




REGULATORY STUDIES – LOTS 1 AND 2

ECOWAS Regional Electricity Regulatory Authority

Workshop on Tariff Methodology

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Accra, 5 April 2013

ARTELIA

PPA energy

SUMMARY

1) Introduction to alternative approaches for calculation of wheeling charges
2) Review of international practices
3) Review of transmission charges within and between ECOWAS countries
4) Review of reports on transmission pricing prepared for WAPP
5) Possible implementation models for ECOWAS
6) Feedback from ERERA / Proposed next steps

PROGRAMME FOR TODAY

08:30 – 10:30	Introduction to alternative approaches for calculation of wheeling charges: • Postage stamp • MW km • Nodal pricing
10.30 - 10.45	COFFEE BREAK
10:45 – 11:45	Review of international practices
11:45 – 12:45	Review of transmission charges within and between ECOWAS countries
12.45 – 14.00	LUNCH
14:00 – 15:00	Review of reports on transmission pricing prepared for WAPP
15:00 – 15:45	Possible implementation models for ECOWAS
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16:00 – 17:00	Feedback from ERERA / Proposed next steps
17:00	*CLOSING CEREMONY*

THE NETWORK CONTEXT

TRANSMISSION PRICING - PRINCIPLES

- Promote efficiency
- Recover costs
- Be transparent, fair and predictable
- Be non-discriminatory

PROMOTES EFFICIENCY

- Appropriate price signals to generation and demand
- Incentives for appropriate investment –locational signals
- Promotes competition

1)

RECOVERS COST

- Security in cost recovery ⟹ Lowered cost of capital
- Incentives for appropriate investment
  - if recovery of cost for appropriate investments is assured
- Different methods available for cost computation
- Historic cost, Future cost (nodal pricing)
- Transmission prices can recover
  - capital costs
  - O&M costs
  - losses
  - congestion

BE TRANSPARENT, FAIR AND PREDICTABLE

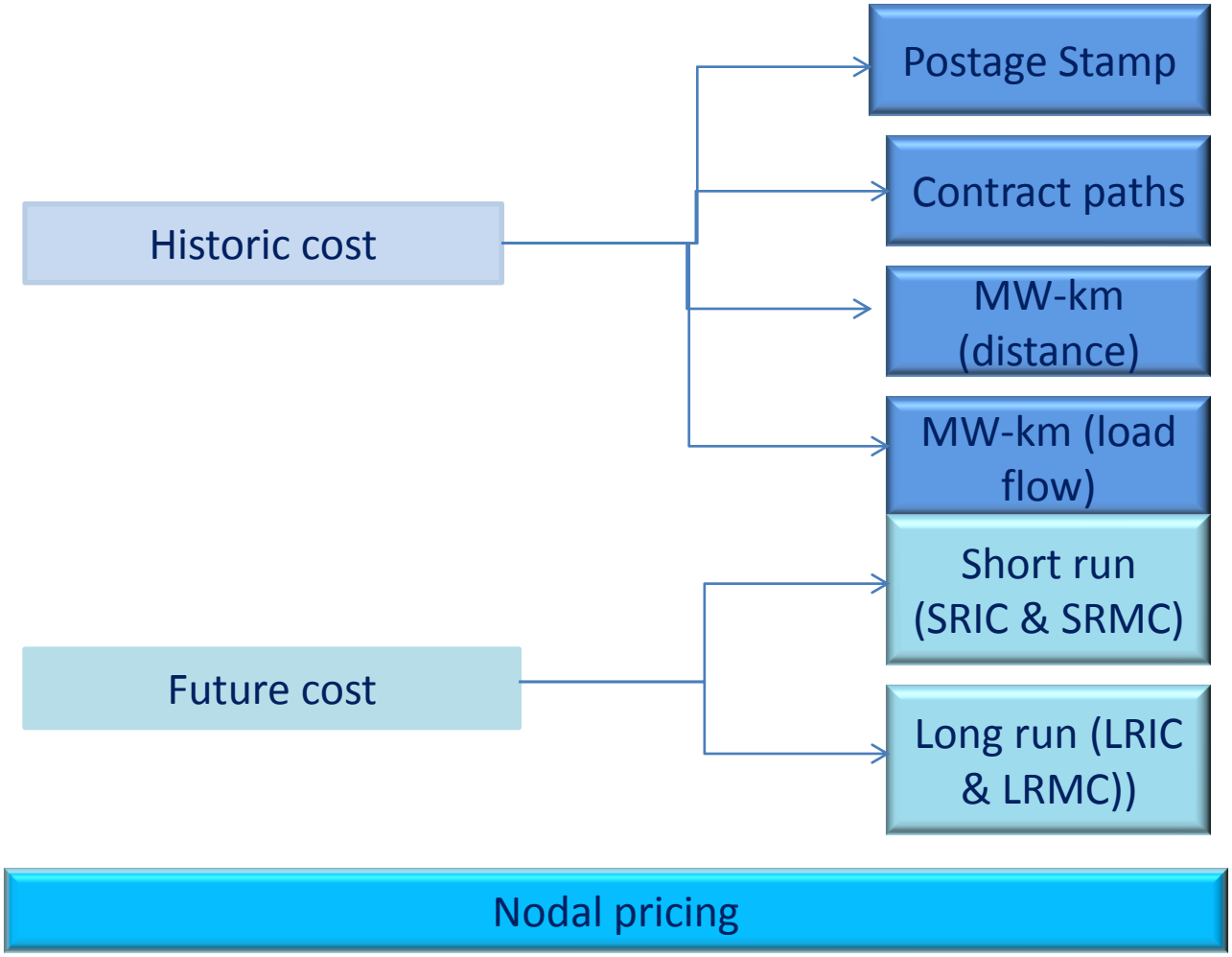
- Encourage new market participants
- Fair
- Stable- immune to ‘price shocks’
- Clear and straightforward to apply

BE NON - DISCRIMINATORY

- Treat the network users equally in non discriminating nature.

- Residual costs are allocated in a fair manner
  - Key issue: balance between local and “international wheeling” costs

SUMMARY OF TRANSMISSION PRICING METHODS



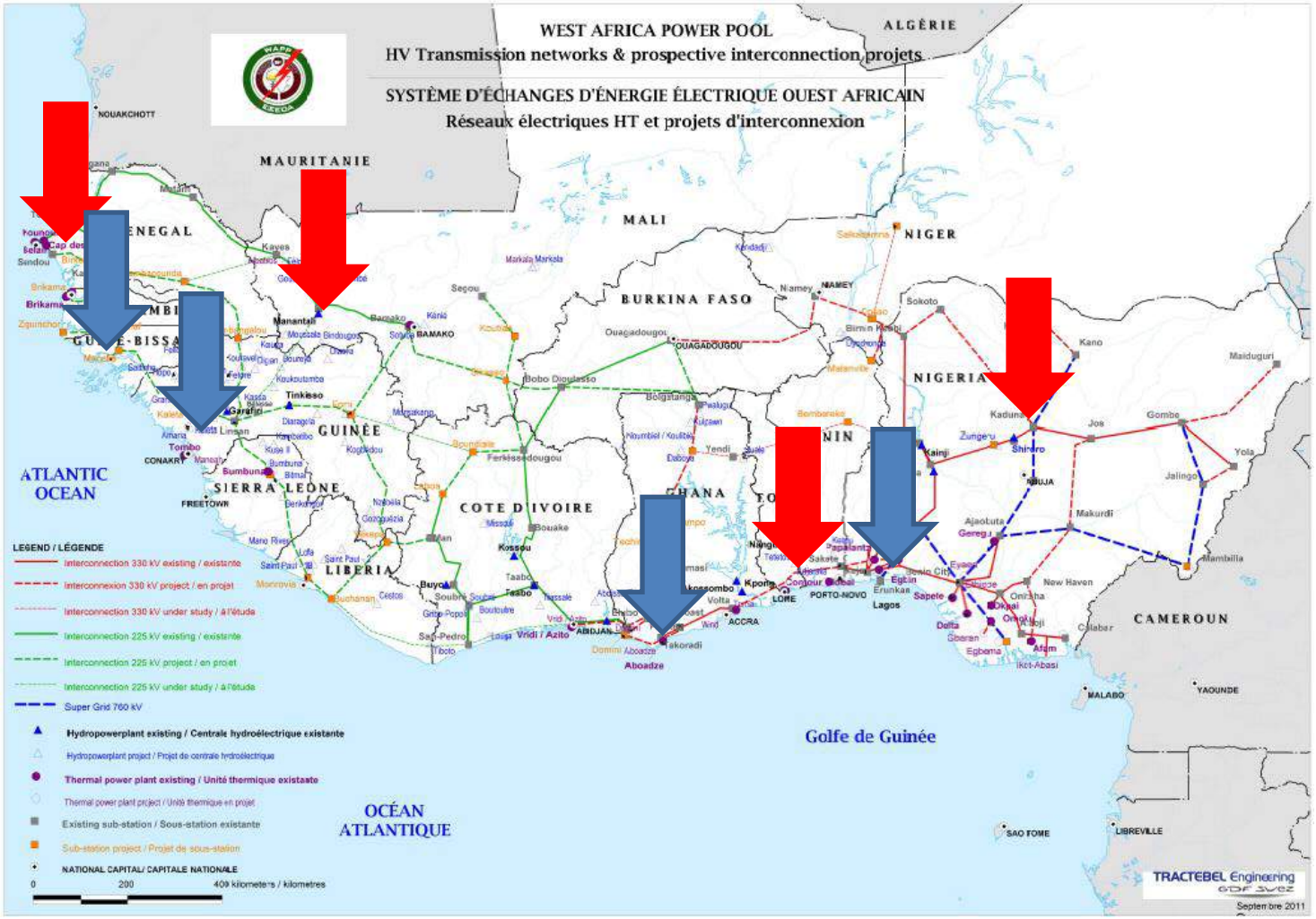
HISTORIC COSTS – POSTAGE STAMP

- Method
  - Costs based on the specific path agreed for an individual wheeling transaction.
- Advantages
  - Full historic cost recovery encouraging efficient level of investment
  - simple, stable charges
  - An improved ability to signals the costs of decisions of individuals
- Disadvantages
  - Does not take into account of utilisation of system, lack of incentive for system users
  - Potentially discriminates between users
  - Low economic efficiency as it may lead to investments out of contract path as well.

EXAMPLE:GENERATION IN MALI, DEMAND IN NIGERIA

1)

POSTAGE STAMP METHODOLOGY



HISTORIC COSTS – CONTRACT PATHS

- Method
  - Costs based on the specific path agreed for an individual wheeling transaction
- Advantages
  - Full historic cost recovery encouraging efficient level of investment
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- Disadvantages
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  - Low economic efficiency as it may lead to investments out of contract path as well

CONTRACT PATHS

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CONTRACT PATHS

HISTORIC COSTS: MW-KM (DISTANCE BASED)

- Method
  - Distance travelled by the energy in a specific transaction (MW-km) in relation to the total MW-km in the system
- Advantages
  - An improved version of postage stamp and contract path approaches
- Disadvantages
  - Does not take into account of system costs and actual operation in the system
  - Does not provide accurate economic signals to users

MW-KM (DISTANCE BASED)

HISTORIC COSTS: MW-KM (LOAD FLOW BASED)

- Method
  - Uses power flow model, hence reflects to a better extent, the actual use of the system.
  - Transmission prices reflect the proportion of system use.
- Advantages
  - An improved version of postage stamp and contract path approaches.
  - Simple, clear, stable charges
  - System congestion is starting to be taken into account
- Disadvantages
  - As power flows are less than circuit capacity fails to recover full capital costs.
  - Does not provide correct economic signals to users for future investments.

