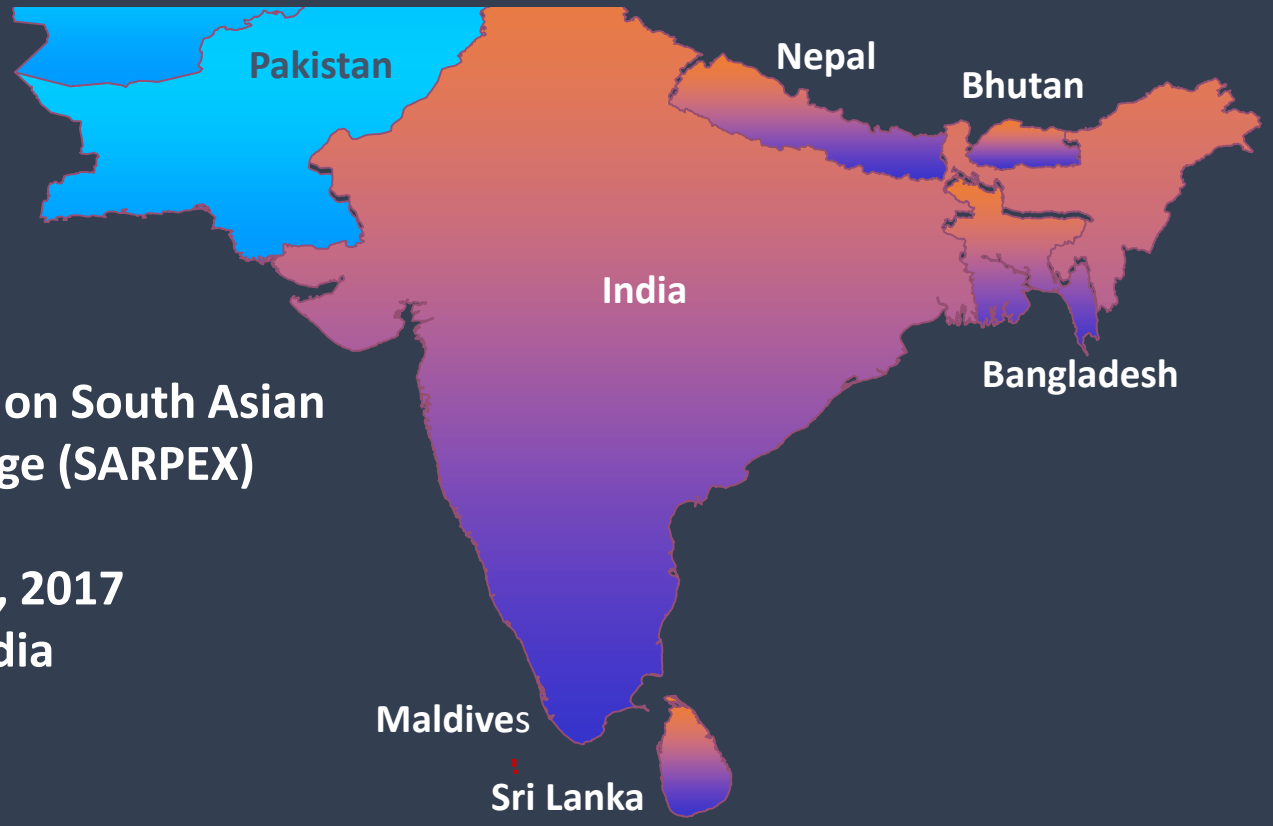
IRADe Integrated Research and Action for Development

Trade Simulation Pilot Market



First meeting of core team on South Asian Regional Power Exchange (SARPEX)

