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Are there common features across Electricity Exchanges?

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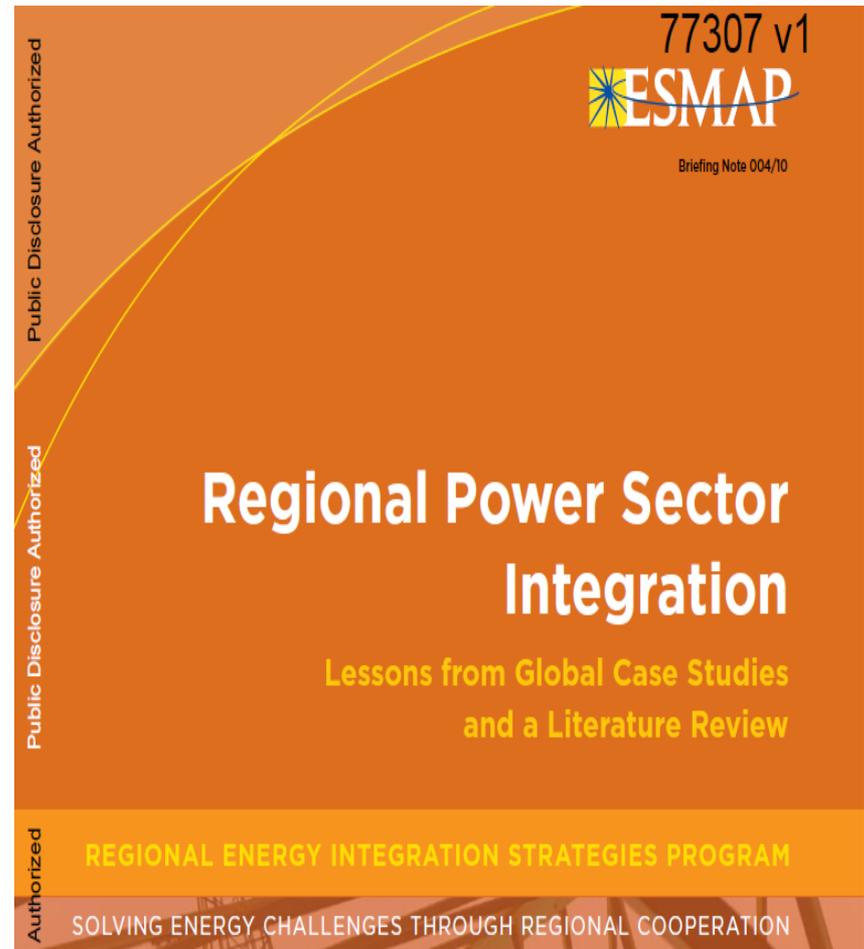
Overview

- World Bank-ESMAP Study (2010)
- Different drivers for electricity exchanges
- Different models for regional integration and paths towards it
- Lessons learned

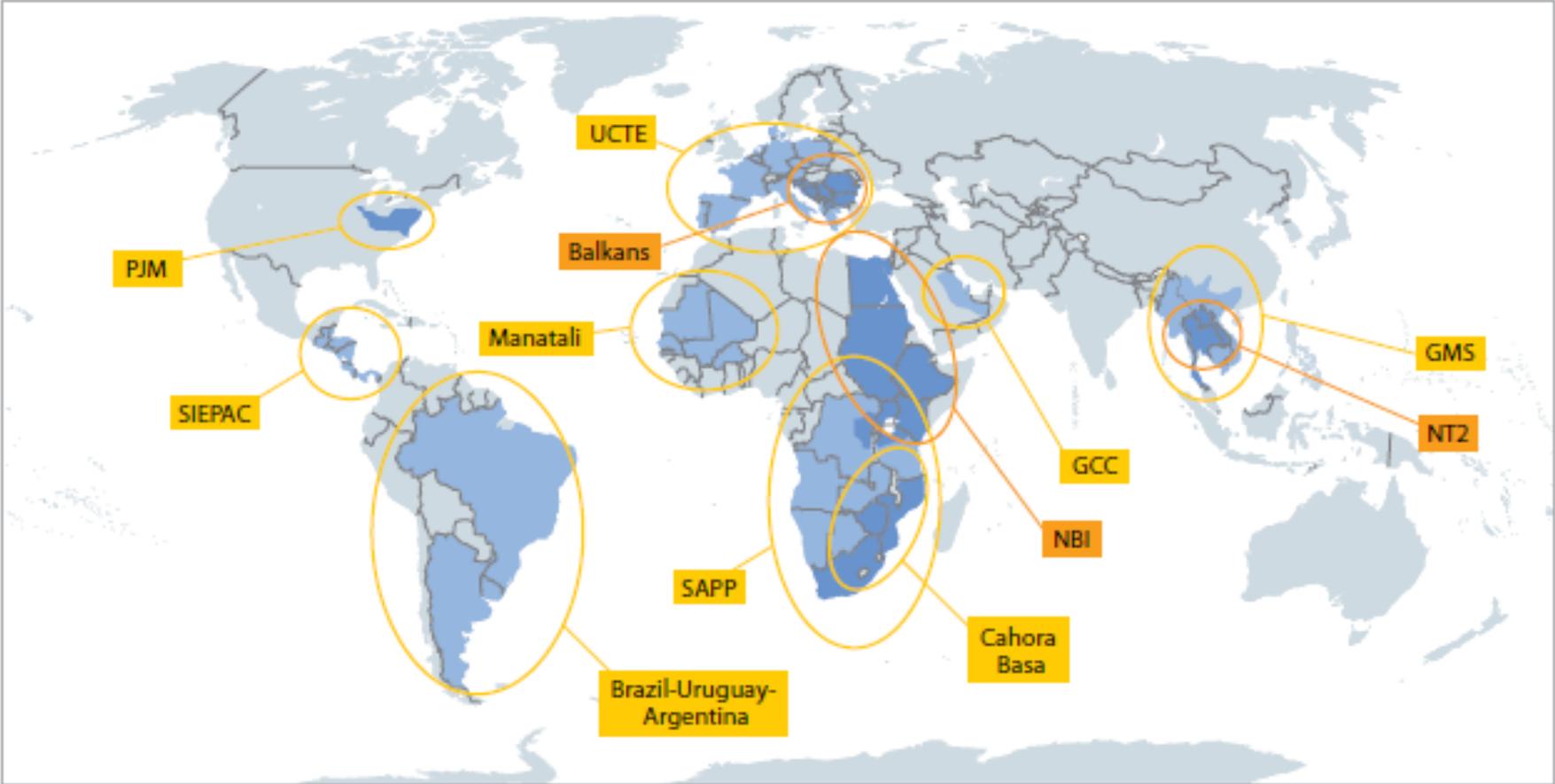
World Bank-ESMAP Study (2010)

