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SOUTH ASIA REGIONAL INITIATIVE FOR ENERGY INTEGRATION (SARI/EI)

Roadmap for South Asian Regional Power Exchange (SARPEX)

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We hope this document will provide the clarity of vision for conducting the SARPEX mock exercise and will be a milestone in establishing a South Asian Regional Power Exchange particularly when finalising the modalities of launching the “Day Ahead Spot Product”.

Contents

Context

Cross-Border Electricity Trade (CBET) in South Asia is currently being undertaken in the form of bilateral trade and is limited to only a few instances covering India and Nepal; India and Bangladesh; and India and Bhutan. Additionally, Myanmar imports small amounts of electricity from India while Pakistan imports electricity from Iran, and Afghanistan imports it from Uzbekistan, Tajikistan and Iran. This scenario is, however, set to change in the medium and long term with several new transmission interconnections being proposed that would enable greater integration of power systems in member countries. Such integration would also enable trading on a multi-lateral basis in case the concerned governments make a decision to do so. If this happens, even if two countries have no common borders, they could trade electricity through a third country acting as a transit route or through a regional power exchange as envisaged in this roadmap.

As recognized, regions worldwide have different regional power market structures depending on market size, complexity, fuel dominance and market maturity. Almost all the power markets, whether in Europe or Southern Africa, have started the process of moving from bilateral to multilateral and eventually to power pool or power exchange set ups.

Based on the review of various power pools or regional power markets and power system integration schemes, a thought provoking discussion was initiated by the SARI/EI program to understand the feasibility and desirability of a power exchange in the region based on concrete evidence. There are some typical features as far as the power sector in South Asian Countries (SACs) is concerned. India has functional power exchanges but other SACs do not. By and large, there is a single utility which buys power in other SACs whereas in India we have multiple utilities. The generation and transmission tariff structures also differ from each other in the SACs.

The concept has been developed keeping in view the above factors. The policies of the SACs' governments and their expectations from a regional power exchange have also been considered. Thought has been given to accommodate the differences in the tariffs etc., so that the regional power exchange can function in a manner which does not disturb or require major changes in the above.

It is important to mention the SAARC Inter-Governmental Framework Agreement (IGFA) for Energy Cooperation, signed on November 27, 2014, by the Foreign Ministers of the eight member states. This agreement provides a strong basis for concluding that the various governments are keen to enhance power trade in the region.

The Ministry of Power (MoP), India has framed the guidelines on Cross Border Electricity Trade, on 5th December, 2016.[1] As per the same, SACs are now allowed to participate in the Indian Power Exchange for Term Ahead Contracts, Intra Day Contracts/Contingency Contracts subject to certain conditions. The guidelines also mentioned that other categories of contracts may be included based on review by the MoP, India in consultation with CERC. **The other category of contract mentioned here apparently includes the "Day Ahead Spot", which is the market where the bulk of the trading takes place.**

It is felt that a regional power exchange would provide the SACs with an opportunity for better price signals and would support a competitive power market.

[1] *Ministry of Power, India Guidelines on CBET dated 5th December 2016 available at http://powermin.nic.in/sites/default/files/webform/notices/Guidelines%20for%20Cross%20Boarder%20Trade.pdf*

It is imperative to initiate action to undertake in-depth analysis of the desirability and feasibility of the Day Ahead Market in South Asian region. Moreover, in view of the spirit of the guidelines, **the roadmap addresses various aspects of the inter-relationship between the Indian Domestic Power Exchange and the power from neighbouring nations. This is addressed in the two modes of operation of the Day Ahead Spot Market, the Unified and the Residual or the Sequential Mode.**

The roadmap and the mock exercise being conducted by the SARI/EI program will give a firm basis for establishing a Day Ahead Spot Market in the South Asian region. The mock exercise would also lead to the framing of the market design and rules for running the mock exercise and it would be a useful input for setting up a Regional Power Exchange.

1
Introduction

The South Asian (SA) region comprises of eight nations namely, Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. The region constitutes only four per cent of the world's total surface area while accounting for nearly 23 per cent of its population. The region has witnessed immense economic growth over the last decade of about five-six per cent per annum. Even though the energy demand in the region is rising, fuelled by economic growth, there are huge variations in the energy resource endowments and consumption patterns within the region. The region is characterised with skewed distribution of the available energy resources both within individual countries and across the region as a whole.

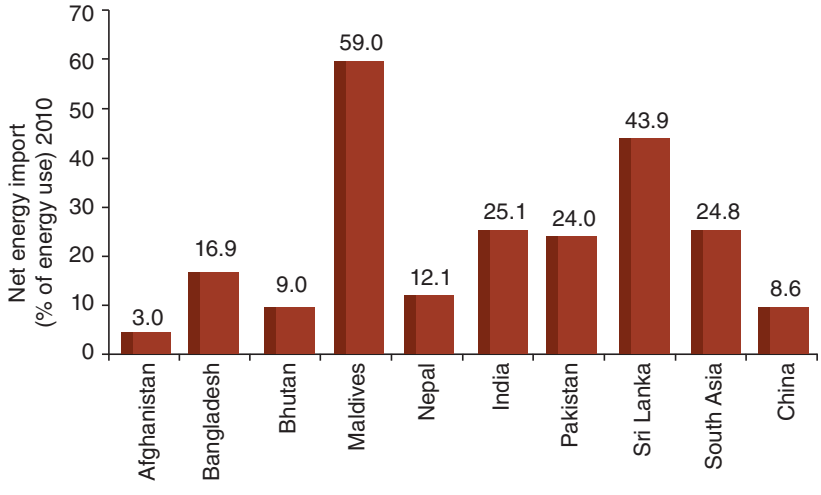
This creates large potential for benefits to accrue to the countries in the SA region if the electric grids and markets can be made to function more closely with each other. In addition, it is also important to provide incentives for the efficient use of resources for power generation while minimising the associated environmental impact. Responding effectively to these challenges requires concerted efforts from all the regional countries in SA.

1.1. South Asian Regional Power Sector Overview

There is a significant variation in the electricity consumption patterns across the SA region. The annual energy consumption ranges from as low as 0.17 million tons of oil equivalent (mtoe) for Maldives to 423.2 mtoe for India.[2] On the other hand, per capita consumption is the highest in Bhutan (2420 kWh)[3] and lowest in Afghanistan (49 kWh).[4] It is evident that the per capita energy consumption in the region continues to be quite low as compared to the world average. With such low electricity consumption, most countries in the region are struggling with generation capacity shortages and seasonal variations impacting the availability of existing capacity and hence electricity access. These, coupled with poor quality of supply owing to regular demand-supply mismatches, are resulting in the loss of economic output and productivity. Electricity consumers, as a result, are forced to invest in costlier diesel generators which impact environmental sustainability while increasing the import burden of the countries.