MW-KM (FLOW-BASED)

FORWARD LOOKING – SHORT RUN PRICING

- SRIC (Short Run Incremental Cost)
  - Short run incremental operating cost
  - Uses a model of optimal power flows
- SRMC (Short Run Marginal Cost)
  - The marginal cost of extra use of transmission system
  - The marginal operating cost of an extra MW
- Disadvantages of short run methods
  - Difficult to estimate the operating cost of a single transaction while multiple transactions are occurring simultaneously
  - Requires future forecasting , the accuracy of which can become decreasingly accurate
  - Data volatility in the short run can result in under investment
  - Additional disadvantages of SRMC method

FORWARD LOOKING – LONG RUN PRICING

- LRIC and LRMC (Long Run Incremental Cost and Long Run Marginal Cost)
  - Both take into account of investment cost, in addition to incremental operating cost
  - Full long term costs including new investments
  - More stable prices compared to short run

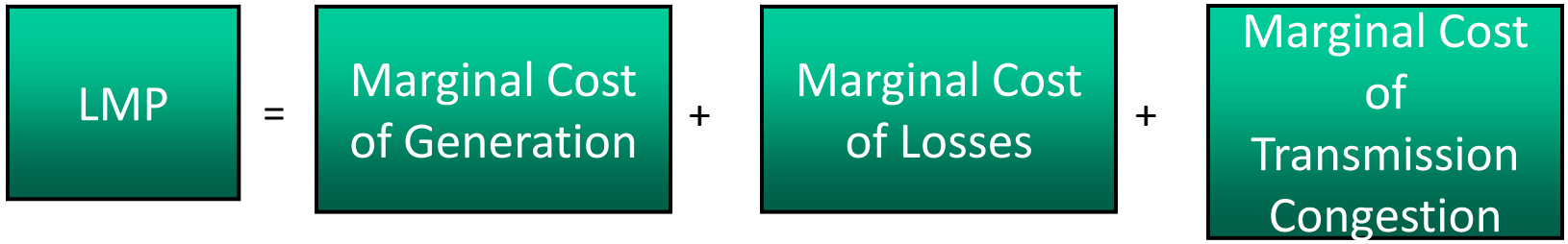
- Disadvantages of long run methods
  - Difficult to estimate the operating cost of a single transaction while multiple transactions are occurring simultaneously
  - Double counting of investment requirements

NODAL

- Node is typically a substation
- Generators and loads connecting at a node will have the same energy price, energy price at the node will depend on congestion on the transmission lines
- Each node has its transmission and losses charge for loads and generators depending on flow on lines towards or out of substation, these are the marginal costs and depend on the whole network

LOCATIONAL MARGINAL PRICE (LMP)

- A Locational Marginal Price is the cost of serving the next MW of load at a given location (node)
- LMPs are formulated using a security constrained dispatch and the marginal costs of supply are based upon participant offers and bids
- LMP consists of three components:



Source IMO Ontario www.theimo.com

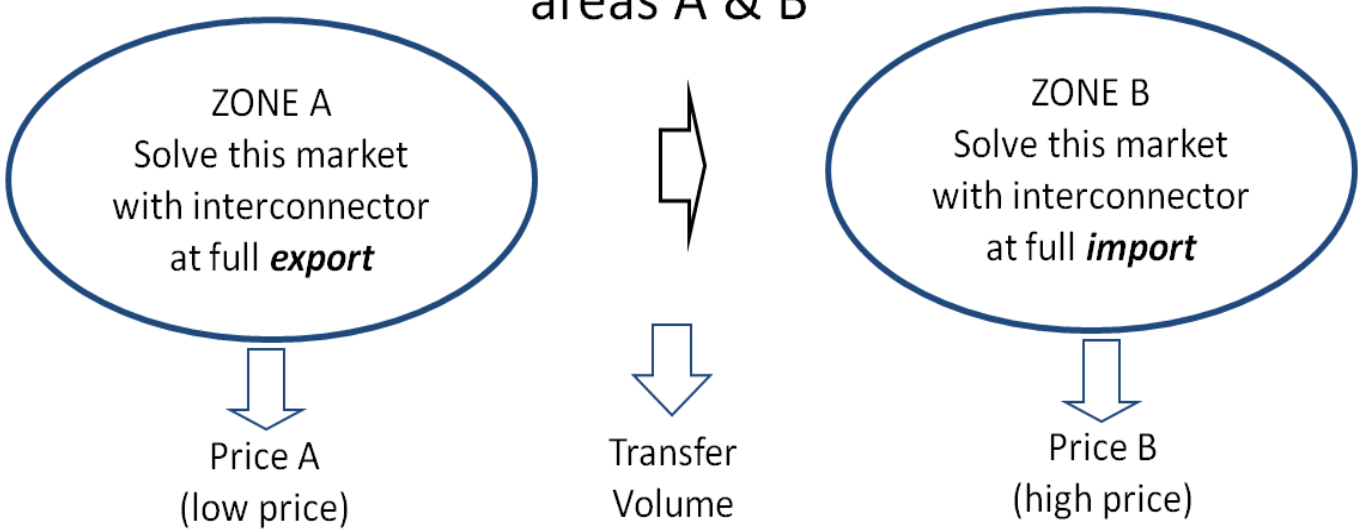
NODAL PRICING

- Method
  - Nodal charges vary at nodes depending on marginal cost of losses and congestion at that node
- Advantages
  - Economically ideal transmission prices
  - Ensures optimal dispatch thus maximizing allocative and dynamic efficiency
- Disadvantages
  - Possible under recovery of fixed costs due to marginal pricing
  - Requires constant real time information about loads, generators, bids and condition of the equipment
  - Potential Instability and complexity in methodology implementation

NODAL PRICING

CONGESTION MANAGEMENT

Market Splitting to manage congestion constraint between areas A & B



Congestion Price = (Price B – Price A)

Congestion Rent = Congestion Price * Transfer Volume

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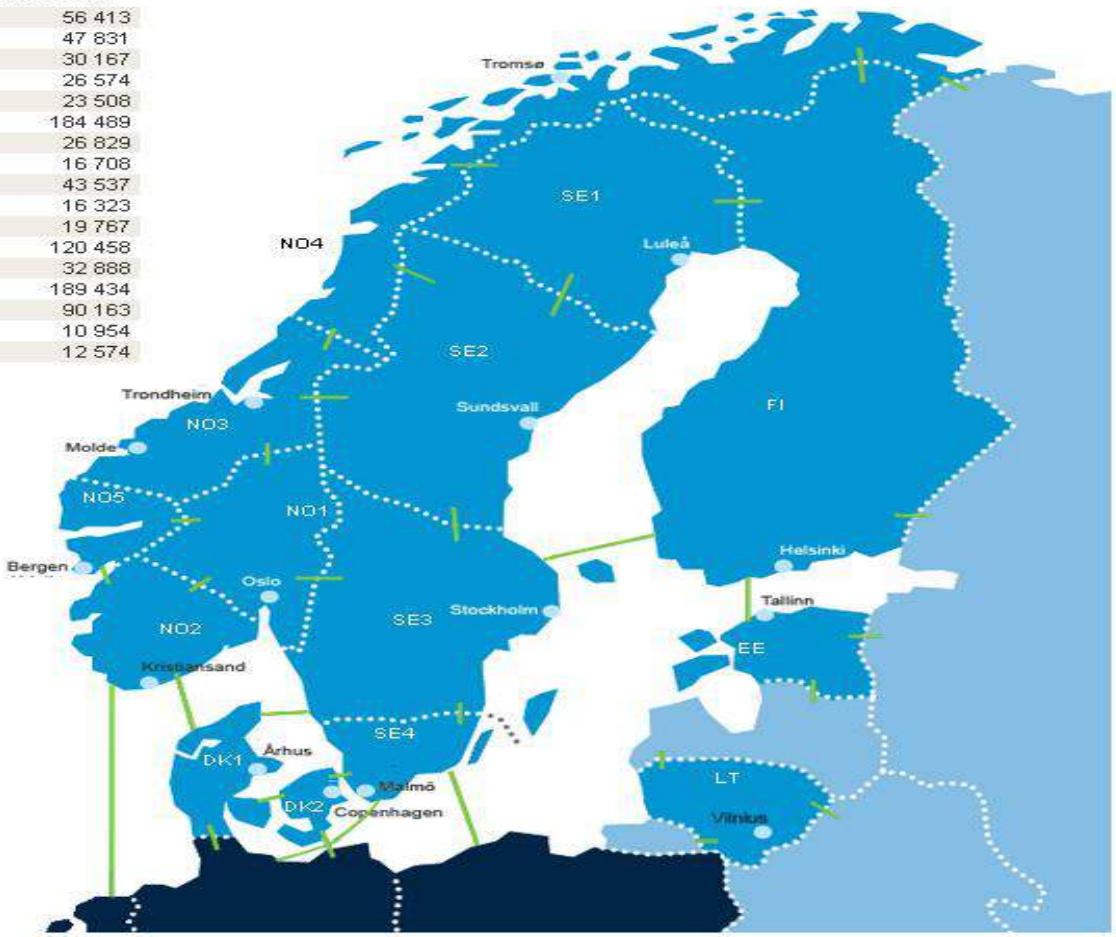
TRANSMISSION PRICING – INTERNATIONAL EXAMPLES

- Nord Pool
- Europe
- Ireland
- Southern African Power Pool (SAPP)
- Great Britain
- United states: PJM
- New Zealand
- Brazil

INTERNATIONAL EXAMPLES: NORD POOL

NORDPOOL TRANSMISSION ZONES

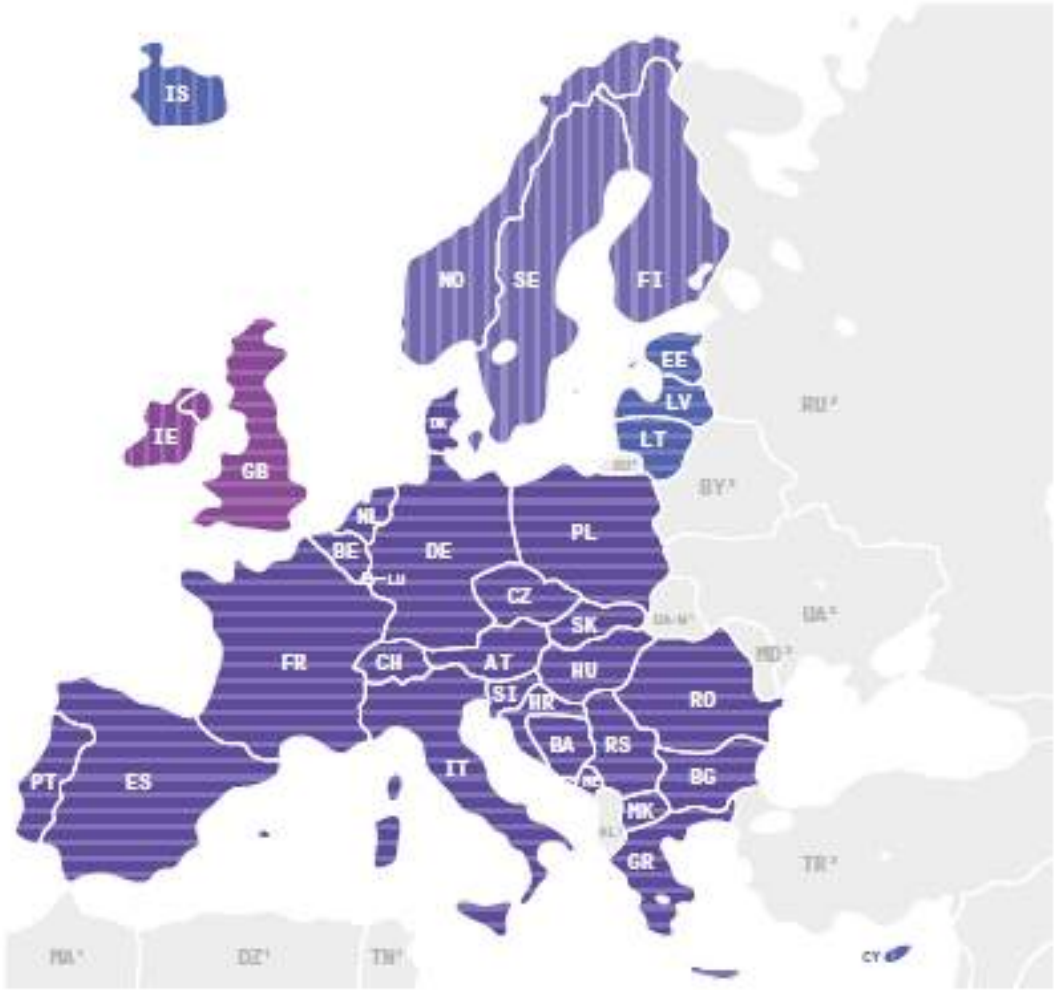
Consumption
56 413
47 831
30 167
26 574
23 508
184 489
26 829
16 708
43 537
16 323
19 767
120 458
32 888
189 434
90 163
10 954
12 574



INTERNATIONAL EXAMPLES: NORD POOL

- Nord pool covers six countries in Europe: Denmark, Finland, Sweden, Norway, Estonia and Lithuania.
- Each country has its own TSO and often has more than one market areas.
- Nord pool spot market operates 14 market areas in six countries.
- Nord pool has Point or stamp tariff system
- Producers and consumers pay a fee for the kWh injected or drawn.
- Distance between the countries does not impact the prices.
- Each country has its own transmission tariff for within the country transactions. i.e in Norway, transmission charges include fixed, load and energy components.
- Each country has a different way of allocating charges between consumers and producers.
- Transmission losses (Elspot) – recovered by a standard trading fee Eur/MWh, paid by both buyers and sellers

INTERNATIONAL EXAMPLES: EU



The European Network of Transmission System Operators for Electricity (ENTSO-E)

- The regulatory arrangements that apply across Continental Europe are implemented by national energy regulators in each member state of the European Union.
- The regulations are required to comply with policy criteria determined by the European Parliament and implemented through European Directives and Regulations.
- To assist with this process in relation to electricity networks, a number of bodies have been set up that represent regulators and transmission system operators.