7th - 9th February, 2017
New Delhi, India

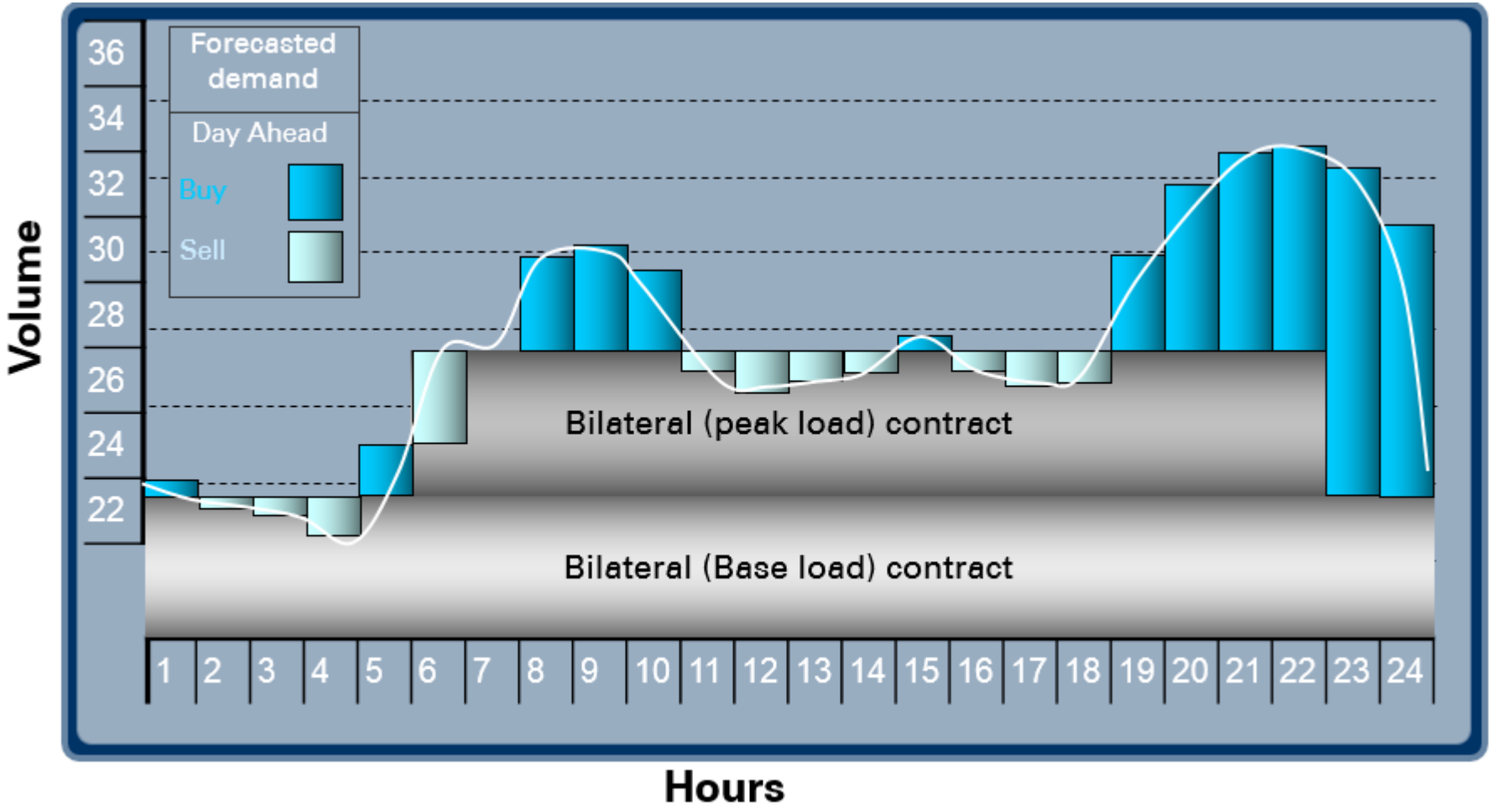
Presented by:
Aniket Ghosh
Anup Tiwari

Outline

- Introduction to Day Ahead Market
- Trading Process in a Day Ahead Market
- Market Clearing
- Illustrative Order-book
- Application Workflow
- Application Screen Shots

