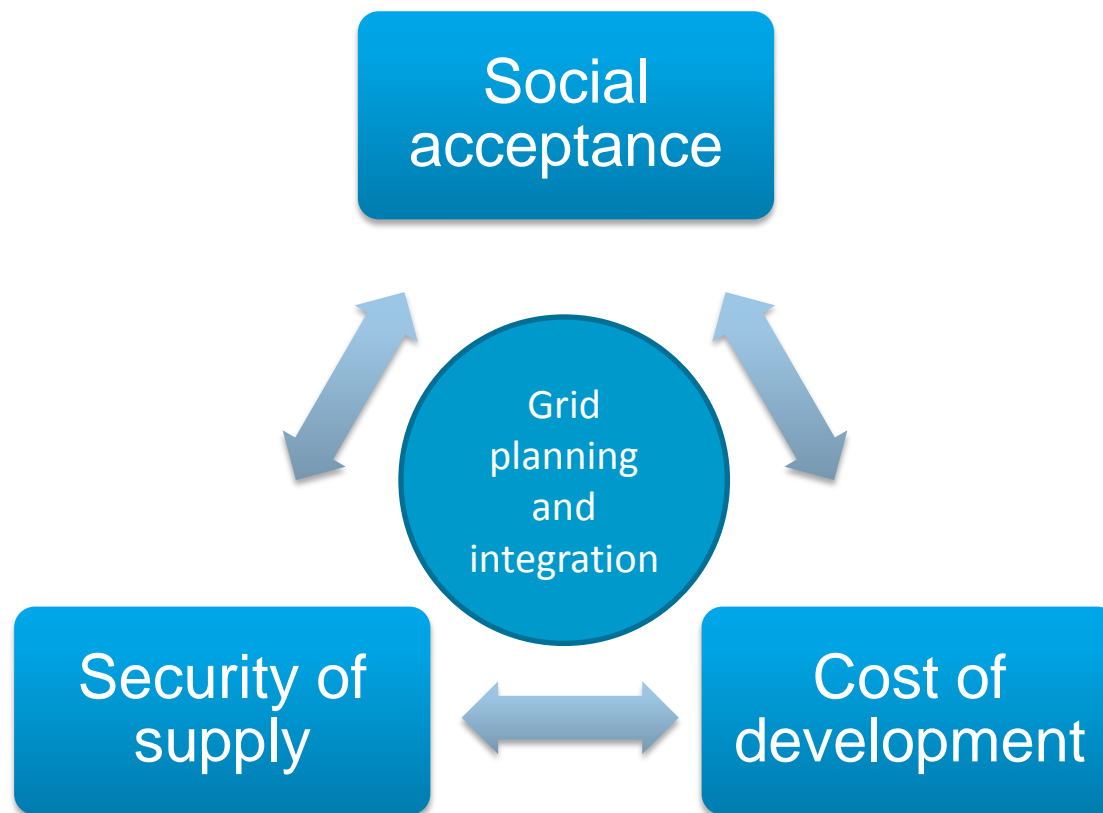# Global experiences in cross-border power system integration

Matthew Wittenstein
Electricity Analyst, IEA
HAPUA-UNESCAP Workshop, 17-19 April 2017, Jakarta