At present majority of the SA economies are hugely dependent on fossil fuel resources for electricity generation and meeting energy requirements. To meet the growing energy demand, primarily for electricity generation, these countries are importing fossil fuel resources from other regions of the world (Figure 1.1). For example, due to the lack of domestic energy resources, Bangladesh and

Figure 1.1: *Net Energy Import (2010) as a Percentage of Total Energy Use*



Source: World Bank, 2013

[2] *Cross-Border Electricity Trade in South Asia: Challenges and Investment Opportunities, Sept 2014*
[3] *Royal Government of Bhutan, 2012*
[4] *International Renewable Energy Agency, 2009*

Sri Lanka are planning imported coal-based power plants (8,400 MW in Bangladesh by 2032 and 4,600 MW in Sri Lanka by 2030), thereby increasing their dependency on coal imports. Further, in India, coal imports for power plants in 2012–13 reached 62.5 million tons (CEA, 2013b) and are expected to be around 200 MT at the end of the 12th Plan (2012–2017). The import of energy resources expose these countries to the vagaries of fluctuation in prices, as this is linked to international dynamics, causing macroeconomic stress.

To protect themselves from the increasing dependence on fossil fuel imports and price vulnerabilities, the SA countries are investing in the utilisation of regional energy resources and cross-border transmission infrastructure.

It is already well established that energy demand and growth are interlinked; therefore energy demand in the SA region is going to increase substantially to sustain its progress. Increasingly the country governments in the region are warming up to the opportunities of Cross-Border Electricity Trade (CBET). To meet the growing energy demand, improve energy access, reduce fuel import dependency and maintain energy security, the SARI/EI studies and other entities have shown how border electricity trade in the SACs may benefit the region as a whole and the member countries individually. Power pools worldwide have already demonstrated the benefits of shared resources, aiding economic growth and sustaining indigenous resources.

1.2. Power Trading and Market Structure in the South Asian Region

The existing cross-border transactions in the SA region are shown in Table 1.1 below. Bhutan has four export-oriented hydro power projects, aggregating a capacity of 1,480 MW, besides the recent addition, Dagachhu HEP (126 MW) which is Bhutan's first hydropower on PPP basis created through a Joint Venture with the Tata Power Company Limited, India.

Bangladesh is importing 600 MW from India to partially meet the power deficit prevailing in the country. There is a commercial arrangement for transfer of 500 MW power from India to Bangladesh. Additionally, 100 MW from western Tripura is supplied to the Comilla Power Grid in Bangladesh.

The power exchange between India and Nepal under various bilateral treaties and contracts since 1970s has grown over the years to about 237 MW in December 2015.The details of existing contracts are given below in Table 1.1.

Table 1.1: Existing Contracts for CBET in South Asia (December 2015)

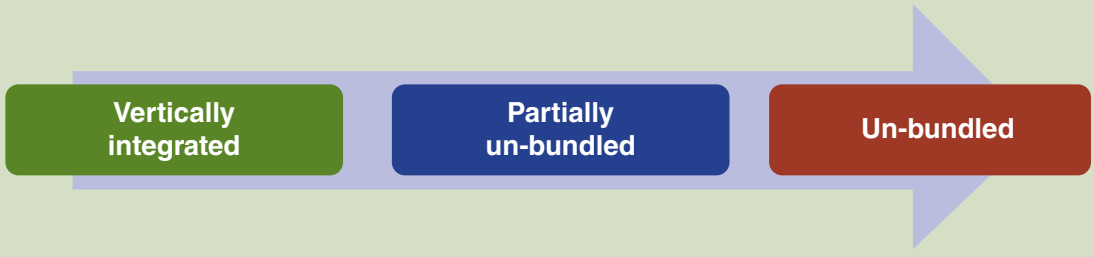
Country	Contracts quantum and duration	Type
Bhutan → India	Contract with PTC for Chukka (336 MW), Kurichhu (60 MW) Hydro Projects (Long Term)	Government - Government
	Contract with PTC for Tala (1040 MW) Hydro Project (Long Term)	Government - Government
	Contract with TPTCL for Dagachhu (126 MW) Hydro Project (Long Term)	Commercial
India → Bangladesh	BPDB Long Term contract with NVVNL for 250 MW	Government - Government
	BPDB Medium Term contract with PTC for 250 MW Tripura – Comilla 100 MW contract	Commercial Government - Government
India → Nepal	NEA Bilateral contracts / Treaties to the tune of 237 MW	Government - Government
	NEA Past contracts with PTC (2011-2015) during December-April months for ~20-30 MW	Commercial

Source: SARI/EI Task force-3 Presentation, 2016

As is evident from above, the regional power trade in the region is bilateral, confined to Bhutan-India, India-Bangladesh and India-Nepal. These power exchanges are via long-term Power Purchase Agreements (PPAs). In addition, there are some medium term contracts also. However, unlike the regional power trade in other parts of the world, SA is yet to have a short-term power trade through power exchange.

The power sector in SACs is at different phases of development and only India and Pakistan have unbundled their power sector while India has moved towards an active market based power trade. Other countries are either having a bundled utility structure or partially bundled structure as shown in Box 1.

Box 1: Power sector structure in the South Asian nations: Except in India and Pakistan, where electricity utilities are fully unbundled into generation, transmission and distribution functions, the electricity utilities in other SA nations are either vertically integrated or partially unbundled as shown below:



- Afghanistan (DABS)
- Maldives (FENAKA)
- Nepal (NEA)
- Sri Lanka (CEB)

- Bangladesh (Separate Trans, Utility)
- Bhutan (Separate Gen. utility)

- India (Separate G,T,D utilities)
- Pakistan (Separate G,T,D utilities)

Source: SARI/EI Task Force-3 Presentation

Taking the case of India, various distribution utilities in the country have signed many long-term and medium term PPAs. Before the induction of power exchanges, short term contracts were mainly driven by either direct contract between parties or through power traders. The power exchanges have to a great extent re-structured the short term market. The Day Ahead Contracts have been particularly popular in India as in other places globally.

The most common product of an exchange is the day-ahead spot mechanism, where both producers and consumers/distributors submit bids for the purchase and sale of electricity for each hour or any other time block in the coming 24 hours.

The new market structure which has evolved over the last few years, provides the distribution utilities with the avenue to optimise their power purchase portfolios and reduce their overall power purchase cost.