ENTSO-E

- ENTSO-E represents all Transmission System Operators (TSOs) in the European Union (EU), as well as other TSOs connected to member countries.
  - This comprises 41 TSOs across 34 countries.
  - Continental Europe is one of five synchronized zone of ENTSO-E, the other synchronized zones being Irish, British (Great Britain), Nordic and Baltic.
  - There are also isolated systems in Iceland and Cyprus.

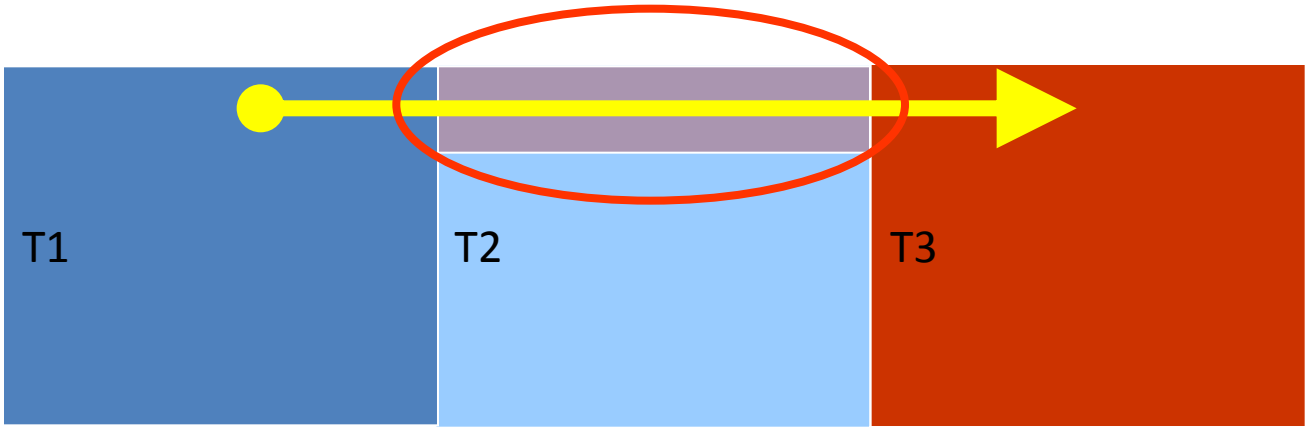
Europe: Previous Network Charges

- Internal network costs recovered by national utilities
- ETSO Cross Border Trade (CBT) Mechanism
  - Calculates compensation fund for inter-TSO transits (in 2006 valued at €370M)
  - Works by attributing costs of transits on a “horizontal network” to national TSOs based on net imports/exports
  - Values the network and losses in line with national regulatory principles

EUROPE: CBT METHODOLOGY

- Horizontal network defined
  - Those assets which have a flow >1MW in response to a transit of 100MW
- Transit flows identified
  - “Transit key” based on proportion of energy flows associated with transits rather than native demand
- Horizontal network costs identified
  - Based on agreed regulatory asset base plus losses
- Compensation fund financing
  - Contributions from “perimeter” countries @ €1/MWh
  - Contributions from national TSOs proportional to net flow

ETSO CBT EXAMPLE



- T1 and T3 would contribute to the “wheeling fund” to cover the proportion of network costs of T2 associated with the transit flow

INTER TRANSMISSION SYSTEM OPERATOR COMPENSATION (ITC)

- The ITC mechanism, based on Commission Regulation (EU) 838/2010, was implemented on 3rd March 2011.
- ENTSO-E operates the ITC mechanism, through the ITC Agreement, and the Agency for the Co-operation of Energy Regulators (ACER) oversees and reports on the implementation.
- The Regulation (838/2010) established an ITC fund to compensate TSOs for the costs incurred hosting cross-border flows.
- The fund aims to cover the cost of transmission losses and making infrastructure available, for cross-border flows.
- TSOs participating in the mechanism either contribute to the fund, or are compensated, according to their net imports / exports.

ITC METHODOLOGY

- Determine costs to recover (Compensation Fund) associated with:
  - Cross-border infrastructure – the assessment of costs should be based on **forward-looking Long Run Average Incremental Costs (LRAIC).** This method and assessment is currently under review; in the meantime a figure of EUR 100 million per year is used. (EUR 100 million)
  - Losses – based on a With and Without Transits (WWT) model and the value of losses allowed by national regulators. (EUR 125 million)

ITC METHODOLOGY (CONT)

- Determine the compensation owed to each party from the Compensation Fund according to:
  - Cross-border infrastructure – the use of two factors; Transit Factor and Load Factor. (EUR 100 million)
  - Losses – WWT model and national loss values. (EUR 125 million)

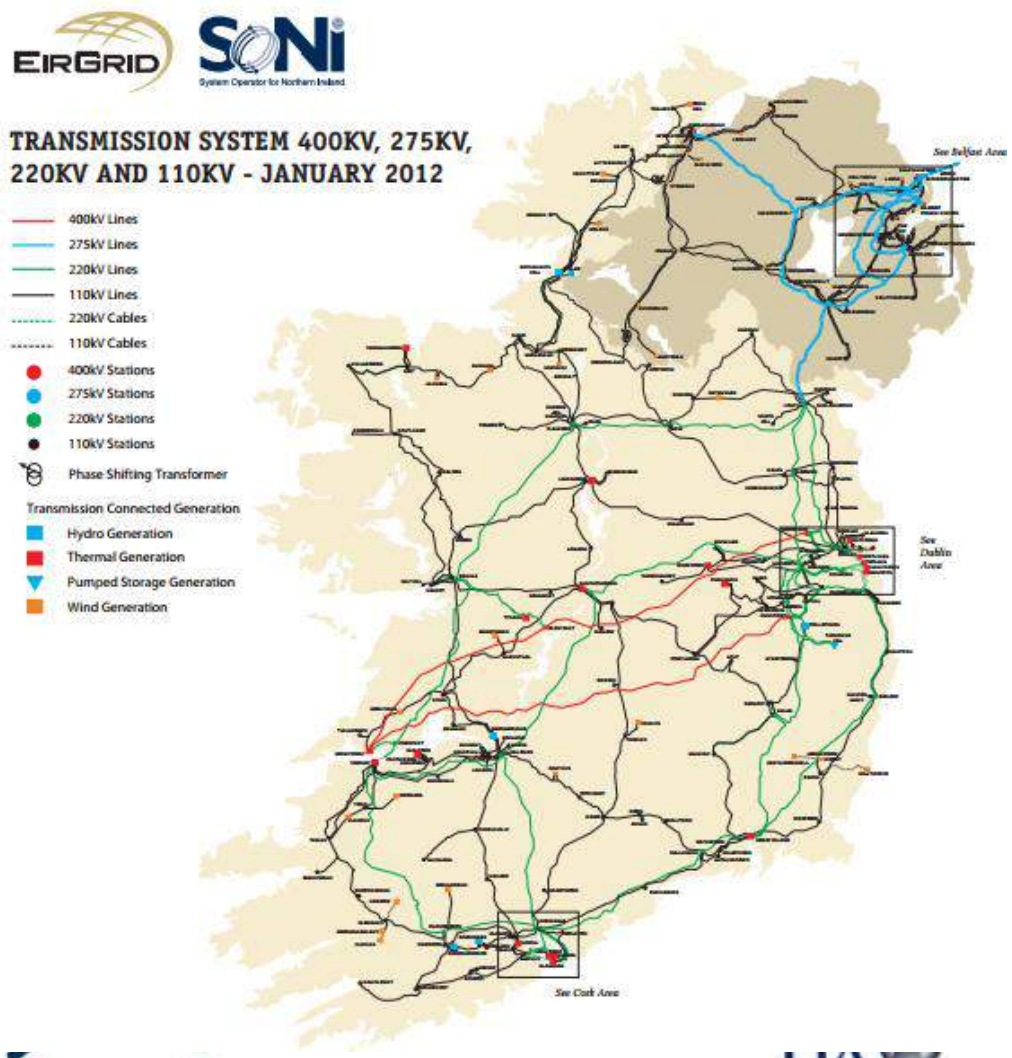
ITC METHODOLOGY (CONT)

- Determine the contribution to the Compensation Fund from each party based on:
  - Net flows (the absolute value of net flows onto and from national systems as a share of the sum of the absolute value of net flows onto and from all systems) (EUR 205 million); and
  - Perimeter fees – a transmission use of system fee levied on all scheduled imports and exports from perimeter countries, in EUR/MWh. The fee is calculated by ENSTO-E each year in advance. (EUR 20 million)
- Calculate the net financial result for each party (i.e. compensation – contribution).

Determining the Cross – Border Infrastructure Fund

- In determining the cross-border infrastructure fund, the Regulation (838/2010) specifies that the method should be based on forward-looking Long Run Average Incremental Costs (LRAIC). The details of the method are not known, as they are currently under review. However:
  - "Long-run" means that future investment costs should be included; and
  - "Forward-looking" suggests that replacement costs should be used, rather than historic costs.

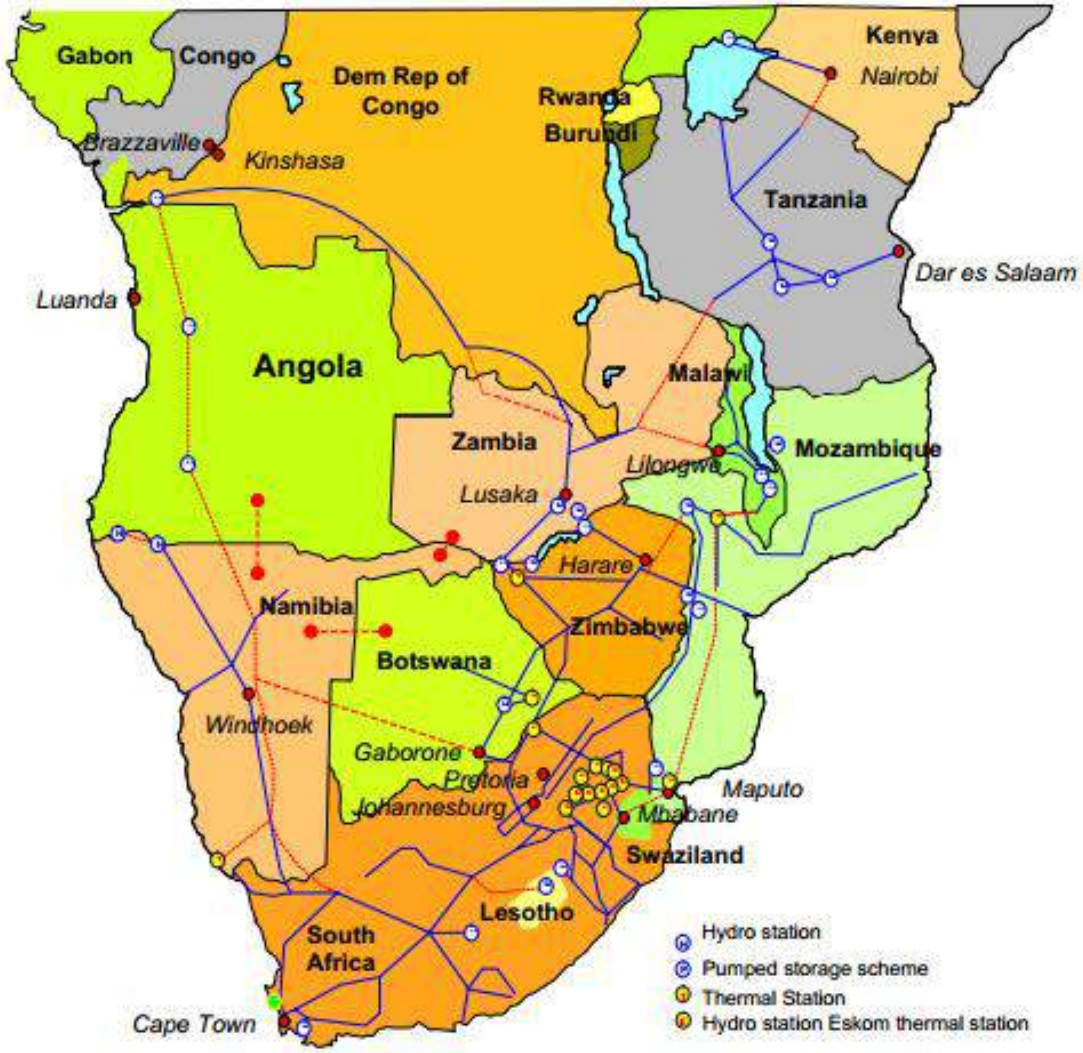
INTERNATIONAL EXAMPLES : IRELAND



INTERNATIONAL EXAMPLES : IRELANDTITLE

- Eirgrid is the TSO for Republic of Island (RoI) and SONI is the System Operator for Northern Ireland (NI)
- SEMO (Single Electricity Market Operator) operates the centralised gross pool/wholesale market.
- Transmission costs allocated 25:75 between generation and demand
- All island generator transmission tariff recovers 30% from locational element and 70% from a postage stamp element.
- Losses allocated to generators and interconnectors by Transmission Loss Adjustment Factors (TLAF)