Power systems planners must balance competing goals
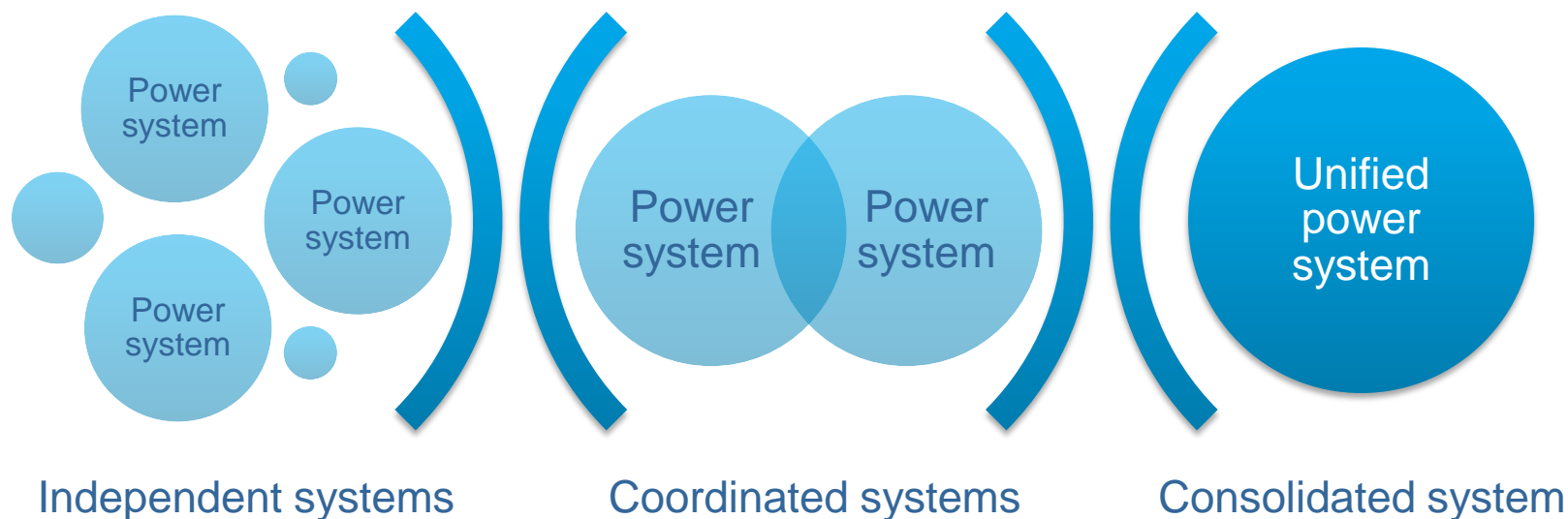
The Energy Trilemma

Effective transmission planning and regional integration can help resolve the energy trilemma, especially when other technology options are limited.
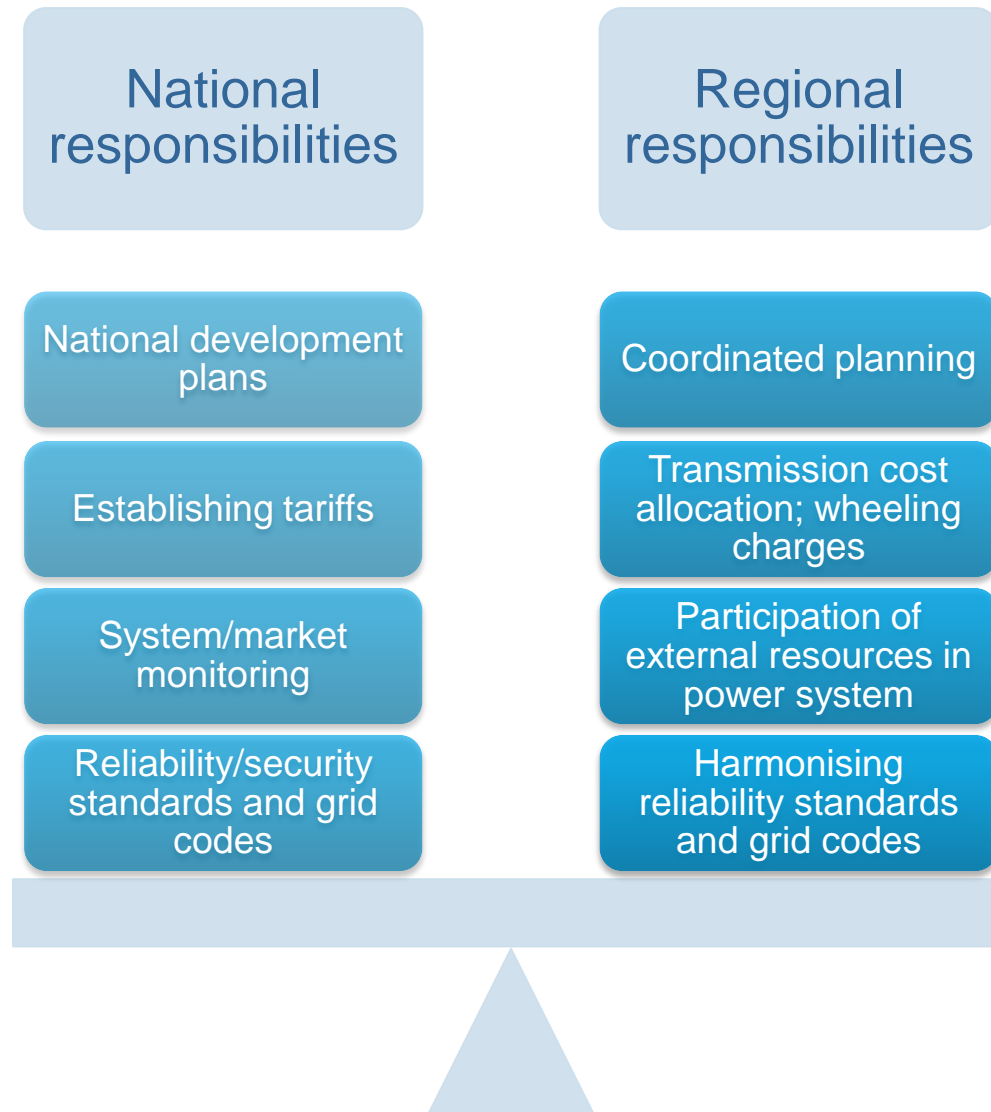
Regional integration: a matter of degree