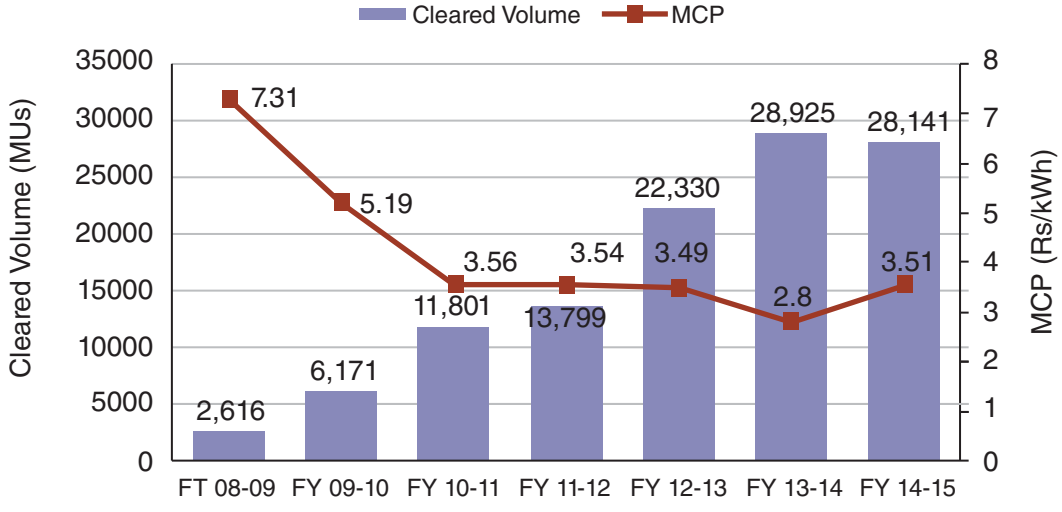
Table 1.2: Existing Power Market Structure in India

Long Term	
> 12 years	Power Purchase Agreements
Medium Term	
3 months -3 years	OTC (License Traders)
Short Term	
Intra Day - 3 months	OTC , Power Exchanges (IEX)
Balancing	
Real-time	Deviations (TSO)

Power exchanges have offered a fair, transparent and neutral platform at the national level which has resulted in efficient price recovery of electricity. The prices have not only brought up the "time of delivery" aspect (peak, day, and night hours) but also the "locational" component of electricity.

Moreover, it is partly due to the power exchanges that the temporal nature of prices and seasonality of the supply and demand dynamics have also been captured. Similarly, the operation of the market has also played an important role in identifying grid congestion, its severity, which in turn has resulted in proper signals for the need to augment, strengthen, and upgrade the transmission network of the country.

Figure 1.2: *Indian Power Exchange -Transactions and Market Clearing Price in the last 5 Years*



2
International Cross Border Exchanges

In almost all continents such as Europe, Africa and America, there has been large scale integration of the power markets. To understand the journey of integration in the developed power systems, the following paragraphs provide brief details of the process of connecting regional markets.

2.1. Nord Pool

Norway was the first of the Nordic countries to deregulate its power markets. Norway's Energy Act of 1990 formed the basis for deregulation in the other Nordic countries. The framework for an integrated Nordic power market was made by the Norwegian Parliament. Together with Nord Pool's license for cross-border trading (given by the Norwegian Water Resources and Energy Administration), this framework provided the foundation for spot trading at Nord Pool.

Table 2.1: Evolution of Nord Pool Regional Power Market[5]

Timeline	European Regional Market
1991-1995	Norwegian power market deregulated
1993	Nord Pool Spot established as 'Statnett Marked'
1995	Nordic Energy Ministers formed a committee to investigate the establishment of a common Nordic electricity market. Committee provide favourable report
1998	Finland joins Nord Pool
1999	Elbas becomes the first intraday market
2000	The Nordic market fully integrated as Denmark joins
2002	Nord Pool Spot established as a separate company
2005	The Kontek bidding area in Germany opens
2008	Financial market sold to NASDAQ OMX Commodities
2009	Market coupling of 11 European countries launched through EMCC (European Market Coupling Company)
2010	N2EX launched by Nord Pool Spot and NASDAQ OMX Nord Pool Spot opens bidding area in Estonia
2013	Nord Pool Spot opens bidding area in Latvia thus including all the Baltic countries

2.2. Integrated Europe

The European Commission has a stated goal of harmonising all the European power markets. The ultimate aim is to create a pan-European market with closer connections between power markets to improve the efficient use of energy across national borders; this is the European Target Model for electricity market integration.

Under the Target Model, the EU has set-up common rules to lead to the efficient use of cross-border capacity and harmonisation of European wholesale power market arrangements. The main features of the model are electricity balancing between Transmission System Operators (TSOs), day-ahead market coupling and continuous day-ahead trading to allow cross-border trading of electricity closer to real-time and long-term transmission rights to access capacity on interconnectors.

Initially, markets were coupled in the Scandinavian

[5] *Learning from Nord Pool Region: Power Market Development, 2015*

market with Norway-Sweden (1996) and subsequently the Nordic Market (2000-Norway, Denmark, and Finland). The experience was adopted in Central Europe through Trilateral Coupling (TLC) between Belgium, Netherlands and France (2006). The EU, convinced of the success of the TLC model, included it in its 3rd Energy Package in 2008 in its directive (EC/714/2009).

The coupling of Central Western Europe (CWE), Scandinavia, and Central South Europe (CSE) was achieved through Price Coupling of Regions (PCR) in 2014. Further, expansion of this market would continue with the addition of East European markets in the future. After market coupling began prices began to converge in participating countries.

Table 2.2: Evolution of European Regional Power Market

Timeline	European Regional Market
1996	Markets were coupled in the Scandinavian market with Norway-Sweden
2000	Market coupled between Norway-Sweden-Finland-Denmark
2006	Central Europe through Trilateral Coupling (TLC)-Belgium, Netherlands & France
2009	3rd Energy Package in 2008 in its directive (EC/714/2009) - Trilateral market coupling
2014	The coupling of Central Western Europe (CWE), Scandinavia, and Central South Europe (CSE) - Price Coupling of regions

2.3. South African Power Pool (SAPP)

SAPP was created with the primary aim of providing reliable and economical electricity supply to the consumers of each of the SAPP members, consistent with reasonable utilisation of natural resources and the effect on the environment. SAPP's goal is to optimise the use of energy resources in the region as well as supporting each other in emergencies. The members of SAPP have undertaken to create a common market for electricity in the Southern African Development Community (SADC) region and to let their customers benefit from the advantages associated with this market. All utilities participating in SAPP have equal rights and obligations, and have agreed to act in solidarity without taking advantage of one another.[6]

The genesis of SAPP may be traced to two memorandums of understanding (MoUs) signed by member states and their respective national power utilities: (1) the Inter-Governmental MoU in 1994, which formally established SAPP; and (2) the Inter-Utility MoU, which gathered all the national power utilities throughout SAPP and defined their management and operating interactions. Later, both MoUs were revised in 2006 and 2007. An agreement between the operating members was also signed to define the specific operating rules and pricing, and this was revised in 2008.