INTERNATIONAL EXAMPLES: SOUTH AFRICA



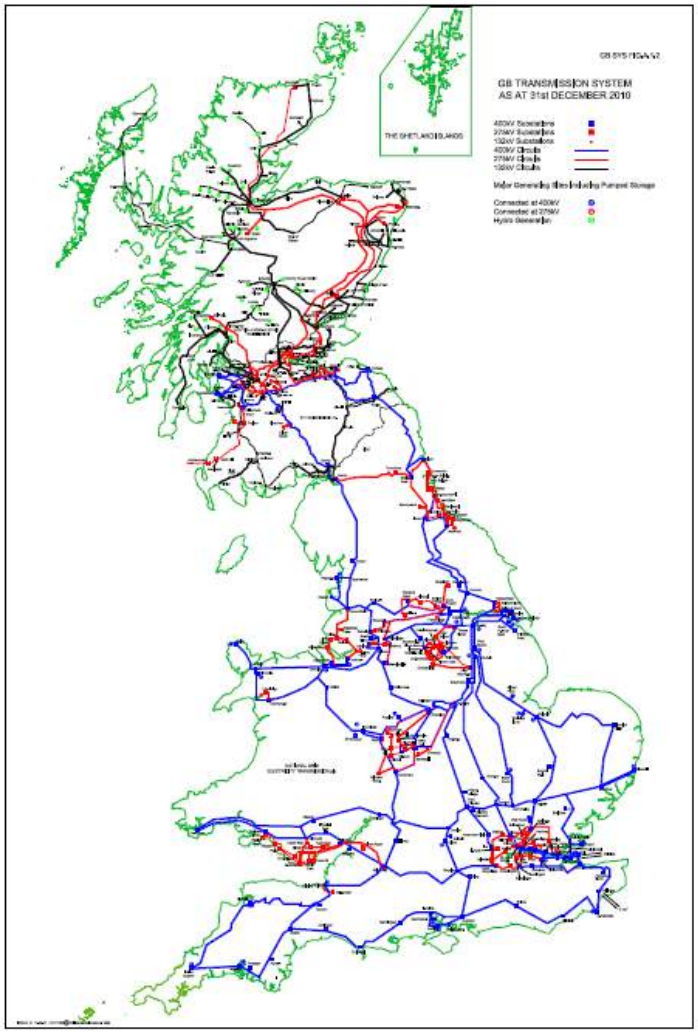
INTERNATIONAL EXAMPLES : SAPP

- SAPP includes utilities and ministries in energy use in 11 countries: Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zaire, Zimbabwe and South Africa.
- In 2003, SAPP moved from postage stamp to MW-km (load flow) methodology.
- In 2005, Plans to move to Nodal pricing did not go ahead due to various factors.
- Sophisticated Day Ahead Market (DAM) facilitates trading across interconnectors in real time.
- SAPP region is split into market zones that can split as constraints become binding on the interconnectors.

INTERNATIONAL EXAMPLES : GREAT BRITAIN

- National Grid is the System Operator in Great Britain (England, Scotland and Wales)
- GB transmission system is divided into 14 demand zones and 20 generation zones
- Transmission charges based on nodal pricing that uses DCLF (Direct Current Load flow) ICRP (Investment cost Related Pricing)
- Charges reflect the incremental cost in addition to locational factor
- Transmission costs are allocated at 27:73 split between generation and demand
- Transmission losses recovered via energy market, through loss factor application

INTERNATIONAL EXAMPLES : GREAT BRITAIN



GREAT BRITAIN – DEMAND ZONES

Demand Zone	Zone Area	Demand Tariff (£/kW)	Energy Consumption Tariff (p/kWh)
1	Northern Scotland	10.741418	1.481661
2	Southern Scotland	16.001744	2.260958
3	Northern	19.662769	2.720973
4	North West	22.838742	3.310579
5	Yorkshire	23.180244	3.216258
6	N Wales & Mersey	23.639502	3.392395
7	East Midlands	25.451532	3.602558
8	Midlands	27.358246	3.936288
9	Eastern	25.952047	3.633328
10	South Wales	25.257265	3.368021
11	South East	28.248124	3.967297
12	London	31.174616	4.169758
13	Southern	30.613447	4.343659
14	South Western	31.062748	4.226735

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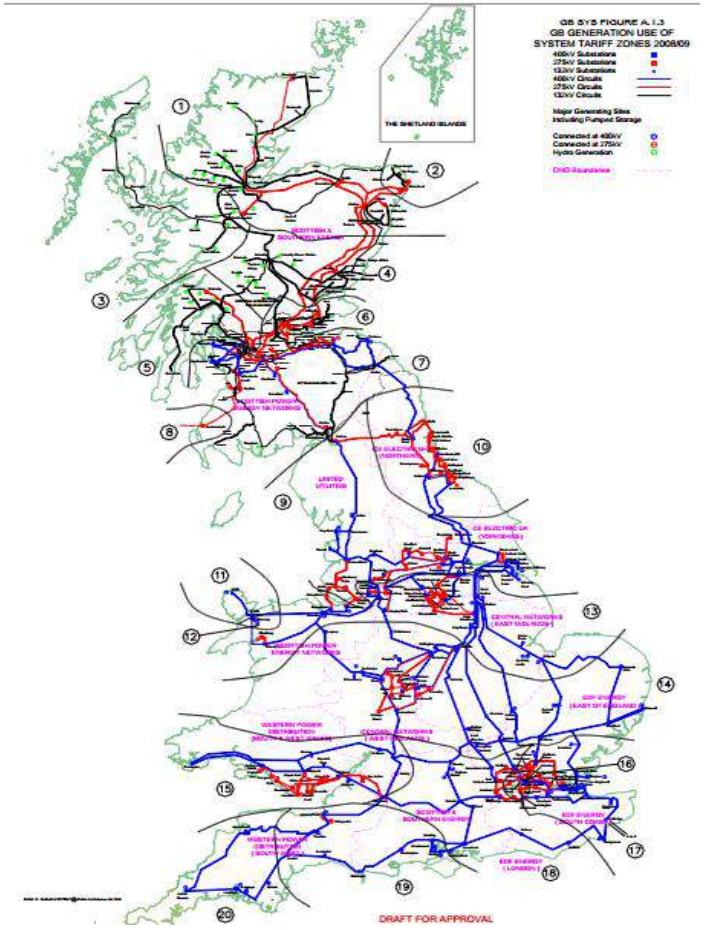
GREAT BRITAIN GENERATION ZONES

Zone	Zone Name	Tariff (£/kW)
1	North Scotland	21.958097
2	Peterhead	20.113140
3	Western Highland & Skye	22.051017
4	Central Highlands	17.560345
5	Argyll	14.187889
6	Stirlingshire	14.227364
7	South Scotland	12.787463
8	Auchencrosh	10.504012
9	Humber & Lancashire	6.078531
10	North East England	8.426476
11	Anglesey	7.099147
12	Dinorwig	6.355496
13	South Yorks & North Wales	4.605096
14	Midlands	2.392870
15	South Wales & Gloucester	2.031854
16	Central London	-13.350709
17	South East	2.324187
18	Oxon & South Coast	-1.106129
19	Wessex	-1.708422
20	Peninsula	-5.676387