"If you want to go fast, go alone; if you want to go far, go together."

Independent systems   Coordinated systems   Consolidated system

Consolidated systems are best able to meet the <u>technical</u> requirements of decarbonisation, but require strong <u>jurisdictional</u> alignment. Coordinated systems require significant <u>harmonisation</u>, ideally supported by regional institutions.

What role for institutions in an interconnected world?

National responsibilities	Regional responsibilities
National development plans	Coordinated planning
Establishing tariffs	Transmission cost allocation; wheeling charges
System/market monitoring	Participation of external resources in power system
Reliability/security standards and grid codes	Harmonising reliability standards and grid codes

Different models for regional institutions

Loose cooperation
- ASEAN Energy Regulators Network
- MedReg (Mediterranean region)
- NordReg (Nordic Region)

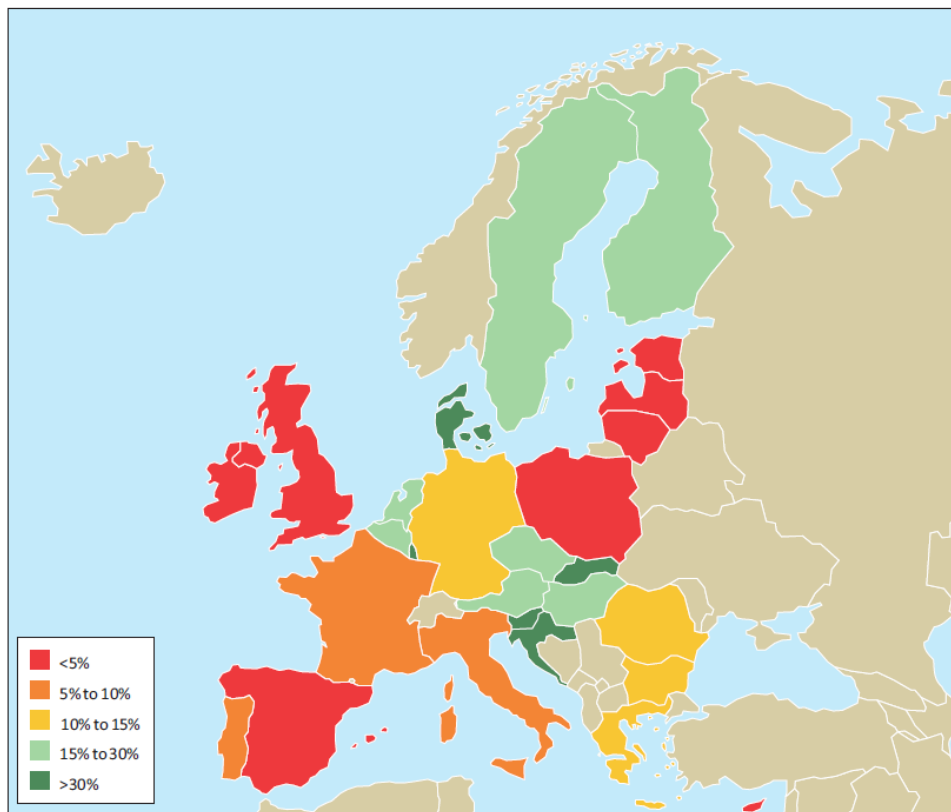**Limited regional authority**
- ACER (EU)
- CRIE (Central America)

Strong regional authority
- FERC (US)
- NERC (North America)
- CERC (India)

EU power system integration: an ever closer union

Interconnection level assuming all Projects of Common Interest (PCIs) are completed

Legend:
- <5%
- 5% to 10%
- 10% to 15%
- 15% to 30%
- >30%

This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

The EU goal of a single, Internal Energy Market (IEM) is driven by a "market first" approach: free movement of goods, people, capital... and electrons.

# Benefits of power system integration: increased reliability

Loss of Load Expectation in 2020 for isolated systems and integrated regions (EU)
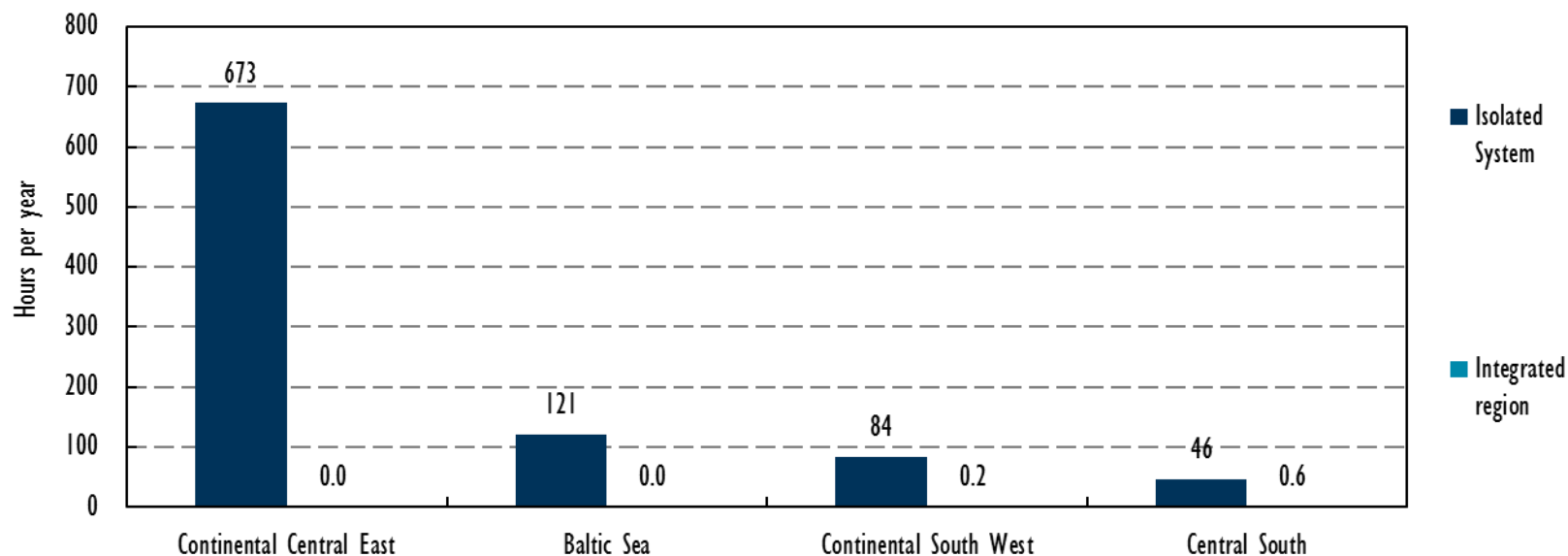
Historically, cross-border power sector integration often starts with the sharing of primary reserves.