In 1995, SAPP was founded and it was the first advanced power pool in Africa. The aim was to optimise the use of available energy resources in the region and provide support during emergencies.

In 2001, SAPP established a short-term energy market followed by a balancing market in 2002; and a competitive electricity market, known as a day-ahead market, in 2009. Over the period, SAPP shifted from a co-operative pool to a competitive market. Ancillary services are now used by utilities and grid operators to improve reliability and increase economic efficiency in regional energy markets by addressing short-term imbalances and dispatching resources.

[6] *South African Power Pool website: http://www.sapp.co.zw/*

Table 2.3: Evolution of South African Power Pool[7]

Timeline	South African Power Pool
1994	Inter-Governmental MoU formerly established SAPP, Inter-Utility MoU
1995	SAPP was founded and it was the first advanced power pool in Africa; initial focus on trading of excess generation capacity available in the region based on ongoing transmission projects
2001	Short-Term Energy Market (STEM) commences operation
2002	Regional Electricity Regulatory Association of Southern Africa (RERA) is established (Secretariat is located in Namibia) Post STEM (Balancing Market)
2007 & 2008	Emergence of regional shortage of generation capacity and emergency plan
2009	Day Ahead Market (DAM) due to commence operations
2013	Post Day Ahead Market
2014	Review and approved operating guidelines and market guidelines

Inference: Typically power exchanges/power pools started operations in one or two countries. Subsequently, they expanded their operations to other countries turning into a regional exchange. In a few cases like Nord Pool Spot and Operador del Mercado Ibérico de la Energía, polo español S.A. (OMIE), expansion to other countries resulted in equity participation by those countries. APX's (Europe's premier provider of power exchange and clearing services for the wholesale market) expansion was through mergers or buying equity stake in national exchanges. In the case of SAPP, 11 SADC members signed an Inter-Governmental MoU in 1994 paving the way for the creation of SAPP in 1995. Subsequently, other member nations joined the pool.

Day Ahead Market (DAM) and Intra Day Market (IDM), are the main products offered on all national and regional power exchanges around the world. The objective of floating these products is to cater to day-ahead and contingency requirements and absorbing surplus in the concerned markets. The discovery of market price and volume is done through open or closed auction for a duration ranging from 15-minute time blocks to hourly time blocks. A client/member of a power exchange can bid for a single block or a combination of blocks. The product prices have upper and lower limits within which the bidding and clearing is done.

[7] *The Potential of Regional Power Sector Integration, Economic Consulting Associates, 2009*

3

Why a power Exchange is Required in the South Asian Region

Currently in the SA regional power market, there is long and medium term power trading through bilateral agreements. However to extract the full benefit of regional power trade of day ahead nature, a regional power exchange is essential.

The sporadic demand-supply mismatch at the geographical level also calls for a market place where surpluses can be disposed of efficiently on a real time basis to optimise resource allocation. In the SA region, the complementarities in individual countries are substantial; the details of the same are discussed below.

3.1. Hourly Complementarities

The power market is complex as electricity cannot be stored as in other commodity markets. Efficient utilisation of resources could be possible, if electricity could be generated as per the demand in the market, so that conversion losses of storage could be saved given the economic benefits.

This **daily demand variation** is also substantial and provides a sizable opportunity of hourly trade as shown below in Table 3.1. **This representative Table has been prepared based on hourly variations in the SACs as on 1st April 2014.**

Table 3.1: Hourly Complementarities of South Asian Countries

Countries	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Bangladesh - April																								
Bhutan - April																								
India - April																								
Nepal - April																								
Pakistan - April																								
Sri Lanka - April																								

Colour Coding	Range	
	Min	Min+(Max-Min)*20%
	Min+(Max-Min)*20%	Min+(Max-Min)*40%
	Min+(Max-Min)*40%	Min+(Max-Min)*60%
	Min+(Max-Min)*60%	Min+(Max-Min)*80%
	Min+(Max-Min)*80%	Max

Source: SARI/EI Task Force-2 Presentation on Trading Potential Assessment, 2015

3.2. Seasonal Complementarities

The **demand in various countries** varies significantly from season to season as depicted in Table 3.2. As shown in the month of May, the demand for electricity was high in Bangladesh as compared to the other countries where it was either low or medium. Due to the high variation of seasonal demand across the countries, they provide complementarities and opportunities for optimal utilisation of resources.

Table 3.2: Seasonal Complementarity in Power Systems in SA - Monthly Load Profiles across SA grids

	January	February	March	April	May	June	July	August	September	October	November	December
Bangladesh	Low	Low	Medium	High	High	High	Medium	Medium	Medium	Medium	Low	Low
India - North East	Medium	Low	Medium	Low	Low	Medium	High	High	Medium	High	High	Medium
Bhutan	High	High	Medium	Medium	Medium	Low	Low	Low	Low	Medium	Medium	High
India - East	Low	Medium	High	High	Medium	High	High	High	High	Medium	Low	Low
Nepal	High	High	Medium	Medium	Low	Low	Low	Low	Low	Medium	Medium	Medium
India - North	Medium	Medium	Low	Low	Medium	High	High	High	High	Medium	Low	Medium
India - West	High	High	High	Medium	Medium	Medium	Low	Low	Low	High	High	High
Pakistan	Low	Low	Medium	Medium	Medium	High	High	High	High	Medium	Medium	Medium
India - South	High	High	High	High	Medium	Low	Low	Medium	Medium	Medium	Low	Medium

Low Medium High

Source: World Bank, Policy Research Working Paper, 2015

3.3. Resource Complementarities

India and Pakistan account for the major share of coal and natural gas, respectively. However, owing to the burgeoning population levels in these nations, these resources are not sufficient to meet their energy demands. On the other hand, there are regions such as Nepal and Bhutan, which have huge hydropower potential in excess of their demand. Bangladesh is heavily reliant on natural gas reserves which are fast depleting. Energy supply in Sri Lanka is primarily based on biomass, petroleum and hydroelectricity. Maldives is dependent heavily on diesel for its domestic needs which it largely imports as its own domestic resources comprise primarily of biomass.