INTRODUCTION TO DAY AHEAD MARKET

Introduction to Day Ahead Market



Key Features of the Day-Ahead Pilot Market

Parameter	IEX	PXIL	Pilot Market
Market Design	Social Welfare Maximization	Social Welfare Maximization	**Social Welfare Maximization**
Auction Type	Double Sided Closed Bid Auction	Double Sided Closed Bid Auction	**Double Sided Closed Bid Auction**
Types of Products	Block and Normal Bids	Block and Normal Bids	**Normal Bids**
Aggregate Demand and Supply Curves	Piecewise Linear	Stepwise	**Stepwise**
Congestion Management	Market Splitting	Market Splitting	**NA**
Delivery Date	Next Day	Next Day	**Next Day**
Contracts	15 Minutes	15 Minutes	**15 Minutes**
Delivery Type	Physical	Physical	**Physical**
Tick Size	.1 MW Re.1/- per MWh	.01 MW Rs.10/- per MWh	**.1 MW** **Re.1/- per MWh**

A typical bid cycle and impact of time zones

Day: D-1 — *Activity: Bidding, Scheduling and Pay-in*

Slot (IEX)	1	2	39	40	41	42	48	49	50	53	56	57	58	61	62	63	71	72	73	93	94	95	96
India	0:00	0:15	9:30	9:45	10:00	10:15	11:45	12:00	12:15	13:00	13:45	14:00	14:15	15:00	15:15	15:30	17:30	17:45	18:00	23:00	23:15	23:30	23:45
Nepal	0:15	0:30	9:45	10:00	10:15	10:30	12:00	12:15	12:30	13:15	14:00	14:15	14:30	15:15	15:30	15:45	17:45	18:00	18:15	23:15	23:30	23:45	0:00
Bhutan	0:30	0:45	10:00	10:15	10:30	10:45	12:15	12:30	12:45	13:30	14:15	14:30	14:45	15:30	15:45	16:00	18:00	18:15	18:30	23:30	23:45	0:00	0:15
Bangladesh	0:30	0:45	10:00	10:15	10:30	10:45	12:15	12:30	12:45	13:30	14:15	14:30	14:45	15:30	15:45	16:00	18:00	18:15	18:30	23:30	23:45	0:00	0:15

- Bid start time for Day D
- Gate Closure Time for Day D
- Unconstrained solution
- NLDC to check congestion & declare margins
- PX sends scheduling request to NLDC
- Pay-in
- NLDC to confirm scheduling
- RLDC/SLDC to incorporate transactions in daily schedules

Day: D — *Activity: Dispatch*

Slot (IEX)	1	2	39	40	41	42	48	49	50	53	56	57	58	61	62	63	71	72	73	93	94	95	96
India	0:00	0:15	9:30	9:45	10:00	10:15	11:45	12:00	12:15	13:00	13:45	14:00	14:15	15:00	15:15	15:30	17:30	17:45	18:00	23:00	23:15	23:30	23:45
Nepal	0:15	0:30	9:45	10:00	10:15	10:30	12:00	12:15	12:30	13:15	14:00	14:15	14:30	15:15	15:30	15:45	17:45	18:00	18:15	23:15	23:30	23:45	*0:00*
Bhutan	0:30	0:45	10:00	10:15	10:30	10:45	12:15	12:30	12:45	13:30	14:15	14:30	14:45	15:30	15:45	16:00	18:00	18:15	18:30	23:30	23:45	*0:00*	*0:15*
Bangladesh	0:30	0:45	10:00	10:15	10:30	10:45	12:15	12:30	12:45	13:30	14:15	14:30	14:45	15:30	15:45	16:00	18:00	18:15	18:30	23:30	23:45	*0:00*	*0:15*

Slots 95 and 96 become critical slots as they fall on the next day – D+1 (highlighted red) – for BBN countries while belong to Day D in India

Day: D+1 — *Activity: Pay-outs*

Slot (IEX)	1	2	39	40	41	42	48	49	50	53	56	57	58	61	62	63	71	72	73	93	94	95	96
India	0:00	0:15	9:30	9:45	10:00	10:15	11:45	12:00	12:15	13:00	13:45	14:00	14:15	15:00	15:15	15:30	17:30	17:45	18:00	23:00	23:15	23:30	23:45
Nepal	0:15	0:30	9:45	10:00	10:15	10:30	12:00	12:15	12:30	13:15	14:00	14:15	14:30	15:15	15:30	15:45	17:45	18:00	18:15	23:15	23:30	23:45	0:00
Bhutan	0:30	0:45	10:00	10:15	10:30	10:45	12:15	12:30	12:45	13:30	14:15	14:30	14:45	15:30	15:45	16:00	18:00	18:15	18:30	23:30	23:45	0:00	0:15
Bangladesh	0:30	0:45	10:00	10:15	10:30	10:45	12:15	12:30	12:45	13:30	14:15	14:30	14:45	15:30	15:45	16:00	18:00	18:15	18:30	23:30	23:45	0:00	0:15