Source: ENTSO-E

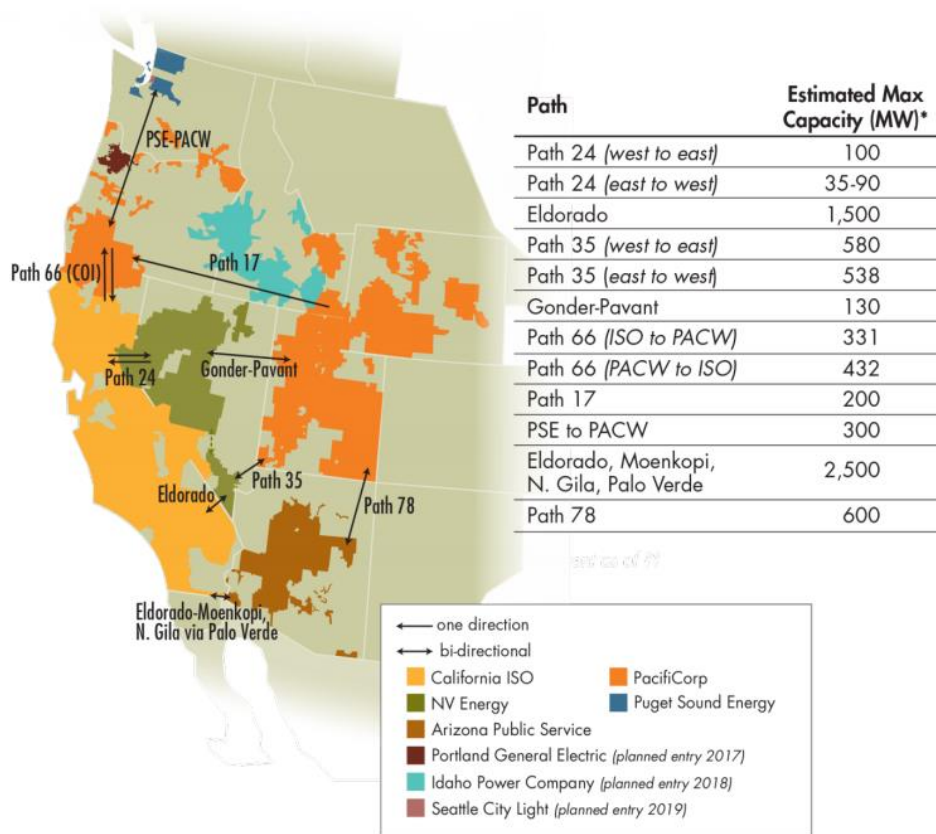# North America: overlapping jurisdictional boundaries