The biggest advantage of a market place is that it is less open to manipulation, compared to non-market mechanisms based on negotiations. There is also no room for vested interests and political influence to set prices at inefficient levels.

Once the SACs form an interconnected system, cross border power trading would benefit immensely from an open market place that facilitates efficient, transparent and reliable prices. It would also boost investor confidence to develop regional generation projects. In fact, one could argue that the price discovery mechanism may even virtually precede the physical interconnection to pre-emptively develop an idea of what prices in neighbouring countries may look like.[8]

The idea of a regional power exchange for the SA region is not new. It has been suggested earlier and some studies have also been conducted by the World Bank, Asian Development Bank (Study on a South Asia Regional Power Exchange) etc. The range of opinion put forward varies; from having an independent South Asian platform to the simplest option of allowing the neighbouring countries to participate in the Indian domestic exchanges.

[8] *Indeed, we have seen such pseudo market developments in Australia where some of the states operated as part of the National Electricity Market before they were interconnected. The mere presence of a price for a commodity sends useful signals to prospective buyers and sellers who can make an informed business decision to engage in a trade once the physical interconnection is put in place.*

4

Concept of Pilot Market (Mock Exercise for SARPEX)

As a step towards establishing a South Asian Regional Power Exchange (SARPEX), the mock exercise will give practical options for establishing such an exchange. This will be backed by data and numbers. A trading platform mimicking a regional energy exchange for the SA region will be created and operated in pilot mode. The mock exchange will provide an answer to various key questions, related to possible volume which may become available to the regional market, the impact of the regional market on domestic energy markets in each country and willingness of the individual countries to trade. It will provide useful signals to prospective buyers and sellers as well as country governments for making informed decisions to engage in a regional exchange once the member countries agree on the same. **The mock exercise results will provide the desired inputs for the decision makers to enable the selection of a suitable option for market design. This will also give clarity about the identity of the buyers and sellers in such a regional exchange.**

The power exchange would constitute another option for power trading among the several existing short-term and long term trading options which are available in the region including direct bilateral contracts and long term PPAs. While the volume of trade through power exchanges has increased significantly and is expected to continue to do so, it is envisaged that these other forms, especially long-term PPAs would remain the dominant form of trade. **Having said that, a regional power exchange would provide an open market forum and a benchmark price based on a set of a transparent mechanisms and rules, thereby encouraging and bringing efficiency along with price signals for short term trades specially those limited to a few days.**

4.1. Modes for Running the SARPEX

Some feasible options for running the regional power exchange are discussed in this section. Ideally, the options to be adopted would be decided by the country governments. However, an attempt is being made to showcase the impact of two options so that informed decisions could be made based on the results of the exercise.

A) **Residual Mode or Sequential Mode:** The un-cleared bids from the Indian participants would be cleared with the bids of participants from the other countries. The Indian domestic exchange would not be influenced in any manner due to other participating countries.

B) **Unified Mode:** The bids from the Indian participants and participants from the other countries would be cleared simultaneously.

A. **Residual or Sequential Mode:** In this case, countries other than India would bid directly (because of bundled utility structure) on the pilot exchange platform. These bids would then be matched against the un-cleared bids from the power exchanges of India. Figure 4.1 shows the Residual Mode pictorially. The main advantages and disadvantages of the Residual Mode are mentioned below.

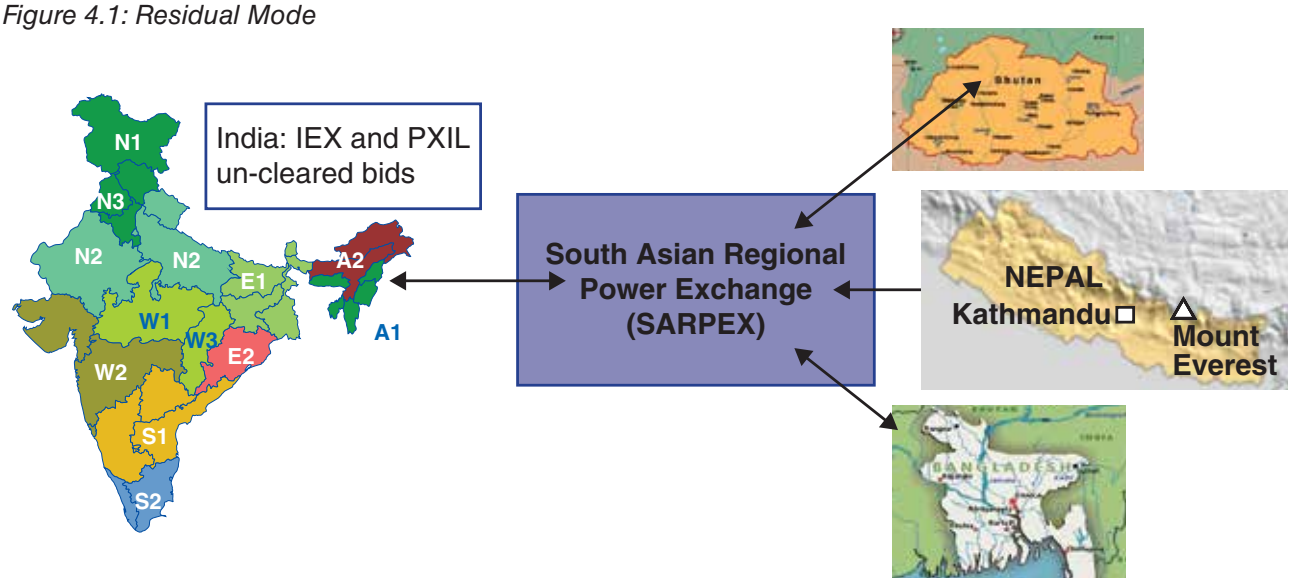
Table 4.1: Key Advantages and Disadvantages of Residual Mode

Advantage	Disadvantage
• The impact on the Indian domestic **market** would be negligible.	• The quantum of power available for countries other than India may decrease as they are only using the left over bids.
• **The main advantage is that it provides a level playing field for all the nations. The power which goes into this platform is the power left after meeting the internal requirements of the respective nations.**	• It is a long and steady path for regional power markets.

Advantage	Disadvantage
• In case the separate platform is created with the full involvement of the other nations in the SA region, it will give a sense of belongingness and commitment to all the participating countries which is not possible otherwise.	

All the countries involved have to agree on the various aspects of the exchange and the time that may be required to set up the exchange with all the systems and procedures, especially the grid related matters.