- Pay-out to Sellers

TRADING PROCESS IN A DAY AHEAD MARKET

Illustrative DAM Trading Process

Bidding
Bids for 15-min each or block bids can be placed

Corridor availability and funds verified

Confirmation
Confirmation by NLDC

Matching
MCP & MCV calculated

Result
Final ACV and ACP calculated
Market splitting if congestion

Scheduling
Final Schedule sent to RLDC for incorporation

DAM Trading Process of the Pilot Market

The reconciled bids are fed into the Market Clearing Engine for matching

Normal Orders collected from participants are validated and reconciled

The MCP and MCV obtained from the Market Clearing Engine are published

MARKET CLEARING

Market Clearing – Graphical approach

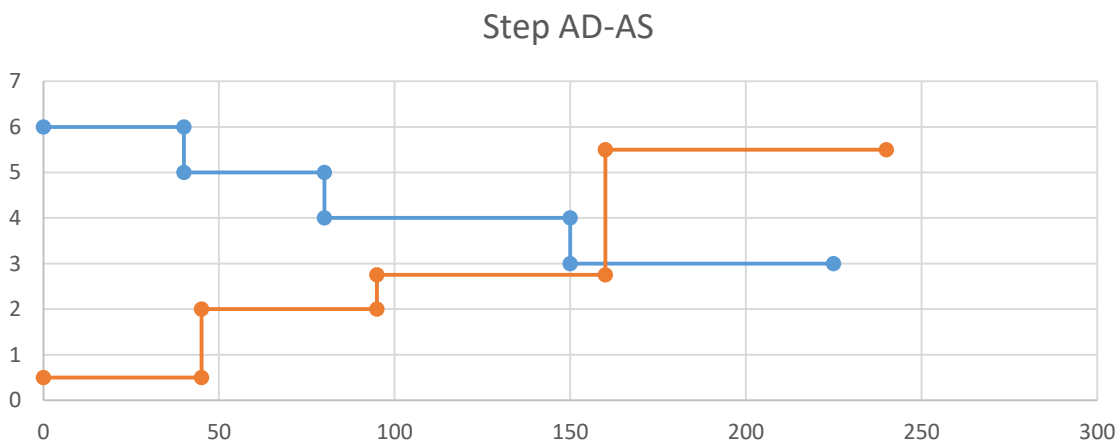
A participant specifies the following parameters in his/ her bid:

- Time of delivery, and,
- Maximum amount deliverable/consumable at various price levels (step function)

Sample Bids for a time period

Bids		Offers	
Price	Quantity	Price	Quantity
6	40	0.5	45
5	40	2	50
4	70	2.75	65
3	75	5.5	80