Case studies of 12 Regional Power System Integration (RPSI) projects and how they are dealing with key aspects of RPSI, such as:

- Finding the right level of integration
- Optimizing investment on a regional basis
- Appropriate regional institutions
- Technical and regulatory harmonization
- Power sector reform and integration
- The role of donor agencies
- Reducing emissions through RPSI
- RPSI and renewable energy



Case Studies



Key Characteristics of the Case Studies

SCHEME	YEAR	# PARTICIPANTS	MW	GWH PA	MAX TRADE %	PSP ¹	TRADE AGREEMENTS
TRANSMISSION & TRADE							
GMS	1971 (1995)	6	88,000	366,000	1%	✓	Bilateral
SAPP	1995	12 (9)	46,000	274,000	7%		STEM, now DAM
Argentina-Brazil	2000	2 (3)	125,000	480,000	13%	✓	Bilateral
SEE	2005	9	43,600	183,000	14%	✓	EU single market
SIEPAC	2010	6	9,700	32,000		✓	MER regional market
GCC	2010	6	73,000	290,000			Spinning reserve
NBI	2010	9	27,400	142,000			Bilateral
GENERATION							
Cahora Bassa	1977 (1997)	3	2,075	13,000			Bilateral
Manantali	2002	3	200	767			Bilateral
NT2	2009	2	1,070	5,636	100%	✓	Bilateral
DEVELOPED COUNTRIES					10%		
PJM	1927	14	163,500	700,000		✓	Multiple markets
UCTE/ENTSO-E	1951	24 (29)	672,000	2,300,000		✓	EU Single Market

¹ Private sector participation.

Diverse Motivations in the Regional Power Case Studies

Scheme	Motivations/Objectives	Comments
TRANSMISSION & TRADE		
GMS	Efficient, environmentally sound development of the power sector to aid economic growth; support to regional projects and electricity trade as means for these objectives	Planned stages: (1) bilateral export projects (well advanced); (2) trade between any pair of GMS countries; (3) interconnections expressly for trade, with third party access effective; (4) integrated, competitive regional power market (still conceptual)
SAPP	Development of a safe, efficient, reliable, and stable interconnected electrical system and of a regional power trading mechanism	Subsidiary objectives are harmonized standards and regulations (well advanced)
Argentina-Brazil	Reduce drought vulnerability of Brazil's hydropower-dominated system and expand Argentina's trading opportunities	In practice, following political and economic crisis in Argentina and suspension of electricity exports, power flows have been from Brazil to Argentina (and also to Uruguay), but the system is fulfilling its energy security purpose
SEE	Create a regionally integrated electricity market, forming part of the wider EU single market	Political commitment to join the EU provides motivation for aligning with EU energy directives; economies-of-scale and access to lower-cost regional resources also a consideration for generation and transmission investment
SIEPAC	Create an integrated regional electricity market in Central America	Regional market seen as means to improve efficiency, security of supply, lower costs, attract foreign investment, and contribute to economic development
GCC	Share reserve capacity, thereby reducing generation investment requirements	Shared reserves is effective; trade in electricity is still under development
NBI	Ensure coordinated power investment in Nile Basin to meet social and economic development objectives in the region	The power integration component is part of a broader scheme for the optimized management of water in the Nile Basin with irrigation as the main concern