North American Electric Reliability Corporation (NERC) regions
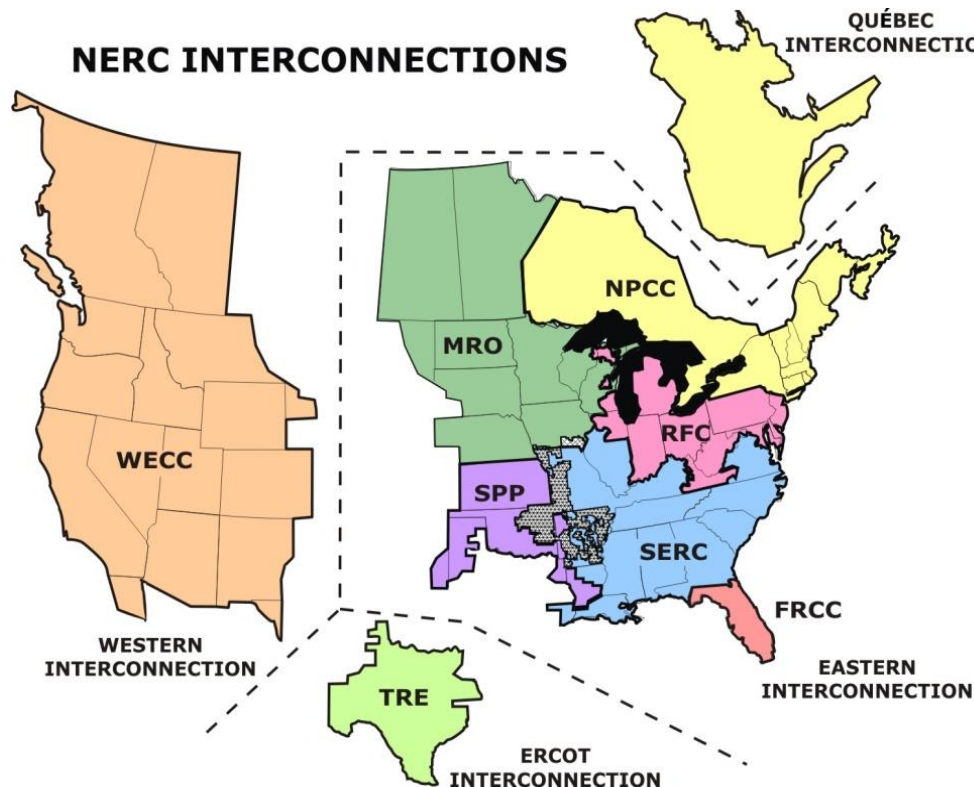
North America has many (at times overlapping) jurisdictional boundaries. Reliability standards have evolved from voluntary to mandatory.

US power system integration: economics and environment

Western Energy Imbalance Market (WEIM)

Path	Estimated Max Capacity (MW)*
Path 24 (west to east)	100
Path 24 (east to west)	35-90
Eldorado	1,500
Path 35 (west to east)	580
Path 35 (east to west)	538
Gonder-Pavant	130
Path 66 (ISO to PACW)	331
Path 66 (PACW to ISO)	432
Path 17	200
PSE to PACW	300
Eldorado, Moenkopi, N. Gila, Palo Verde	2,500
Path 78	600

Legend:
- one direction
- bi-directional
- California ISO
- PacifiCorp
- NV Energy
- Puget Sound Energy
- Arizona Public Service
- Portland General Electric (planned entry 2017)
- Idaho Power Company (planned entry 2018)
- Seattle City Light (planned entry 2019)