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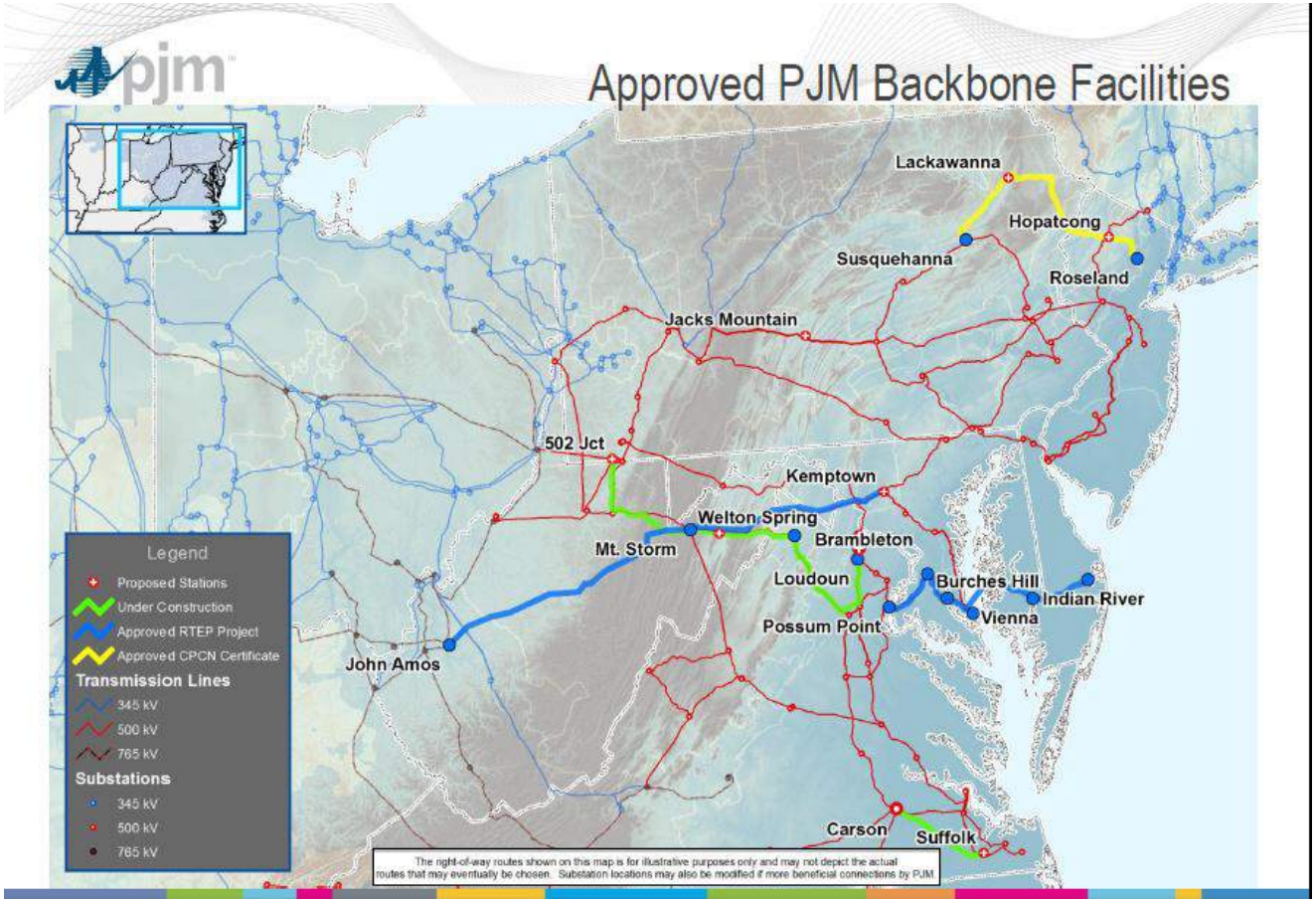
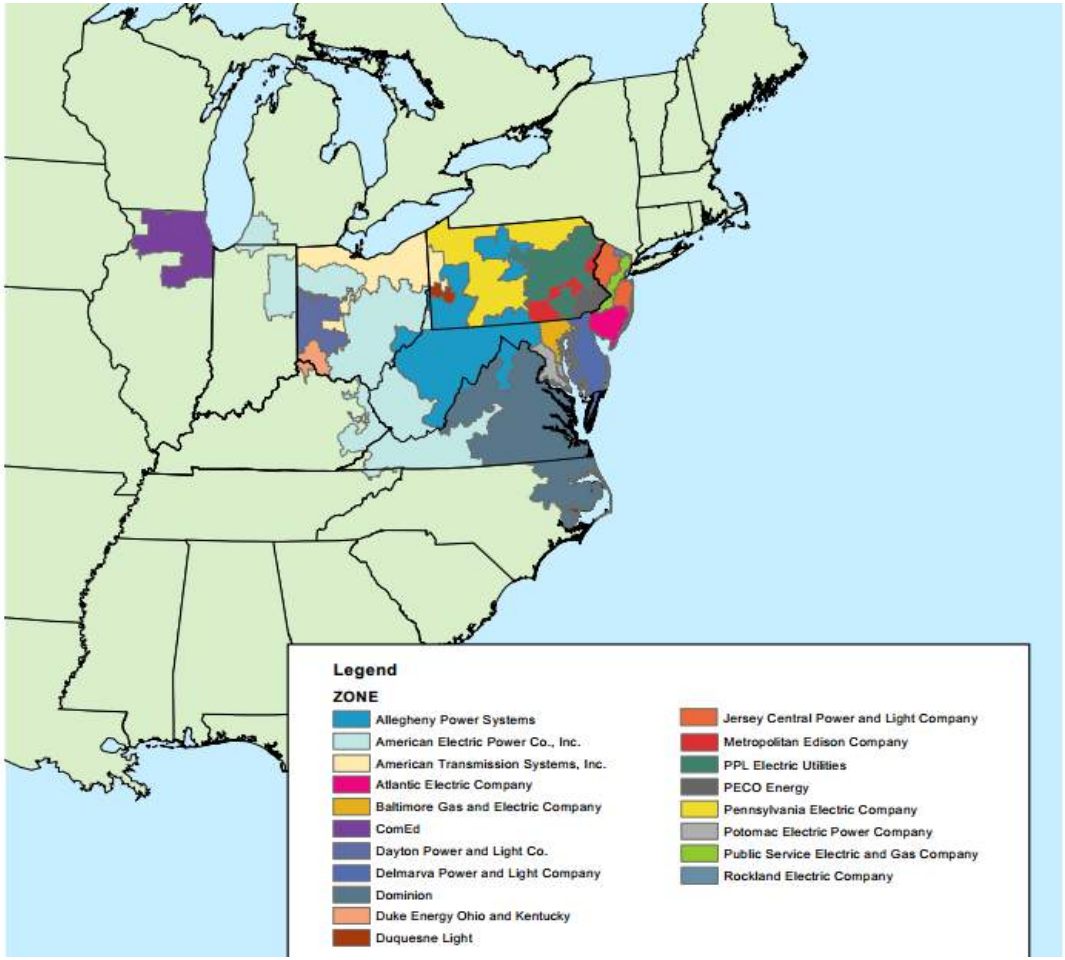
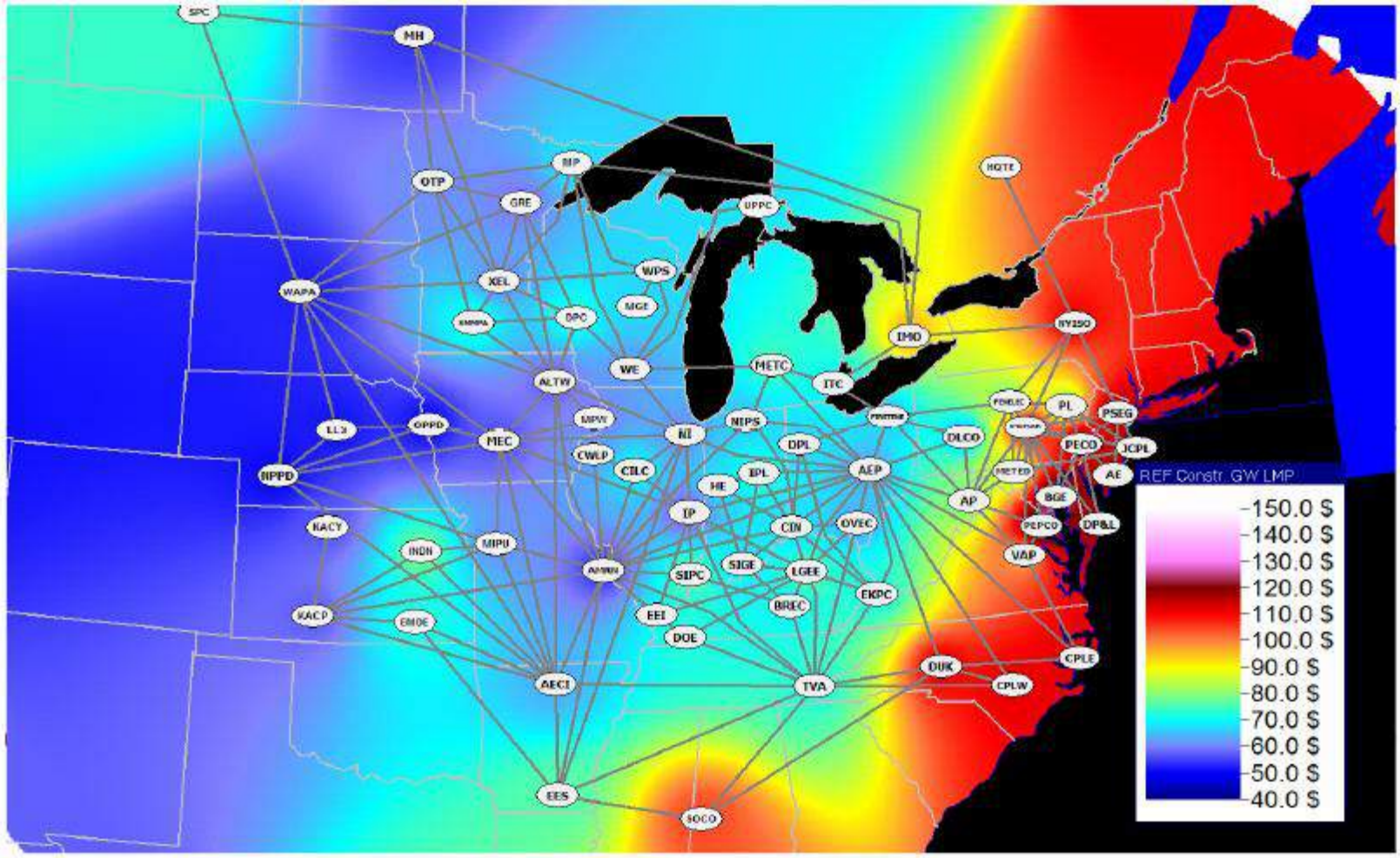
INTERNATIONAL EXAMPLES : PJM



PJM TRANSMISSION ZONES



PJM Weighted Local Marginal Prices



INTERNATIONAL EXAMPLES: US (PJM)

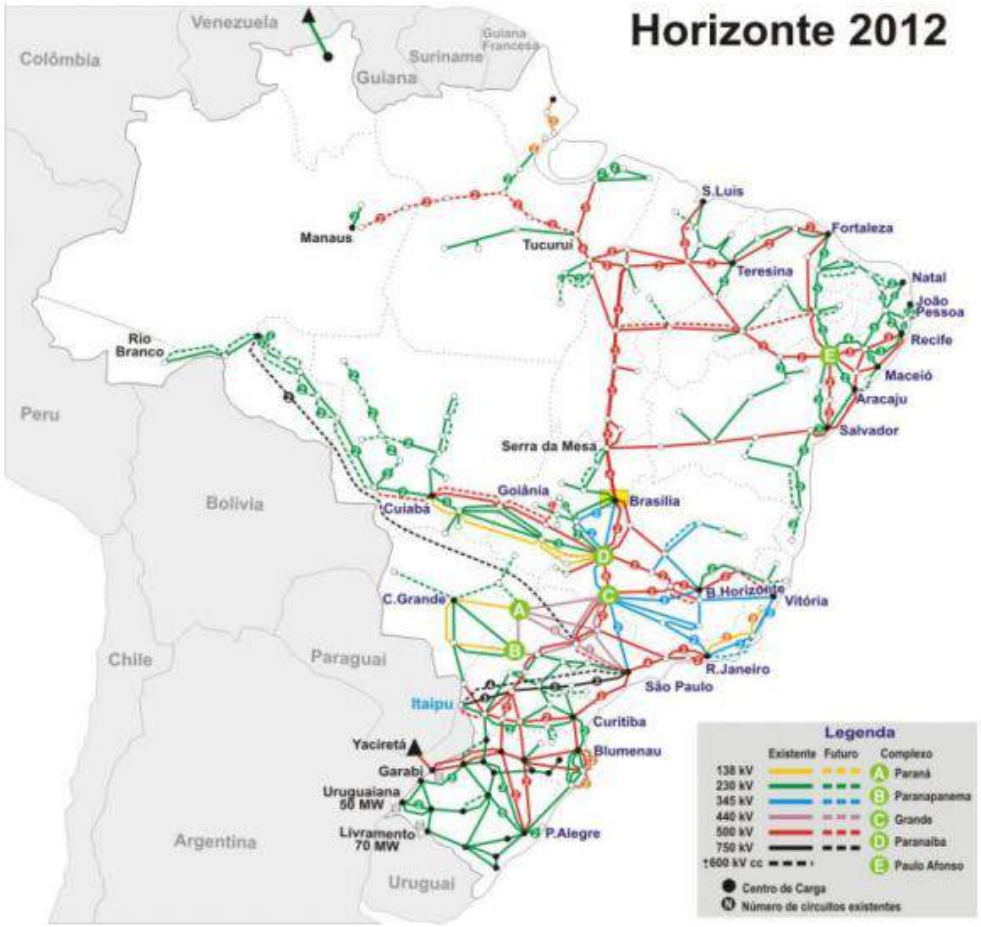
- PJM , a Regional Transmission Organisation (RTO) manages the interconnection between 13 states and District Columbia and a market operator.
- Uses Locational Marginal Pricing (LMP) – reflects value of energy at the specific location and the time of delivery
- Demand pays 100% transmission costs
- PJM Day ahead market – Forward market- Hourly LMPs are calculated based on generation offers, demand bids and scheduled bilateral transactions.
- PJM Real time market- Spot market –real time LMPs calculated at 5 min intervals.
- FTR (Financial Transmission Rights) traded separately from transmission service.
- Cost of transmission losses are reflected in the energy market prices.

INTERNATIONAL EXAMPLES: NEW ZEALAND

INTERNATIONAL EXAMPLES: NEW ZEALAND

- TransPower is the system operator covering north and south islands.
- Uses LMP and based on full nodal pricing to calculate transmission costs.
- Loads pay the interconnection charges- weighted average of the regional coincident peak demand
- 100% transmission costs are allocated to the loads.
- NZEM, New Zealand electricity Market operates whole sale electricity market.
- Long term bilateral contracts known as contracts market
- Spot market
- Transmission losses are reflected in the half hourly energy prices.