Figure 4.1: Residual Mode



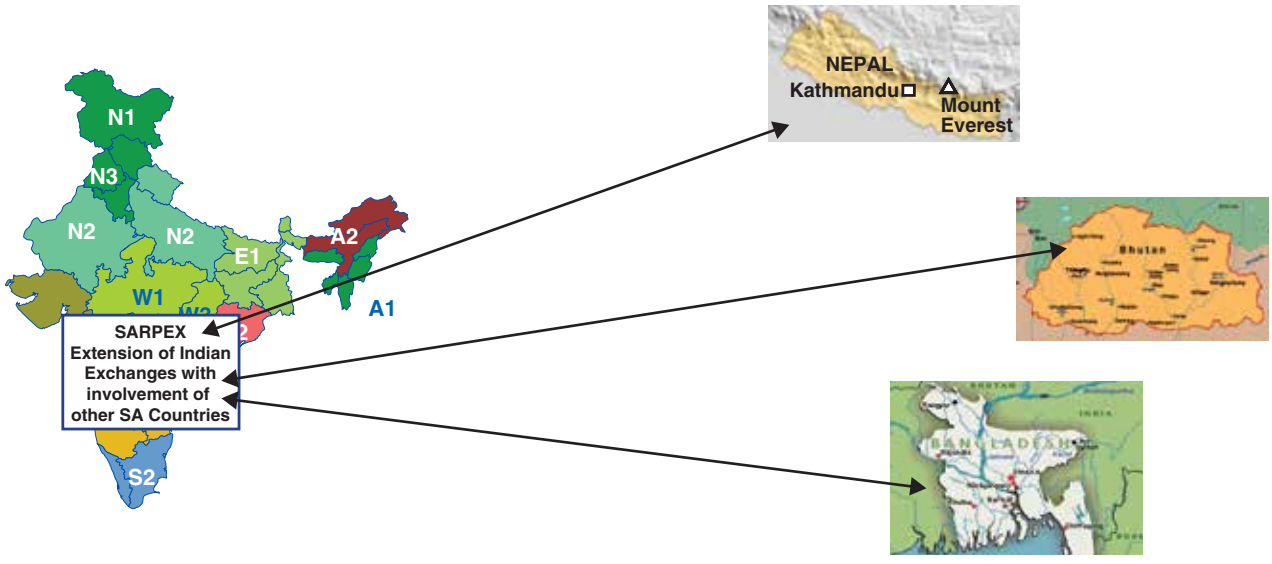
B. Unified Mode: The bids from Indian participants and participants from the other countries are cleared simultaneously. Effectively it is an extension of existing power exchange of India into the other countries. Figure 4.2 shows the Unified Mode pictorially.

Table 4.2: Advantages and Disadvantages of Unified Mode

Advantage	Disadvantage
• **Operational power exchange in India.** It has already gone through various developmental phases and taken a step wise growth approach. The benefits of the same will be readily available if the Unified Mode is adopted by integrating with the existing Indian domestic exchanges.	• By-laws and all the processes and procedures are streamlined as per Indian requirements. Some modifications will have to be made to accommodate the other countries. These modifications will have to be acceptable to all stakeholders.
• **Large quantum is** already **available** in the existing Indian power market. As compared to the Residual Mode, the Unified Mode is likely to be more liquid as the entire quantum of Indian domestic market will be available to the cross border participants.	• **A major drawback is the fact that it do not exactly provide for a level playing field for all the participating nations.** While Indian bids are considered before meeting the domestic market requirements, the other nations will place bids after catering to the needs of their domestic market. This is because of the current status of unbundling of the utilities in the various SACs.

Advantage	Disadvantage
	• The Indian domestic market will definitely be affected. The quantification of the impact would be estimated based on the result of the mock exercise.
• **Well defined procedures and principles** for dispute resolution, regulations, ownership, governance, etc., have already been established.	• Enforcement and acceptability of the same for other participating sovereign nations will have to be looked into very carefully.

Figure 4.2: Unified Mode



The mock exercise and its result will help decision makers in selecting the most feasible option and taking steps that may be needed to initiate a regional power exchange. Additionally, the mock exercise would also develop/provide:

- A draft set of market design and rules of a SA regional electricity market.
- A detailed report based on the analysis of the pilot market data to ascertain the desirability and the feasibility of a SARPEX, and
- To build the capacity of relevant officials from the SA countries on the functions of a power exchange which is critical irrespective of the option finally selected.

The impact of transmission constraints in the cross border lines as well as in the countries' own national grid shall not be considered and only the Unconstrained Market Price (UMP) and Unconstrained Market Volume (UMV) shall be taken into consideration. Assessing transmission constraints and corridor availability depends on the coordination with the related load dispatch centres. At present to do this is not feasible but the mock exercise results would be analysed empirically to account for these issues.

4.2. Conducting the Mock Exercise

The SA region has witnessed the inception and operationalisation of the two existing power exchanges in India. The region is witnessing power trade to the tune of 1,500 MW through regional

transmission connectivity. India is connected to Bangladesh, Bhutan and Nepal though separately. As Bangladesh, Bhutan and Nepal are not directly connected to each other, any trade among them has to pass through the Indian network. At present the connectivity status between India, Pakistan, Afghanistan and Sri Lanka does not really encourage any power transfer between India and these countries. This practically splits the region into two sections, one on the eastern side with electrical connectivity and the other on the western side with no connectivity between them.

The power sector has been unbundled in India whereas the utilities of Bangladesh, Nepal and Bhutan are bundled. This implies that it is likely that there will be only one participant from each of these countries in SARPEX. However, in the future the country governments may prepare by-laws or regulations for the direct participation of various Independent Power Producers (IPPs) and government organisations in regional power trading.

On the other hand, a very large number of bids/ bidding parties are present in the Indian exchange market. Thus, the Indian bids shall be sourced based on the data available in the public domain of the Indian Energy Exchanges.

A) Securing the bids: The mock exercise will need bidding from the participating countries. Indian bids shall be ascertained as highlighted above. For securing the bids from other countries, a core team headed by a nodal officer would be nominated by the suitable authority in these countries. The team would bid for their countries as in the case of any power exchange. Suitable training would be imparted to the core team and the nodal officer covering all aspects of the pilot market including bidding, data requirement, data analysis and how to arrive at the bid volume and cost.

B) Period of bidding: It would be ideal to run the mock exercise by actual bidding for the duration of an entire year. However, there are certain practical issues which make it difficult to run the mock exercise for the entire year. For one, the availability of the core team and the nodal officer for an entire year even on a part time basis may not be feasible. Secondly, maintaining interest in the project which is primarily a mock exercise, even if it has significant implications in the long run, is difficult. Finally, issues related to cost and time for running the pilot market also have to be considered. Hence it was decided that the team would be required to bid for a selected 60 days (approximately) spread over the entire year and not 365 days.