- Markets are already well interconnected, but rising VRE is driving deeper integration
- WEIM is a voluntary market, with CAISO as market operator
  - CAISO organizes market and, therefore, takes on regional responsibilities
- Economic and environmental benefits are real and significant
  - USD 143 million saved (2014-16)
  - 10 000 tonnes of avoided CO_2
  - Reduced reserves requirements (btw 400 and 500 MW)
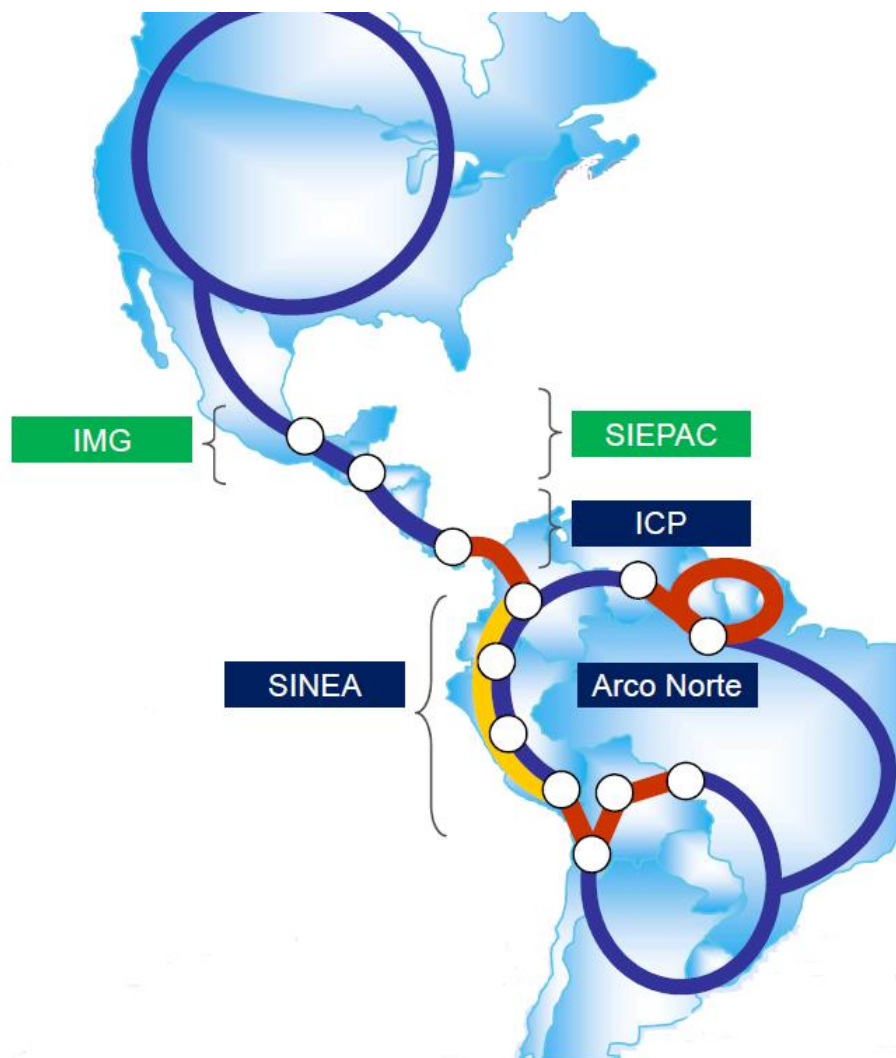
Source: CAISO