AD-AS Curves

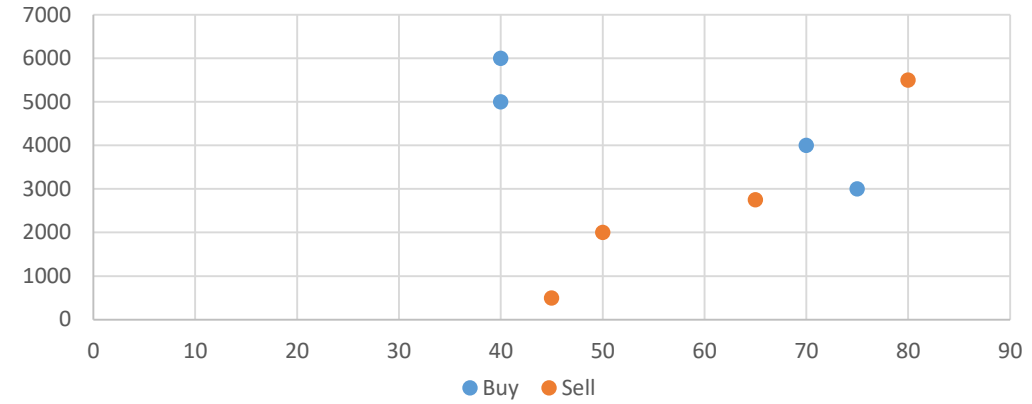


The aggregate demand and supply curves are obtained by stacking the buy bids and sell bids. When the aggregate demand and supply curves are superimposed, the intersection point defines the equilibrium point. The intersection point (equilibrium price) ensures that the welfare accrued to the participants – buyers and sellers is maximum. All sell offers below the MCP and all buy bids above the MCP are cleared completely. Bids and offers at the MCP may be partially cleared and remaining bids are fully curtailed

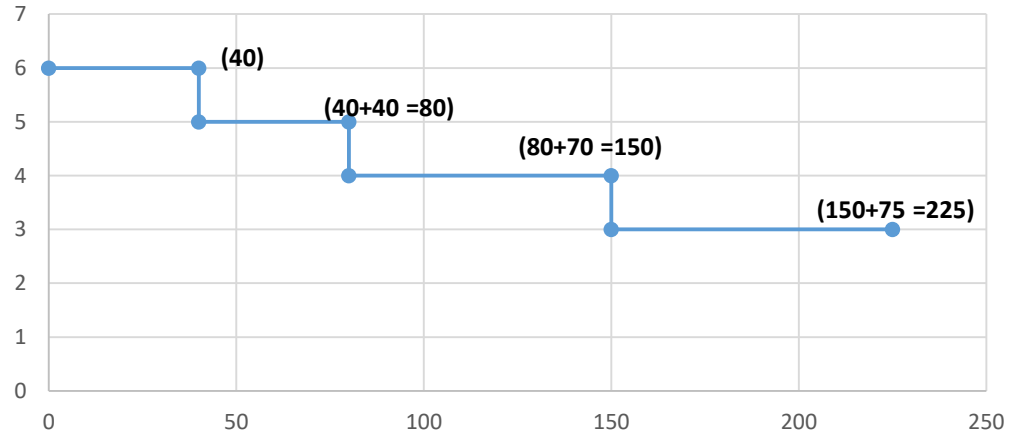
Creation of Aggregate Demand and Supply Curves

Sample Bids for a time period			
Bids		Offers	
Price	Quantity	Price	Quantity
6	40	0.5	45
5	40	2	50
4	70	2.75	65
3	75	5.5	80