Diverse Motivations in the Regional Power Case Studies

Scheme	Motivations/Objectives	Comments
GENERATION		
Cahora Bassa	Import of clean power for more reliable electricity supplies in South Africa	Objectives fall within those of SAPP, but the project was initially developed on a purely bilateral basis
Manantali	Contribute to meeting the power needs and increase the efficiency and reliability of power systems in Mali, Mauritania, and Senegal	Initially, the purpose of the project was the regulation of Senegal River for irrigation purposes; power generation was a secondary aspect
NT2	For Lao PDR, revenues from hydropower exports; for Thailand, access to cost competitive and diversified electricity supplies	One of a number of Lao PDR-Thailand hydro-power projects in operation or under development

Levels of Regional Power Sector Integration

Area of Regional Cooperation	Inter-connectivity	Trading Arrangements	Harmonization	Planning and Investment	Case Study Examples
Interconnection	Typically starts with two countries, later a wider interconnected grid	Long-term bilateral PPAs	Simple rules agreed for the operation of the interconnected system	National planning and investment	Cahora Bassa, Manantali, NT2, GMS, Argentina-Brazil, GCC
Integration—shallow	Interconnected grid involving a number of neighboring countries	Long-term PPAs supplemented with short-term markets	Harmonization of rules, grid codes, and transmission tariff	Some coordination of national investments with optimized regional investment plan	SAPP, SIEPAC
Integration—deep	Full synchronous operation of a multi-country interconnected system	Competition achieved through a range of markets (spot, day ahead, transmission capacity auctions, etc.)	Regional regulatory agencies, systems, and market operators	Regional integration body empowered to require investments in agreed regional plan to be implemented*	PJM, UCTE, SEE

Note: Schemes exhibiting some, but not all, deep integration characteristics are shown in *italics*.

* Full delegation of powers to enforce regional investment plans is yet to be made in any scheme.

Levels of Regional Power Sector Integration

- There are many levels and types of RPSI:
 1. Simpler forms of interconnection, which may only include individual cross-border generation projects;
 2. More advanced forms, which may include some combination of unified multinational power markets, technical and regulatory harmonization, a single power exchange, high interconnection levels, regional coordination of investment, and competition across borders with few impediments.
- Full integration of multiple national electricity systems into a regional electricity market offers the greatest benefits from RPSI. Few regions have achieved this as yet; Nordpool in Scandinavia is probably the closest.
- Substantial benefits can still be achieved at all levels of RPSI. Simple interconnections between national systems and one-off, cross-border electricity trade projects can offer substantial benefits, and countries may be content to stay at this or other intermediate levels of integration.
- Moving from no integration to full integration can take decades, but moving from intermediate to higher levels of integration can be relatively rapid. The rate at which progress is made towards full power sector integration depends on many factors, including the institutional capacity of participating countries.

OPTIMIZATION OF INVESTMENT ON A REGIONAL BASIS

- The optimization of generation and transmission investment on a regional rather than a national basis can offer substantial cost reductions.
- These cost reductions often go unrealized when countries follow national priorities, including domestic energy supply security, economic nationalism, and sovereignty concerns.
- Recognizing as legitimate and appropriately addressing these and other important national priorities is essential to achieving regional investment optimization and the full benefits of RPSI. Approaches for achieving this will differ depending on local circumstances and the combinations of planning and market forces that drive investment decisions.
- With the exception of PJM, none of the regions studied implement mandatory regional planning although several encourage the use of indicative regional plans with buy-in from politicians to ensure commitment to delivering these.
- Explicit mechanisms to share benefits, such as allocating shares in crossborder projects, may help overcome reluctance to implement regional plans.

REGIONAL INSTITUTIONS

- There are typically are of two main forms of regional institutions:
 1. Special purpose vehicles (SPVs): a corporate structure established to execute and operate a specific regional project (such as a large export-oriented hydropower plant).
 2. Regional bodies: groups charged with deepening RPSI through working with governments, regulators, and utilities from member countries on an on-going basis. Examples would include power pools and their secretariats, regional regulators (or regional associations of national regulators), and regional transmission/system/market operators.
- Regional institutions are vital for RPSI but there is no single institutional form that is appropriate for all regional power integration schemes.
- The strongest institutions are those that grow organically from local initiatives rather than imposed from outside. Opportunities to build on existing arrangements should be explored before creating new institutions.
- SPVs provide a good model for projects serving multiple country markets.

TECHNICAL AND REGULATORY HARMONIZATION

Harmonization refers to establishing common norms and rules in technical, economic, and legal matters pertaining to RPSI:

- **Technical**—rules and procedures assuring access to and stable operation of interconnected transmission systems;
- **Economic**—rules for the operation of markets or for the adjustment of tariffs where prices are regulated;
- **Legal**—agreed common procedures and mechanisms for the resolution of disputes.
- Harmonization of technical standards is needed to avoid endangering or loading excessive costs onto neighbouring systems.
- Harmonization of relevant economic regulations among participating countries is not a prerequisite for initial levels of RPSI, but is increasingly required as cross-border competitive power trade develops.
- Deepening RPSI will require a gradual move towards uniform approaches by national regulators, creating a common regulatory framework for regional markets or possibly some form of ‘regional regulator’ with discretionary powers in the regional market.



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