C) Process and duration of running of the pilot market: The pilot market must come up with the results based on at least one year of operation. This is to ensure that all kinds of variations such as seasonal, weekdays, weekends etc. shall be covered during the mock exercise. The operational process is described below.

- The pilot market shall cover a period of one year from 1st April ’15 to 31st Mar’16. This will be selected on the basis of past data in the participating countries as well as the information available on the Indian exchange bids.
- The pilot market shall be run as a day ahead spot market. Currently, there are several products available on the Indian exchange but typically this is the most commonly used product. Intraday market was also considered but given the current scenario, it was decided that the mock exercise would only be run as a day ahead market.
- Based on factors like season, weekdays, weekends etc., sixty representative days would be selected for the purpose of bidding covering the entire year. These bids would be matched and the results generated. These results would be extended to cover the rest of the days in the year for all countries. Thus, the results for the entire duration of a year would be available at the end of this exercise.
- These bids can then be processed in order to generate the results as done in case of the day ahead product in a power exchange.

4.3. Simplifications

To ensure that the pilot market would run smoothly and out of practical considerations, the following simplifications were made applicable.

Determination of Unconstrained Market Price (UMP) and Unconstrained Market Volume (UMV): The impact of transmission constraints in cross border lines as well as in the countries own national grid would not be considered and only the UMP and UMV would be taken into consideration. This was necessary because under the present condition, coordination with the related load dispatch centres was not feasible. Secondly, the mock exercise results would give an indication of the required transmission capacity between the countries and would also be an input for transmission planning related to cross border lines. Further, it would also give an indication of the direction and quantum of power flow across the Indian grid under various conditions. This would give a definite result as to how these flows would impact our grid as far as grid congestion is concerned and also if there was any justification for keeping certain transmission capacity reserved for cross border trades. Lastly, it would give an idea about the additional revenue generated for the transmission operators and how this revenue impacts the transmission costs for Indian domestic consumers. This is also applicable in the case of transmission losses.

Quantification of the transmission losses and charges applicable for the pilot market operation: For quantifying the charges and losses, these countries would be made a part of the bid area defined in the Indian exchanges or included as new bidding areas. This would be reasonable except in the case where the country is connected to the Indian grid both at the state as well as the central transmission utility levels. In this case, average losses and charges based on the ratio of the power flow can be assumed.

One interesting aspect of the whole exercise is due to the fact that the transmission tariffs in different countries vary. To circumvent this issue, one may fix the point of delivery/draw at the national grid periphery of the respective country with the country specific transmission charges being borne by the bundled utility of that country. It is expected that the bidding rate of that country would include the impact of such charges. Similarly for losses, the applicable Indian Point of Connection (PoC) charges can be made applicable with the losses in other nations treated in the same manner as in the case of transmission charges.

4.4. Expected Outcome of the Mock Exercise

The mock exercise will generate results which would help the decision makers of respective countries make decisions on the matters of establishing a regional exchange for the SA region and its possible impact. Some of them are elaborated below.

- **Ascertain the feasibility of SARPEX:** The benefits of cross border trade for all the countries in the SA region have been well established and reaffirmed many a times. Significant amounts of PPA based trades are also taking place in the region. What is lacking in the region is a power exchange which will give an option of day ahead trades and provide optimum utilisation of resources on a day-to-day basis.

  The significance of the regional power market lies in optimising resource allocation over a wide area in order to gain market efficiency. Market efficiency can be quantified by total surplus which is the sum of consumer's surplus and producer's surplus. The output of the exercise will also try to indicate the total surplus leading to market efficiency.

- **Ascertain a suitable mode of operation for SARPEX:** The pilot market will operate in both the modes i.e. Unified as well as Sequential. The results will give a comparison of the outcome in both the modes. This coupled with the policies of the governments of the countries involved, will provide a suitable basis for SARPEX's mode of operation.

- **Preliminary inputs for transmission interconnection:** The mock exercise results will

give an indication of the required transmission capacity between the countries and the same would also provide inputs for transmission planning related to cross border lines. Further, it would also give an indication of the direction and quantum of power flow across the Indian grid under various conditions.

4.5. Way Forward

The mock exercise or the pilot market would be run based on the concept developed. The pilot exercise will produce results based on actual bids. Thus, the results would have a concrete basis and would lead to quantification of expected trades and the consequent economic gains. The results can be further analysed to arrive at the impact on the power systems of the various nations with respect to the effect on transmission constraints, system stability and reliability of not only the cross border lines but also the national grids.

Stakeholder consultation and dissemination of the results would be an integral part of the mock exercise during its operation. This would be further continued once the exercise is over in order to establish the desirability of a power exchange in the South Asian region. The proposed market design and rules document, which is an outcome of this exercise, shall be a starting point on which SARPEX would be formed.

As per the Load Generation Balancing Report (LGBR Report 2016-CEA), India is expected to have surplus power in the current fiscal. If the policy allows, then SARPEX would help Indian power plants sell their excess generation to other countries. Likewise, it would enable the export of excess power from other neighbouring nations. Power plants (Tata Power, GMR Energy and Satluj Jal Vidyut Nigam) aggregating a capacity of 5,000 MW are under construction in neighbouring countries. These generators will also have the option of utilising SARPEX as a platform for selling their power. Similarly the same is also expected to benefit the buyers. **During the execution of the mock exercise, flexibility would be maintained to include the impact of policy changes that may take place in the participating nations during this period.**