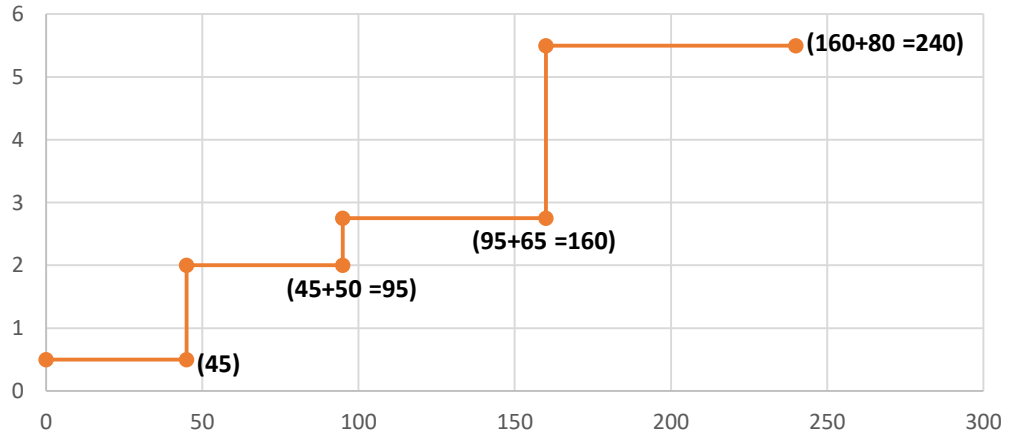
Scatterplot of the Bids



Aggregate Demand Curve



Aggregate Supply Curve



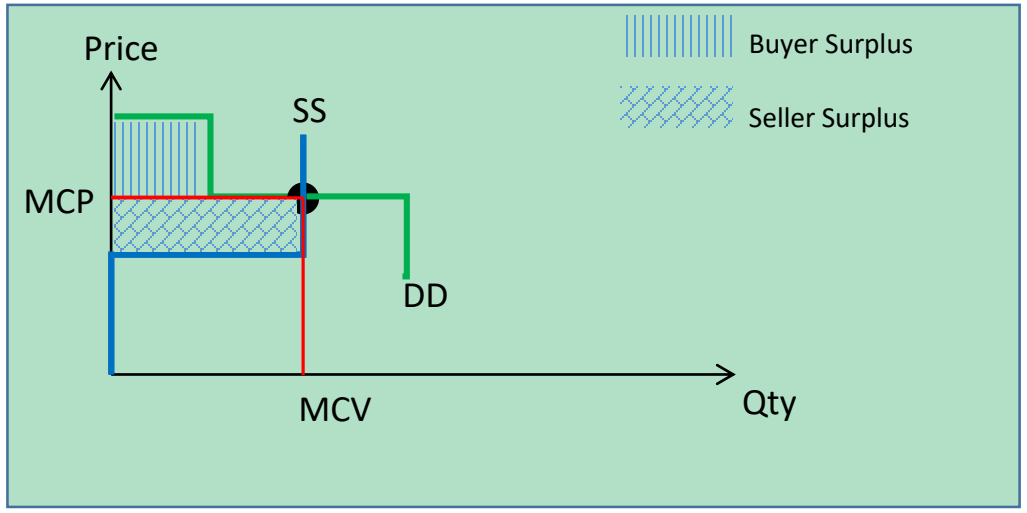
Market Clearing – Algorithmic Approach (1/2)

- Market Clearing Engine provides a platform for electricity suppliers and buyers to trade electricity in advance
- It follows a Double-Sided-Closed Bidding Auction model, where both suppliers and buyers quote their prices and the market is settled at a common Market Clearing Price
- Participants can specify their willingness to buy or sell using bids or offers respectively
- Market participants submit their respective orders on the exchange. The goal is to decide which orders to execute and which to reject and obtain Market Clearing Price such that:
  - The social welfare[1] generated by the executed orders is maximal
  - Orders and prices are coherent

The Market Clearing Engine provides solutions such that
–Orders in-the-money are fully accepted
- Supply at price < MCP
- Demand at price > MCP

–Orders out-of-the-money are fully rejected
- Supply at price > MCP
- Demand at price < MCP

–Orders at-the-money can be curtailed



[1] Social welfare is defined as: buyer surplus + seller surplus. It is the objective function in the Market Clearing Engine

Market Clearing – Algorithmic Approach (2/2)

Primary Optimization

Objective Function: Maximization of Social Welfare

Subject to following Constraints:

1. Selection Criteria for Normal offers/Bids – MCP has to be greater/less than the offer/bid price
2. Volume Schedule – Volume cleared should be less than or equal to volume on offer / bid
3. Demand Supply Balance

Tie Breaking Strategies

Multiplicity in solutions may be handled by employing secondary optimization problems in following sequence:

1. In case of multiple MCQs, the preferred choice is to maximize the traded quantity
2. In case of multiple MCPs, general approaches taken are – Average MCP or distribution of surplus as equivalently as possible between suppliers and buyers

ILLUSTRATIVE ORDERBOOK

Illustrative Orderbook

Order Nature – Block or Normal

Order Type – Buy or Sell

Limit Price

Bid Quantity in MW, positive for buy and negative for sell

Client ID	Region	Time Slot	Order Nature	Order Type	Price (Rs./kWh)	Quantity (MW)	Date
ABC12345	India	T18	Normal	Buy	3.5	30	1/5/2017
ABC12345	India	T73	Normal	Buy	3.5	30	1/5/2017
ABC12345	India	T91	Normal	Buy	3.5	30	1/5/2017
ABC12345	India	T90	Normal	Sell	3.5	-40	1/5/2017
ABC12345	India	T4	Normal	Sell	3.5	-40	1/5/2017
ABC12345	India	T6	Normal	Sell	3.5	-40	1/5/2017