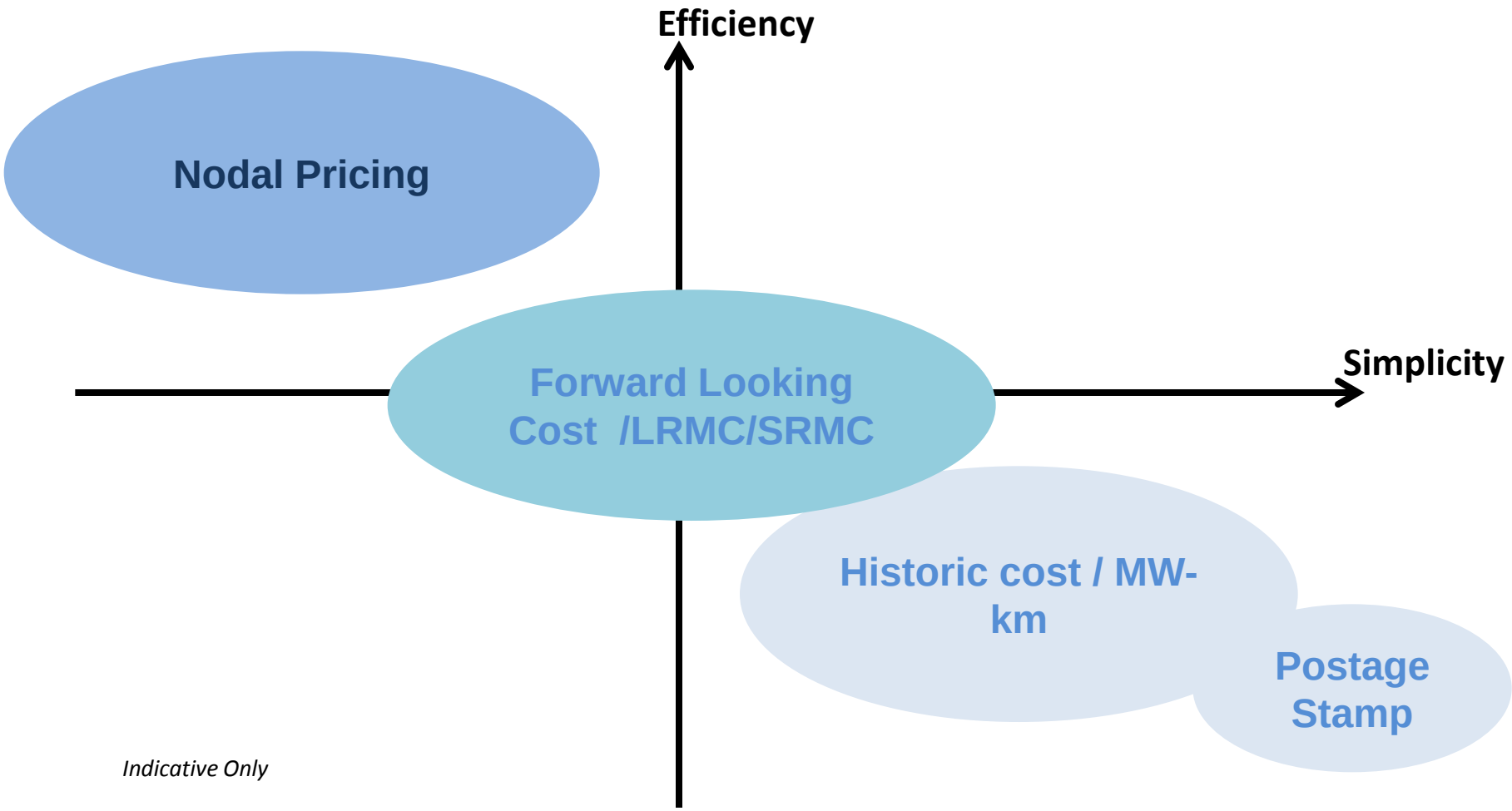
INTERNATIONAL EXAMPLES: BRAZIL



INTERNATIONAL EXAMPLES: BRAZIL

- ONS is the National System Operator in Brazil
- Transmission costs are allocated at 50:50 split between generation and demand.
- Cost recovery- 20% from flow-based calculation and 80% from peak usage charges
- Self producers are charged on nodal basis and charges depends on connection point location and reflect an element of socialised system service charges
- Transmission losses are reflected through the loss factors adjustment. Energy prices reflect marginal loss component

METHODOLOGIES – TRADE OFF BETWEEN EFFICIENCY AND SIMPLICITY



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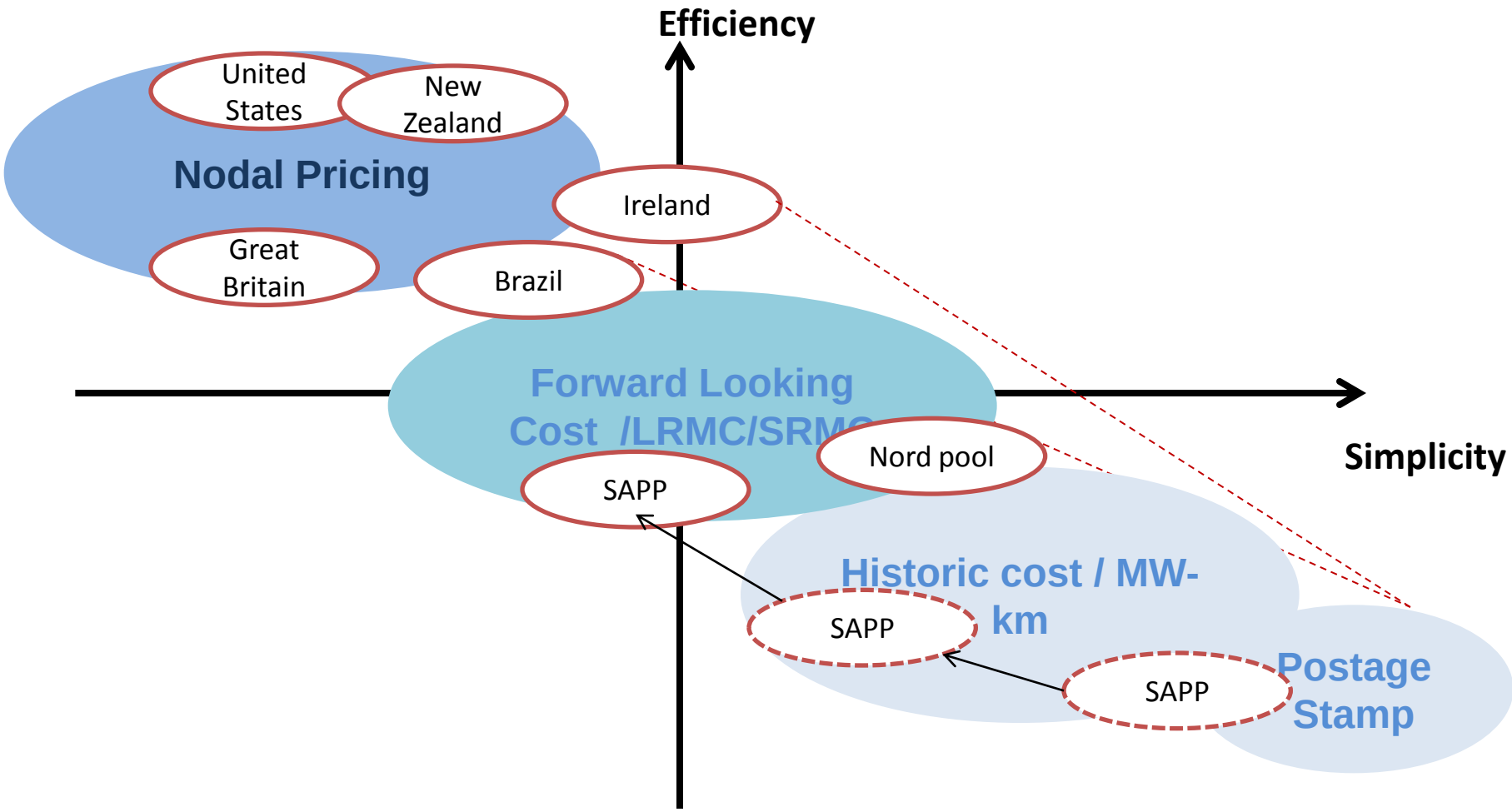
INTERNATIONAL EXAMPLES -TRADE OFF BETWEEN EFFICIENCY AND SIMPLICITY



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International Experience with Transmission Pricing

Country	Experience in wheeling/transmission pricing
Nord Pool	1996 onwards
European Union	1990's Cross Border Trade (CBT) Mechanism 2011 Inter Transmission System Operator Compensation (ITC) – postage stamp
Ireland	2011 onwards (SEM)
Southern African Power Pool (SAPP)	1996 postage stamp 2003 onwards – MWkm method 2005/6 – entry exit charges explored
Great Britain	1990 – market reform introduces Investment Cost Related Pricing 2005 – market platforms change
United states: PJM	1997 onwards 2001 – PJM as an ISO, Open Access Transmission Tariff
New Zealand	2012 – new method introduced
Brazil	1999 – principles defined 2004 – current method implemented by law

INFLUENCING FACTORS

- **Electricity trading rules**:
  - spot market/gross pool vs. bilateral contracts
  - identification of trading counterparties
  - entry/exit charges vs. contract based
  - restriction to self-generators at present
- **Congestion management:**
  - market rules linkage
  - value of signal through T charges
  - importance of significant locational component
  - medium/long term signals of the availability of transmission

INFLUENCING FACTORS

- **Losses:** under all of the methods other than the nodal pricing approach, treated separately from the application of network charges themselves.
  - via a “postage-stamp” approach, allocating the overall cost of losses across all system users; or
  - by identifying the costs arising from the incremental effect of losses arising from specific wheeling transactions.
- **Cost recovery:**
  - to “socialise” the costs; or
  - include in specific the wheeling agreements

REVIEW OF TRANSMISSION CHARGES WITHIN AND BETWEEN ECOWAS COUNTRIES

- Transmission Tariff methodologies within ECOWAS countries
  - Local transmission charges
  - International trading
  - Valuation of transmission assets
  - Investment conditions
- Transmission Tariff methodologies between ECOWAS countries
  - Transmission Costing and Charging Methodologies
  - Wheeling arrangements
  - Open Access
  - Transmission Losses
  - Congestion Management

LOCAL TRANSMISSION CHARGES

Country	Benin	Burkina Faso	Cap Vert	Côte d'Ivoire	Gambia	Ghana	Guinée	Guinée Bissau
LOCAL TRANSMISSION CHARGES								
Unbundled ?	Partially	No		Partially	No	Partially		
Separate KVA charge ?				Yes	No			
Portion generator pay of transmission	> 0			0%	0%			
Locational transmission prices ?	No			Yes	No	No		
Transmission losses calculated separately ?	Yes	Yes		Yes	No	Yes		

LOCAL TRANSMISSION CHARGES (CONT)

	Country	Libéria	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo	
	Unbundled ?		No		No	No		Partially	
	Separate KVA charge ?		Yes		No but 20% fixed prop			No	
	Portion generator pay of transmission		0%		0%			0%	
	Locational transmission prices ?		No		No	No			
	Transmission losses calculated separately ?		No		Yes	Yes		No	

INTERNATIONAL TRADING IN ECOWAS MEMBER COUNTRIES

Country	Benin	Burkina Faso	Cap Vert	Côte d'Ivoire	Gambia	Ghana	Guinée	Guinée Bissau
INTERNATIONAL TRADING								
Is wheeling allowed?				No	N/A			
Can consumer buy from international IPP	No			No	No			
Can IPP export?	No			No	No			
Is utility purchasing power from neighbouring countries?	No?			No	No			
Is utility purchasing power from non neighbouring countries?	No			No	No			
Is there congestion on international connectors	No			No	No			

INTERNATIONAL TRADING IN ECOWAS MEMBER COUNTRIES (CONT)

	Country	Libéria	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo	
	Is wheeling allowed?				No			No	
	Can consumer buy from international IPP		No		No			No	
	Can IPP export?		No?		No			Yes	
	Is utility purchasing power from neighbouring countries?		Yes (no charge) ?		No			Yes (only CEB, so no wheelin g charge)	
	Is utility purchasing power from non neighbouring countries?		No		No			Yes (only CEB, charge s unknow n)	

VALUATION OF TRANSMISSION ASSETS

Country	Benin	Burkina Faso	Cap Vert	Côte d'Ivoire	Gambia	Ghana	Guinée	Guinée Bissau
VALUATION OF TRANSMISSION ASSETS								
Asset Valuation				Value after depreciation	Value after depreciation	Depreciation Replacement Cost		
Depreciation Period HV Lines				25	40			
Depreciation Period Transformers				25	40			
Depreciation Period Substations, Building				25	40			
Depreciation Period Other (IT,...)								
Other comments								

VALUATION OF TRANSMISSION ASSETS (CONT)

	Country	Libéria	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo	
	Asset Valuation		Value after depreciation		Depreciation Optimised Replacement Cost (DORC)	Value after depreciation			
	Depreciation Period HV Lines		30		50	25			
	Depreciation Period Transformers		30		50	25			
	Depreciation Period Substations, Building		25		50	25			
	Depreciation Period Other (IT,...)				10				

INVESTMENT CONDITIONS IN ECOWAS COUNTRIES

Country	Benin	Burkina Faso	Cap Vert	Côte d'Ivoire	Gambia	Ghana	Guinée	Guinée Bissau
INVESTMENT CONDITIONS								
RoE authorized					13%	8%		
RoE real						5%		
MIN WACC (real after tax WACC)					5%			
MAX WACC					12%			
MIN internal loan rate					20%			
MAX internal loan rate					20%			
MIN external loan rate				3%	5%	5%		
MAX external loan rate				5%	12%	12%		

INVESTMENT CONDITIONS IN ECOWAS COUNTRIES (CONT)

	Country	Libéria	Mali	Niger	Nigeria	Senegal	Sierra Leone	Togo	
	RoE authorized								
	RoE real								
	MIN WACC (real after tax WACC)		7%		7%				
	MAX WACC		7%		7%				
	MIN internal loan rate				24%				
	MAX internal loan rate				24%				
	MIN external loan rate								

TRANSMISSION LOSSES

- Transmission losses in ECOWAS countries is estimated in most countries as there is not sufficient metering.
- Incentives are provided for transmission losses to be reduced through incentive based regulation.
- The actual performance is difficult to measure and most countries are looking to improve SCADA and metering to get a more accurate measure of transmission losses.
- All countries apply losses equally to all consumers and charged to all consumers except for Nigeria.
- In Nigeria the generator schedule is increased by the average losses (8% for the current year).
  - Generator hence provides and pays for losses and recovers the money through the generation tariff.