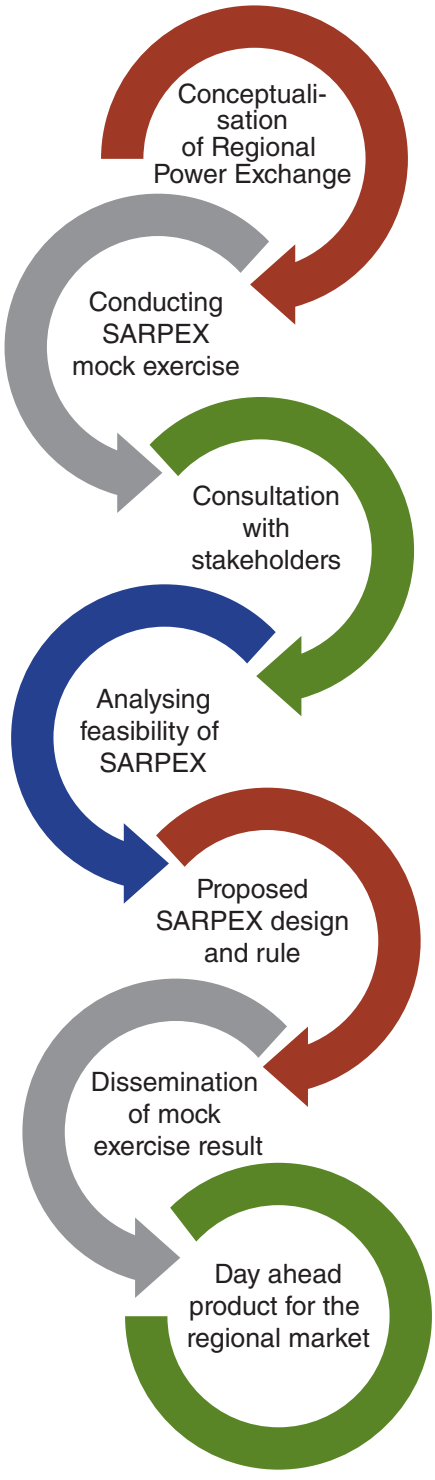
A market advisory committee has been formed comprising of eminent members from various backgrounds to guide the execution of the pilot market project. It is felt that they would also play a key role in the subsequent introduction of the day ahead product in SARPEX. More members may be added during the execution of this exercise, if it is felt that they are required.

It may be noted that the roadmap or the associated mock exercise does not delve into matters such as ownership, governance etc., of SARPEX. The exercise restricts itself to the objectives mentioned above and these issues should be decided at a different level and forum. SARPEX can be an extension of the Indian power exchanges or an entirely separate entity but the same is not pertinent of the present exercise.

In the future, it is hoped that this concept and the associated mock exercise would be useful for the decision makers in the SACs to look at the Day Ahead Market through power exchanges as an option for CBET. The steps in the way forward are depicted in Figure 4.3.

The Day Ahead Trade through a South Asian regional power exchange may appear to be a distant dream today as was the establishing of a domestic power exchange in India some 15 years back. As in the case of the domestic power exchange, it may be just a matter of time before the Day Ahead Market becomes operational in the South Asian Regional Electricity Market.

Figure 4.3: Roadmap for SARPEX



Annexures and References

Annexure-1: Core Team Members from Nepal, Bhutan and Bangladesh

S.No	Name	Country	Designation	Organization
1	Mr. Mohammad Hossain	Bangladesh	Director General	Power Cell
2	Mr. Shiekh Faezul Amin	Bangladesh	JS (Dev)	Power Division
3	Mr. Golam Kibria	Bangladesh	Director IPP 1	Bangladesh Power Development Board (BPDB)
4	Md. Nuruzzaman	Bangladesh	SE (Plg)	Power Grid Corporation of Bangladesh (PGCB)
5	Mr. Karma Namgyel	Bhutan	Chief Engineer, DHPS	Ministry of Economic Affairs
6	Mr. Denkar	Bhutan	Engineer, DHPS	Ministry of Economic Affairs
7	Mr. Ugyen Chophel	Bhutan	Engineer, DHPS	Ministry of Economic Affairs
8	Mr. Nima Tshering	Bhutan	Bhutan Power System Operator (BPSO)	Bhutan Power Coporation (BPC)
9	Mr. Anil Rajbhandary	Nepal	Director	Nepal Electricity Authority (NEA)
10	Mr. Nutan Prakash Sharma	Nepal	Senior Divisional Engineer	Department of Electricity Development, NEA
11	Mr. Tej Krishna Shrestha	Nepal	Asst. Manager, Power Trade Department	NEA
12	Mr. Narendra Shrestha	Nepal	Assistant Manager	Load Dispatch Centre, NEA

Annexure-2: Market Advisory Committee

S.No	Name	Country	Designation	Organization
1	Mr. Anil Razdan	India	Ex- Secretary	Earlier from Ministry of Power
2	Mr. Hans-Arild Bredesen	Norway	CEO	Nord Pool Consulting
3	Mr. Peter Jogersen	Denmark	Vice President	Energinet
4	Mr. Musara Beta	South Africa	Chief Market Analyst	South African Power Pool

References

S.No	Organization
1	Benefits of an integrated European electricity market: the role of competition , 2013
2	Benefits of successful market integration, ICER paper, 2015
3	Cross-Border Trade in Electricity and the Development of Renewables-Based Electric Power: Lesson from Europe, Bahar; Sauvage, 2013
4	Delivering Efficient European Networks: Position of the Agency for the Cooperation of Energy Regulators on improving the efficiency of the European framework for energy infrastructure development, ACER 2013
5	Electricity Transmission Tariffs in the Nordic Countries: An Assessment of Pricing Rules 2009
6	Energy Integration- Creating a South Asian regional electricity market, Power Line, Rajesh K. Mediratta, Director, IEX, 2016
7	EUPHEMIA Public Description PCR Market Coupling Algorithm, PCR PX's, 2016
8	International Experience with Cross-Border Power Trading, Castalia, 2009
9	Italian Borders Market Coupling Consultation Paper, 2014
10	Market Evolution: Wholesale Electricity Market Design for 21st Century Power Systems, NREL 2016
11	Guidelines on Cross Border Trade of Electricity, Ministry of power, Government of India, 5th December 2016
12	Regional Power Integration: Structural and Regulatory Challenges, ESMAP, 2011
13	Task Force-3 Report on "Assessment and recommendation of commercial terms and conditions for CBET and suggesting model for PX in South Asia region, 2016
14	The Potential of Regional Power Sector Integration, Central American Electric Interconnection System (SIEPAC) I Transmission & Trading Case Study, March 2010
15	The Potential of Regional Power Sector Integration, Economic Consulting Associates, 2010

ABOUT SARI/EI

Over the past decade, USAID's South Asia Regional Initiative/Energy (SARI/E) has been advocating energy cooperation in South Asia via regional energy integration and cross border electricity trade in eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Pakistan, Nepal, Sri Lanka and the Maldives). This fourth and the final phase, titled South Asia Regional Initiative for Energy Integration (SARI/EI), was launched in 2012 and is implemented in partnership with Integrated Research and Action for Development (IRADe) through a cooperative agreement with USAID. SARI/EI addresses policy, legal and regulatory issues related to cross border electricity trade in the region, promote transmission interconnections and works toward establishing a regional market exchange for electricity.

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For more information on the South Asia Regional Initiative for Energy Integration (SARI/EI) program, please visit the project website:

www.sari-energy.org