Unique ID assigned to Bidders

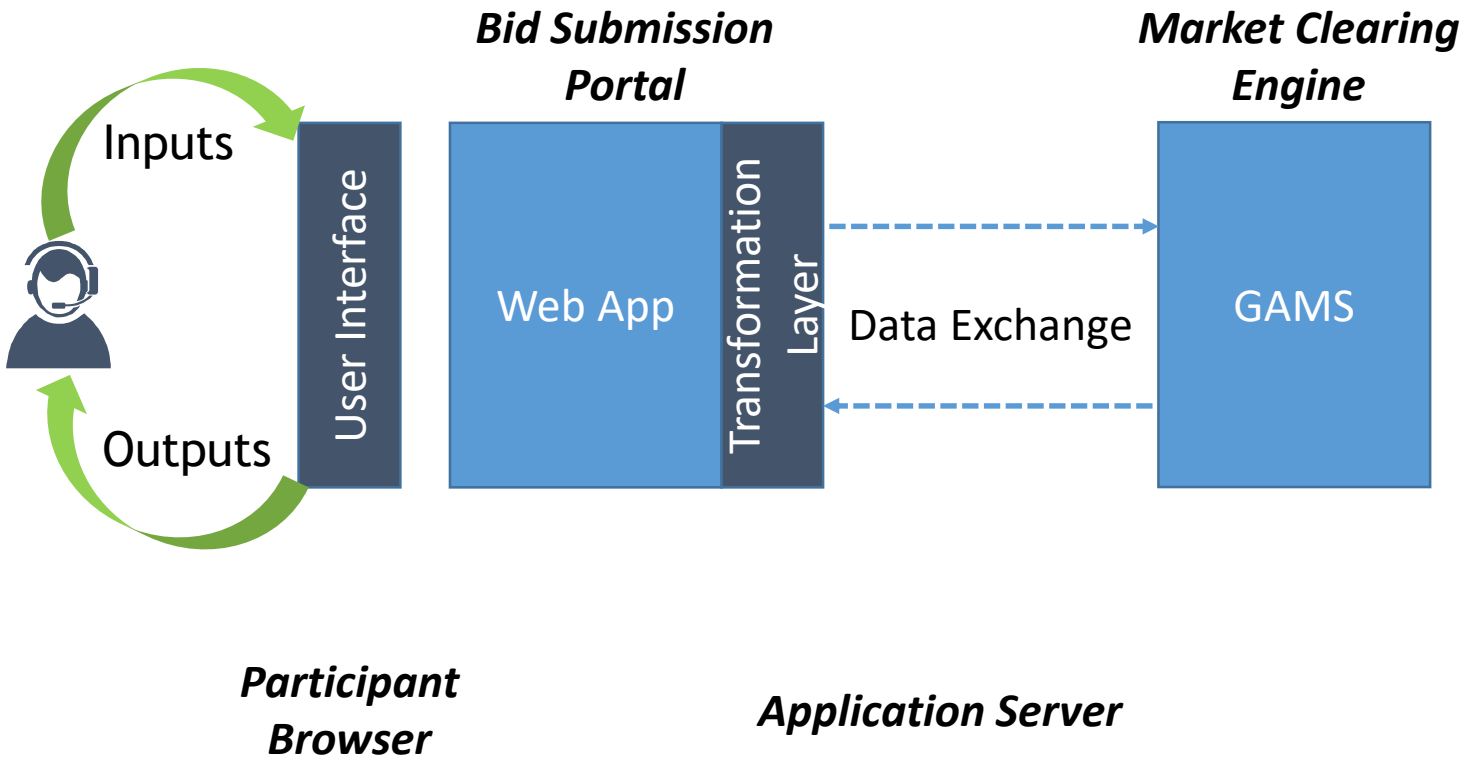
Bid Region – Nepal/ Bhutan/ Bangladesh

Delivery Time Slot – T1 to T96

Delivery Date

APPLICATION WORKFLOW

Application Workflow



LINK TO ACCESS THE WEB-PORTAL

https://267e7636.ngrok.io/sarpex/

sarpex.india.bids@gmail.com