CONGESTION

- Generation is dispatched on merit order and congestion is managed through the selection of the next cheapest generator that will not cause a constraint.
- No ECOWAS country has a market based congestion management philosophy such as apportioning generator outputs or nodal pricing.
- Nigeria allocates the total available generation to each DISCO based on relative size. There have been DISCO complaints that some generators are constrained because they cannot export the proportion allocated to other DISCOS because of transmission constraints.

TRANSMISSION TARIFF METHODOLOGIES BETWEEN ECOWAS COUNTRIES

- 4 PPA's provided for review
- No specific transmission costing and charging methodologies are mentioned
  - PPA's imply that transmission is included in energy price
- No wheeling arrangements mentioned
- Open Access
  - The exclusive first rights of the transmission network belong to the companies that built the international interconnectors.
  - There is no mention of the ability to make excess transmission capacity available for third party users.

TRANSMISSION TARIFF METHODOLOGIES BETWEEN ECOWAS COUNTRIES (CONT)

- **Transmission losses**
  - The PPAs reviewed make the responsibility of transmission losses to the generating company.
  - The point of billing and settlement is at the consumer point of interconnection.
  - Senelec mentioned there is an allocation methodology for losses between Senegal and Mauritania for energy provided from Mali.
- **Congestion management**
  - Congestion is not mentioned in any of the PPA's.
  - All transmission capacity must be made available.
  - There is no mention of allocation methodology if a generator provides more than one country across interconnector.

PROGRAMME FOR TODAY

08:30 – 10:30	Introduction to alternative approaches for calculation of wheeling charges: • Postage stamp • MW km • Nodal pricing
10.30 - 10.45	COFFEE BREAK
10:45 – 11:45	Review of international practices
11:45 – 12:45	Review of transmission charges within and between ECOWAS countries
12.45 – 14.00	LUNCH
14:00 – 15:00	Review of reports on transmission pricing prepared for WAPP
15:00 – 15:45	Possible implementation models for ECOWAS
15.45 – 16.00	COFFEE BREAK
16:00 – 17:00	Feedback from ERERA / Proposed next steps
17:00	*CLOSING CEREMONY*

REVIEW OF WAPP REPORTS ON TRANSMISSION COSTING AND TARIFF METHODOLOGY

- Review of the following reports:
  - Nexant report of October 2008, entitled “A Methodology to Calculate the Demand and Energy Components of a Transmission Tariff within WAPP”, and
  - Mercados reports entitled “Development of WAPP Market Design and Market Rules”

MARKET PHASE 1

- **Phase 1**: from now to 2015 approximately when most regional transmission infrastructure is expected to be commissioned. Main characteristics of this phase would be:
  - Formalise trading that today is carried out on a “case by case” basis and standardise procedures such as:
    - Bilateral agreements (countries, regional companies)
    - Commercial Instruments (type of contracts, short term exchanges)
  - Transmission pricing agreed between parties
  - Initiate the regional operational and commercial coordination
  - Preparation for the following stage
  - Regional regulator: enforcement of rules and dispute resolution
  - Market operator: appoint an institution which will begin developing market operation functions

MARKET PHASE 2

- **Phase 2**: based on the preparations carried out during the 1st phase, and will include but not limited to the following:
  - Bilateral agreements with transit through third countries, based on standard commercial instruments
  - Transactions can be carried out between individual agents of the countries
  - Back up of contracts in the market (possibility)
  - Short term exchanges through day ahead market (regional optimization model)
  - Regional transmission pricing
  - Regional System and Market Operator (SMO)

(*SAPP Implementation so far*)

MARKET PHASE 3

- **Phase 3**: a long term vision which would include:
  - A liquid and competitive market in the region made possible by the availability of enough regional transmission capacity and enough reserve in the countries so as to make possible a competitive market.
  - Countries or a group of countries can voluntarily decide to put their resources under a common optimisation system. This phase can coexist for some time with phase 2.
  - Possibility of trading different product integrating other markets: market for some ancillary services, financial products.

MARKET PHASES (CONT)

- The market phases similar to the development of the Southern African Power Pool.
- Phase 2 has the possibility of an interim phase where short term bilateral trade up to a few hours ahead is allowed through a bulletin board trading mechanism.
- The development of a day-ahead market is probably still some way from realisation and requires market certainty and excess capacity not linked to long term bilateral arrangements.
- Even though the Southern African Power Pool has developed a day-ahead market, trades are very small. This is due to:
  - Lack of available transmission capacity allocated to the day-ahead market.
  - Lack of spare generation capacity.

REGIONAL NETWORK OWNER

- The reports mention of a regional network owner in the two consulting documents
  - Is this a reality or not?
  - In this case all the assets owned by the regional network owner need to be included in the transmission tariff methodology.
  - Probably the best solution would be to move towards a postage stamp system where the costs of the network are recovered by all users on the network.
  - In this case there is no identification method required to identify the assets.
- With a regional network owner there need to be rules dealing with connection charges.

NODAL VS ZONAL PRICING

- The reports mention the possibility of zonal and nodal pricing.
- No conclusions are drawn on this issue except it is not applied in the bilateral trading phase where transmission charges are based on a case by case basis.
- The use of zonal and nodal transmission pricing is open to large debate and it is unclear if this drives transmission investment.
- In all the ECOWAS countries, it is politically unacceptable to have a varying transmission tariff as poorer areas are generally far from the network.

WHAT ARE TRANSMISSION CHARGES AND WHAT DOES IT INCLUDE ?

- The Nexant report details a tariff methodology covering energy, transmission costs, transmission losses and connection charges.
- The scope of task 4 is to cover the calculation of transmission network costs including losses and to develop the transmission tariff to recover these costs.
- The scope of task 4 includes management of constraints and ancillary services costs with respect to the transmission network.
- Energy prices including balancing costs are outside the scope of this task.

TRANSIT FLOWS AND LOOP FLOW

- Nexant report proposes:
- ***Transit load flow*** *is a load flow pattern in which country A receives power at the border with B and delivers power at the border with C, to implement transactions among market participants outside A.*
- ***Loop flows –*** *ENTSO has method to deal with loop flows. In the early phases of development of the high voltage network of the WAPP region, it is possible that there will be no loop flows simply because the grid will have a "linear" structure.*

LOOP FLOW EXAMPLE

TRANSMISSION TARIFF

- The Mercados report does not propose a transmission tariff methodology.
  - The report suggests that the transmission tariff should be negotiated bilaterally between the parties for bilateral trades.
  - The report also mentions that the regional regulator and country regulators could oversee the process.

TRANSMISSION TARIFF

- The Nexant report states that four alternative methods of recovering the cost of transit and loop flows were discussed at the 1st meeting of the transmission tariff task force:
  - Concept #1: The whole regional network is owned and operated by one big transmission company.
  - Concept #2: The regional network consists of several zones. In each zone, the TSO owns the network assets. TSOs charge transit fees and export fees.
  - Concept #3: In each zone, the TSO owns the network assets. TSOs pay each other for costs related to transit, through an Inter-TSO Compensation mechanism.
  - Concept #4: In each zone, the TSO owns the network assets. TSOs pay each other, based on the difference between total revenue and total fixed cost in each zone.

Concept 2 accepted by WAPP task force

TRANSMISSION ASSET DETERMINATION

- The Nexant report proposes that Transmission is defined as 132 kV and above.
- Nexant further proposes for ***Phase 1: Bilateral trading, with transit flows only in Ghana. Measurement of Net Transfer Capacity (NTC). Unbundling of accounts for the regional network***
  - *Under the leadership of the transmission task force, WAPP power companies will identify the transmission lines and substations that are part of the regional network and are projected to be used for import, export, and transit. The regional network includes four voltage levels: 330 kV, 225 kV, 161 kV, and 132 kV. All other transmission lines and transmission substations belong to the national networks. Each power company will calculate the number of km of transmission line (by voltage level) and the number of kVA of transformer capacity (by voltage level) in its portion of the regional network. Each power company should provide a short explanation of the methodology it used to identify the regional network within its country or countries of operation. All of this technical information should be provided to the ICC.*

TRANSMISSION ASSET DETERMINATION (CONT)

- *In addition, each power company will estimate the net book value of the assets in the regional network, and show the components of this total i.e. the net book value of transmission lines (by voltage level) and transformer substations (by voltage level). Each power company should provide a short explanation of the methodology it used to calculate net book value (for example, historical cost or replacement cost) and the number of years over which various categories of transmission assets are depreciated. All of this accounting information should be provided to the ICC.*

TRANSMISSION ASSET DETERMINATION (CONT)

- The proposal that the determination of what the transit network is in each country to the individual countries opens the area of disputes and varying methodologies to suit individual countries.
  - A common methodology should be used to determine the transmission network and the proportion of the network used for transit flows.
  - Each country determines asset values is not ideal as there should be a common database where all agree on asset values
  - Allows the possibility of various zones and transmission companies.

PRIVATE SECTOR PARTICIPATION

- The Nexant report brings up the complexity of private transmission companies requiring rate of return on assets for transmission based on the source of funding and equity return requirements.
- Whilst this is a complex issue this could be solved by agreeing to a different Weighted Average Cost of Capital (WACC) for private investment as opposed to government funded transmission.

TRANSMISSION TARIFF POINT TO POINT VS NODAL

- The Nexant report compares two final options for a transmission tariff:
  - A postage stamp tariff, or
  - Point-to-point service with distance-related tariff
- The proposal is that the postage stamp tariff is the only solution that will work with a power exchange in operation.
- The WAPP transmission tariff task force also preferred zonal pricing over nodal pricing. Zonal in this document is interpreted as each country having a different loss factor depending on position and flows on the network. This similar to methodology developed for SAPP.
- No ECOWAS country has nodal or zonal transmission tariff pricing. Thus there is no current need to blend zonal and nodal countries into the regional methodology.

CONGESTION MANAGEMENT

- There is mention of congestion management in both Nexant and Mercados reports. The expectation is that transmission congestion will be handled by market mechanisms and not through the transmission tariff.
- We are in agreement with the congestion proposals for two reasons:
  - In the bilateral market the principle of first-come-first serve is proposed. Any bilateral transaction that exceeds available transmission capacity is curtailed or excluded. Transmission congestion is managed at this level.
  - Centrally cleared markets will have market splitting or nodal techniques to solving congestion. Thus the problem is solved in the market clearing.

KEY POINTS FOR DISCUSSION AT WORKSHOP ON TRANSMISSION PRICING AND TARIFF METHODOLOGY

- Definition of Regional Transmission Network?
- Definition of Transit Flows and Loop Flows
- Point of Connection to Regional Transmission Network
- Calculation of the Transit Flow through a Network
- Calculation of Asset Value
- Calculation of WACC
- Taxation on International Transmission Company Profits
- Who pays Transmission Tariff
- Zonal, Nodal or Flat Transmission Tariff
- Connection Charges
- Managing Transmission Congestion
- Calculating Available Transmission Transfer Capacity
- Calculation of Transmission Losses
- Who Pays for Transmission Losses
- Ancillary Services

DEFINITION OF REGIONAL TRANSMISSION NETWORK?

- Three options for consideration
  - Regional transmission assets are owned by a regional transmission company
  - Transmission assets based on contractual flow
  - Transmission assets defined by transit load flow studies. SAPP and ENTSO use a rule where any asset where the flow changes by more than 1 MW for 100 MW injection and extraction through the network is included in the transit asset database.

DEFINITION OF TRANSIT FLOWS

- ***Transit load flow*** *is a load flow pattern in which country A receives power at the border with B and delivers power at the border with C, to implement transactions among market participants outside A. In other words, even when electric energy is flowing through the network of power company A, there is no transit load flow unless the transmission system operator of A is helping to implement transactions among market participants outside A. Transit load flow does not exist a situation in which power company A imports energy from power company B on the basis of a power purchase agreement with B, and exports energy to power company C under a separate agreement.*

DEFINITION OF LOOP FLOWS

- ***Loop flow*** *is a load flow pattern in which country A receives power at the border with B through transmission line 1 and delivers power at the border with B through transmission line 2, to implement transactions among market participants outside A. In other words, even when electric energy is flowing through the network of power company A, there is a loop flow when the transmission system operator of A is helping to implement transactions among market participants outside A.*

Point of Consideration to Regional Transmission Network

- For bilateral agreements there are two options for the point of connection:
  - Point of connection is at the generator / consumer substation, or
  - Point of connection is at the boundary of the country of export.
- If the point is at the boundary then the individual countries' regulators will determine the transmission charges from the generator to the boundary.
  - The individual countries' regulators treat the export as a consumer at the border.
  - An importing country regulator treats the import as a generator at the border of the country.
  - In this case there are no specific regional transmission charges for neighbouring bilateral contracts.