Central America: developing the SIEPAC line

SIEPAC system and annual trade volumes (2016)
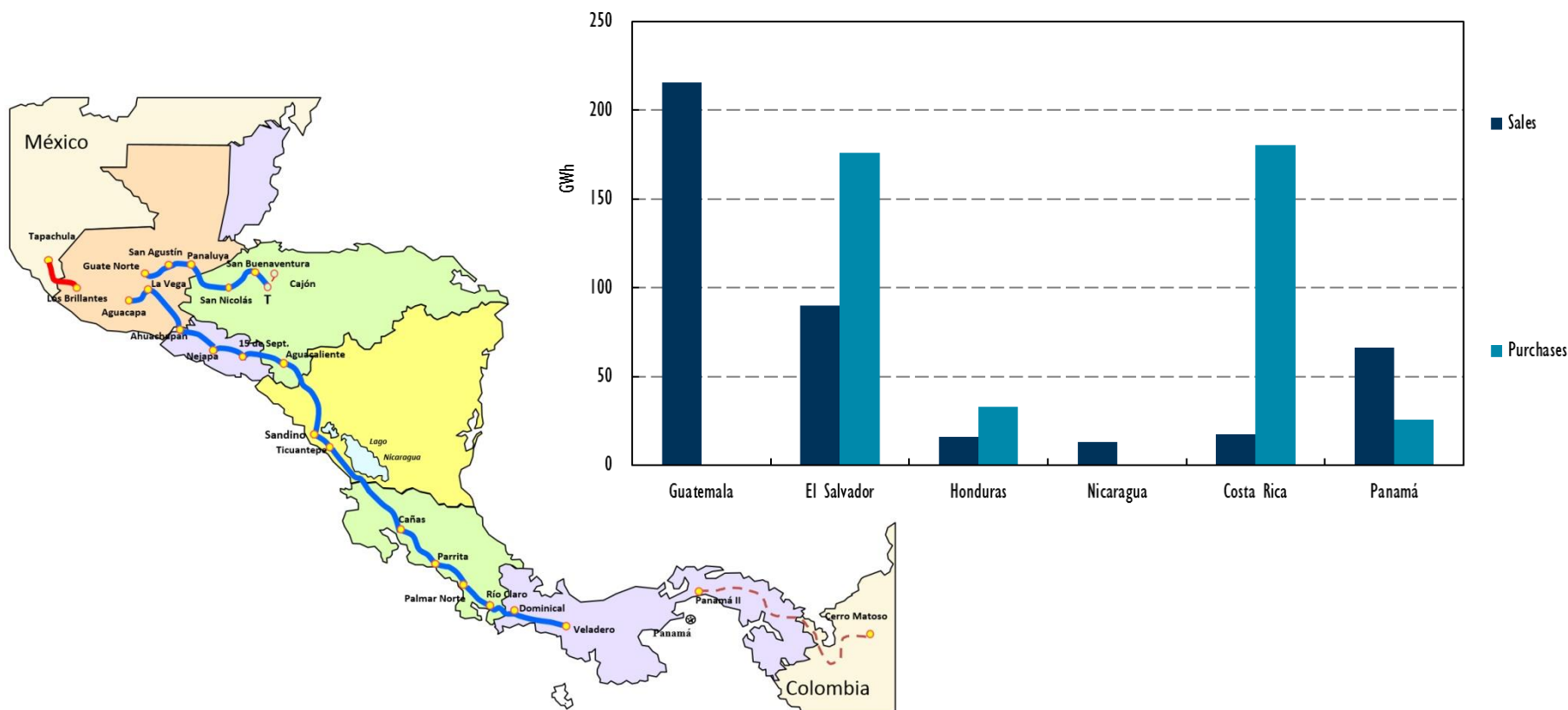
SIEPAC development and trade is supported by a number of regional institutions: CRIE (regulator); EOR (system operator); EPR (transmission owner); CDMER (economic development). Imports are a small % of domestic consumption.

Latin America: an electricity superhighway?

Regional initiatives in South America

Country	SINEA - CAN	UNASUR	ALADI	MERCOSUR
Argentina		●	●	●
Bolivia	●	●	●	●
Brazil		●	●	●
Chile	●	●	●	
Colombia	●	●		
Cuba			●	
Ecuador	●	●	●	
Mexico			●	
Guyana		●		
Panama			●	
Paraguay		●	●	●
Peru	●	●	●	
Suriname		●		
Uruguay		●	●	●
Venezuela		●	●	●

Source: ISA ETESA, IEA research

Summary: lessons for ASEAN

- **Regional integration can help resolve the "energy trilemma"**
  - Economics, security and environment
- **Integration is a matter of degree**
  - No one path, but clear direction helps
- **Need to consider relevant jurisdictional boundaries**
  - Political, geographic, technical
- **Of crucial relevance: the boundaries of *decision making***
  - Are roles and responsibilities clearly defined?
  - Is decision making free of outside influence?
  - Are decisions enforceable?

Thank you

Electricity Security Across Borders

Case Studies on Cross-Border Electricity Security in Europe

Matthew Wittenstein
Jesse Scott
Noor Miza Muhamad Razali

matthew.wittenstein@iea.org