Calculation of the Transit Flow Through A Network

- Transit flows can be calculated three ways:
  - Scheduled or measured imports and exports. Based on schedule or actual flows through a particular country as import and export charges.
  - Scheduled transit flows. Transits flows through a third party country are based on bilateral contractual information. This is the basis of current ECOWAS bilateral arrangements. Scheduled transit flows that are opposite in direction needs to be clarified.
  - Load flow based transit flows. Transit flows based on net measured flows. This is the EU method where the net flow is the minimum of total import and total export (min (import, export)).

CALCULATIONS OF ASSET VALUE

- Three methods for calculating asset value.
  - Depreciated cost. Popular method for single investments. No need to accumulate profit for future transmission investments.
  - Depreciated replacement cost. Periodic re-evaluation of replacement value.
  - Replacement cost. Transmission companies accumulate profits for future transmission expansion.
- In addition to the above methods future approved investments to build up equity for investment plans over the next 5 or so years.
  - Future investments are also bankable as loans repayments are in the revenue base.

CALCULATION OF RETURN ON EQUITY

- The formula provides estimates of the appropriate return on equity and the returns to equity are measured in relation to the risk premium on the equity market as a whole. Thus:

$$Re = Rf + ße\,(Rm - Rf)$$

- Where:
  - R_e is the return on equity
  - R_f is the risk free rate observed in the market
  - $ß_e$ is the correlation between the equity risk and overall market risk
  - R_m is the return on the market portfolio
  - $R_m - R_f$ is the market risk premium

CALCULATION OF WACC

- The WACC lies between the cost of equity and the cost of debt and is calculated as:

$$WACC = Rd \times D/(D + E) + Re \times E/(D + E)$$

- Where:
  - D is the total market value of debt
  - E is the total market value of equity
  - R_d is the nominal cost of debt; and
  - R_e is the nominal cost of equity

CALCULATION OF EFFECTS OF TAX ON WACC

- This formulation does not include the effects of tax. The formulation of the WACC that allows for the effects of taxation (Tc) and used extensively by regulators and post tax WACC is calculated as:

$$\text{Nominal post tax WACC}(w) = Re \times E/V + Rd\,(1-Tc) \times D/V$$

- Where:
  - T_C is the company tax rate,
  - V is the total market value of the business, i.e. debt plus equity
- The formula for WACC allows for company taxation of the transmission companies profits. The transmission company will be registered in one particular country and the taxation will apply to that country only.
- Intergovernmental agreements will have to be reached if an alternative taxation arrangement is required.

REAL PRE-TAX WACC

- A transformation is applied to derive an estimate of the real pre-tax WACC, as follows:

$$\text{Real pre tax WACC (RW)} = [(1 + w/(1 - Tc)) / (1 + i)] - 1$$

- Where:
  - W is the nominal post tax WACC
  - I is the inflation rate

WHO PAYS TRANSMISSION TARIFF

- Transmission tariff can be paid by generators, consumers or a percentage each.
- In ECOWAS countries only consumers pay the transmission tariff. In vertically integrated utilities the transmission tariff is embedded in the end use tariff.
- Allocating a portion of transmission tariff to generators encourages them to seek places on the network where there are no other generators. In reality, the location of a generator is driven by the location of primary energy and access to transmission network.
- Therefore for ECOWAS consumer pays is recommended.

ZONAL, NODAL OR FLAT TRANSMISSION TARIFF

- Zonal is where a group of sub stations pay the same price for transmission tariff. The group can be a transmission company or all the transmission in a country.
- Nodal is charge per transmission substation or higher than an agreed voltage level. No ECWAS country has nodal charging.
- A flat transmission tariff is either a percentage of the transaction value or equal allocation per kWh traded.

CONNECTION CHARGES

- ECOWAS countries have connection charges which pay for the lines required to the nearest substation.
  - Network strengthening from that substation is the transmission company's responsibility.
- Connection charges should apply in the country of location if the generator connects to the local transmission system.
  - Where dedicated lines are built for international trade, these lines are compensated for under the international transmission charges and no specific connection fee is required.

MANAGING TRANSMISSION CONGESTION

- Transmission congestion is solved in the bilateral agreements phase by the first come first serve principle.
- When central trading platforms are introduced then congestion is managed through the central clearing process.
  - The management of congestion in bilateral and central clearing is the market operator's responsibility, in this case WAPP.
- The regional regulator needs to ensure the process for allocating transmission capacity is fair.

Calculating Available Transmission Transfer Capacity

- The available transmission capacity needs to be calculated on a regular basis to enable short term trading.
  - The available transmission capacity is the available capacity for bilateral trading after long term bilateral trades are considered.
  - The available transmission capacity considers limitations due to short term support, thermal transmission limits and dynamic transmission transfer limits.
- It is proposed that bilateral agreements for hours of the following week are sent to WAPP on Thursday 12:00.
  - This should be the firm capacity and expected physical flows not just the contractual flows.
  - WAPP then publishes available capacity for each hour of the week ahead. This will allow short term trading to begin as countries enter into bilateral short term surplus agreements.
  - The time period can be adjusted to day ahead once market participants are actively trading.

CALCULATION OF TRANSMISSION LOSSES

- Transmission losses can be estimated using two techniques:
  - **Measured losses**. Measurement of losses is easy for long transmission lines where meter accuracy is not a significant portion of the losses. In a single transmission system the transmission losses can be calculated relatively easily. Calculation of losses using this method works well in centrally cleared markets where generators and consumers are measured at their point of connection and the losses is defined as the mismatch between the two.
  - **Calculated losses**. Transmission losses can be estimated through load flow studies. Typically the studies are DC load flow studies for typical load flow periods for peak and off peak and seasonal flows. The transmission losses calculated are theoretical minimum losses and penalises transmission companies who are not operating efficiently. If load flow patterns change due to change in network configuration, changing of generation pattern, or commissioning of a new generator then losses needs to be recalculated.

WHO PAYS FOR TRANSMISSION LOSSES

- Transmission losses can be compensated for by generators or consumers or a combination thereof. There are the following techniques available:
  - Generators schedule adjusted for losses.
    - All generators can be adjusted by an equal amount
    - Generator schedule could be adjusted according to position in the network (nodal or zonal)
  - Consumer pays for losses
    - All consumers pay the same amount
    - Consumers pay according to location in the network (nodal or zonal)
  - Consumers and generator pay according to their position in the network.
    - Marginal loss factors are calculated by injecting 1 MW and calculating the marginal change in transmission losses.
    - This method introduces the concept of negative losses where generators are compensated for reducing losses.

ANCILLARY SERVICES

- Ancillary services can be grouped into three broad categories:
  - Frequency control services which includes the provision of operating reserves,
  - Voltage control services including the provision of reactive power and reactive power reserves, and
  - Black start and restoration services.
- Transmission companies are only directly involved in the provision of voltage control services.
  - This would be the provision of specialised equipment for voltage control such as Static Var Compensators (SVC), Static Compensator (Stat Com) or Synchronous Condensers.

ANCILLARY SERVICES (CONT)

- The compensation of the specialised transmission equipment can be through two methods:
  - Through the transmission tariff.
    - The specialised transmission device is compensated by all consumers as all consumers benefit from a stable transmission system. The asset and operating costs are included in the transmission tariff application and not as an ancillary service.
  - Compensated by a specific consumer/s or generator/s who directly benefit from the installation of the specialised device.
    - This method is common when the device is specifically installed for increasing transfer capability (or stability) on a specific transmission line.
    - The compensation is then regarded as an ancillary service, but not paid for by all the users of the transmission network.

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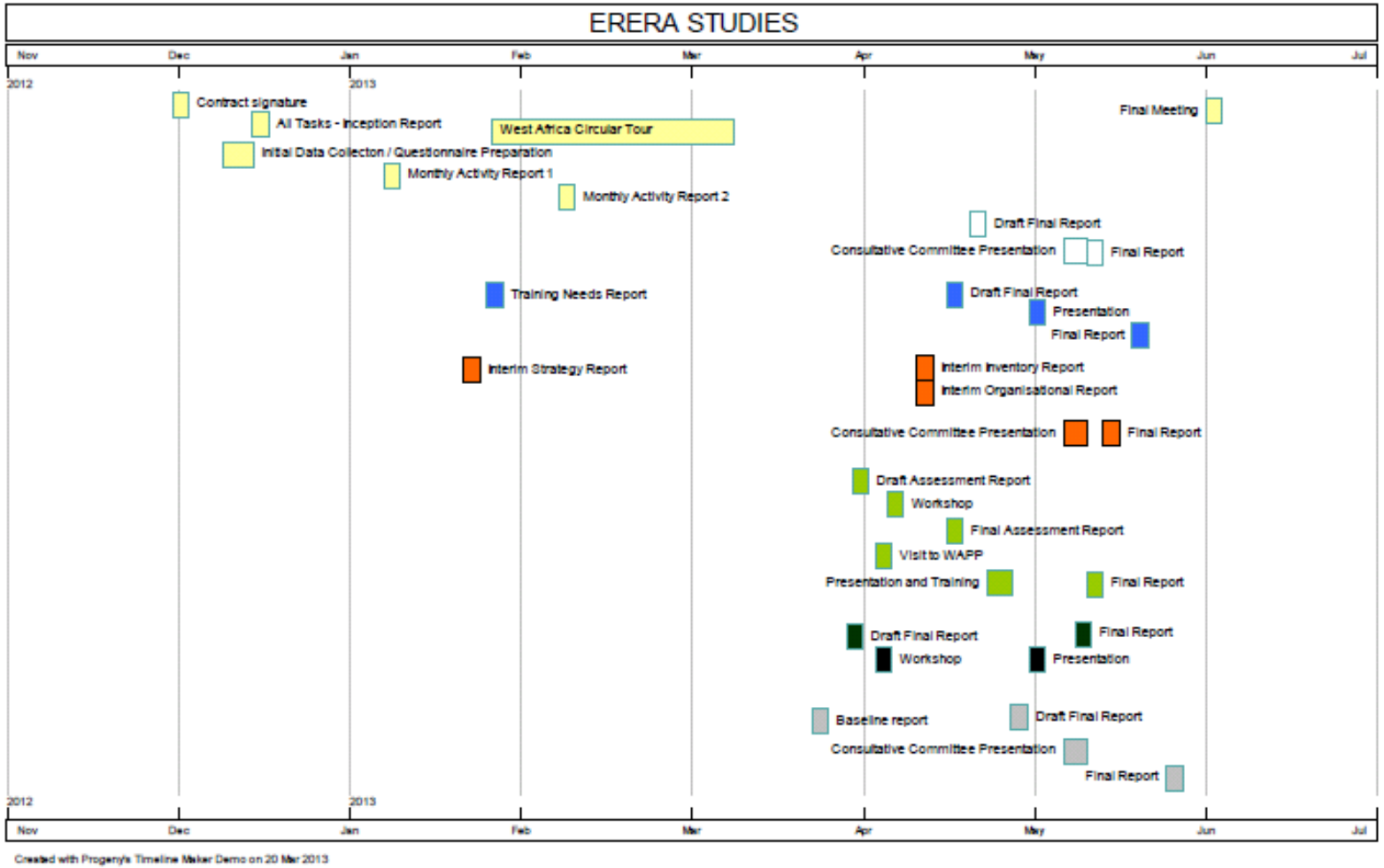
16:00 – 17:00	Feedback from ERERA / Proposed next steps
17:00	*CLOSING CEREMONY*

FEEDBACK FROM ERERA

NEXT STEPS


ERERA STUDIES
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2012
2013
Contract signature
All Tasks - Inception Report
West Africa Circular Tour
Initial Data Collecton / Questionnaire Preparation
Monthly Activity Report 1
Monthly Activity Report 2
Final Meeting
Draft Final Report
Consultative Committee Presentation
Final Report
Training Needs Report
Draft Final Report
Presentation
Final Report
Interim Strategy Report
Interim Inventory Report
Interim Organisational Report
Consultative Committee Presentation
Final Report
Draft Assessment Report
Workshop
Final Assessment Report
Visit to WAPP
Presentation and Training
Final Report
Draft Final Report
Workshop
Final Report
Presentation
Baseline report
Draft Final Report
Consultative Committee Presentation
Final Report
Created with Progeny's Timeline Maker Demo on 20 Mar 2013

TASK 4 PROVISIONAL PROGRAMME

- Final Assessment Report
  - 15 April 2013
- Presentation and Training
  - 22 to 25 April 2013 – Lome
- Final Report
  - 10 May 2013

THANK YOU

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