




REGULATORY STUDIES – LOTS 1 AND 2

ECOWAS Regional Electricity Regulatory Authority

Presentation and Training on Proposed ECOWAS Transmission Tariff Methodology

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Lome, 10 May 2013

ARTELIA

PPA energy

SUMMARY

1) Introduction to proposed ECOWAS regional transmission pricing and losses methodology
2) Training on steps to regional transmission pricing and losses methodology
3) Discussion and feedback from workshop delegates
4) Discussion of impact of proposed method on existing arrangements
5) Finalisation of regional transmission pricing and losses methodology
6) Finalisation of Activity 4 – Review and Agreement on Final Report
7) Closing ceremony and any other business

PROGRAMME FOR FRIDAY, 10 MAY

08.30 – 11:30	Introduction to proposed ECOWAS regional transmission pricing and losses methodology
11.30 - 11.45	COFFEE BREAK
11:45 – 12:45	Training on steps to regional transmission pricing and losses methodology
12.45 – 14.00	LUNCH
14:00 – 15:45	Training on steps to regional transmission pricing and losses methodology (continued)
15.45 – 16.00	COFFEE BREAK
16:00 – 17:00	Training on steps to regional transmission pricing and losses methodology (continued)
17:00 – 18:00	Discussion and feedback from workshop delegates

PROGRAMME FOR SATURDAY, 11 MAY

08:30 – 10:30	Review of comments received from workshop delegates
10.30 - 10.45	COFFEE BREAK
10:45 – 11:45	Discussion of impact of proposed method on existing arrangements
11:45 – 12:45	Finalisation of regional transmission pricing and losses methodology
12.45 – 14.00	LUNCH
14:00 – 15:45	Finalisation of Activity 4 – Review and Agreement on Final Report
15.45 – 16.00	COFFEE BREAK
16:00 – 17:00	Closing ceremony and any other business

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

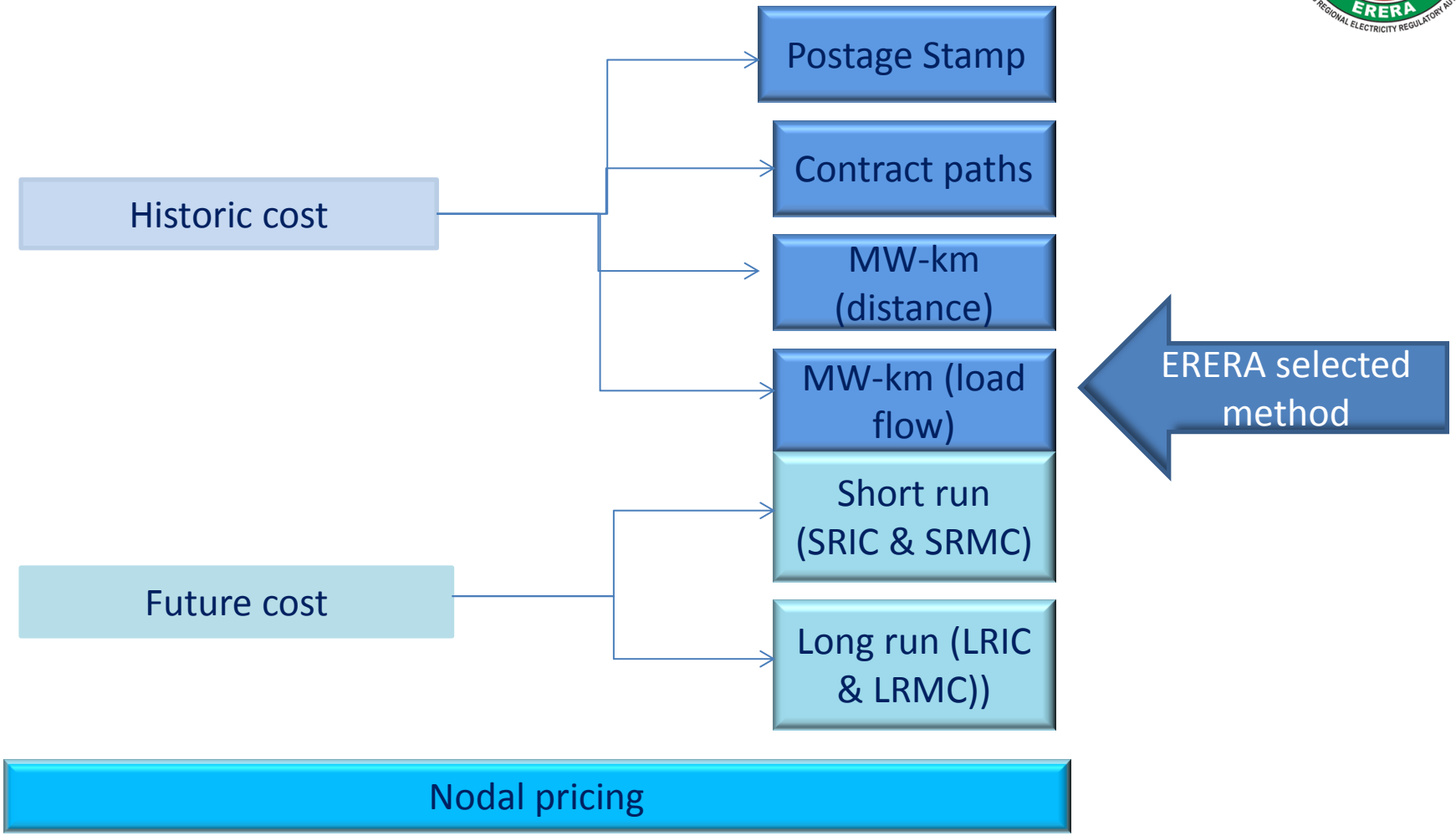
- Encourage new market participants
- Fair
- Stable- immune to ‘price shocks’
- Clear and straightforward to apply

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



EXAMPLE:GENERATION IN MALI, DEMAND IN NIGERIA

1)

CONTRACT PATHS

CONTRACT PATHS

CONTRACT PATHS

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)

SUMMARY OF DISCUSSION AT PREVIOUS 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.* *Not Applicable as proposed method is point to point*

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.* *Yes but will come from load flow*

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: To be decided later Consultant to make a proposal

$$Re = Rf + ße\,(Rm - Rf)$$

- 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: To be decided later Consultant to make a proposal

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

- 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

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. Method is Nodal by definition each bilateral has a different charge
- 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.

ECWAS -Transmission Tariff and Losses Methodology - Introduction

- A point to point - Generator to Consumer
- MW-Km load flow based. Proportional usage of each asset identified
- Transmission Tariff and Losses calculated annually for each and every regional bilateral trade within ECOWAS
- Consumer pays for transmission charges and losses

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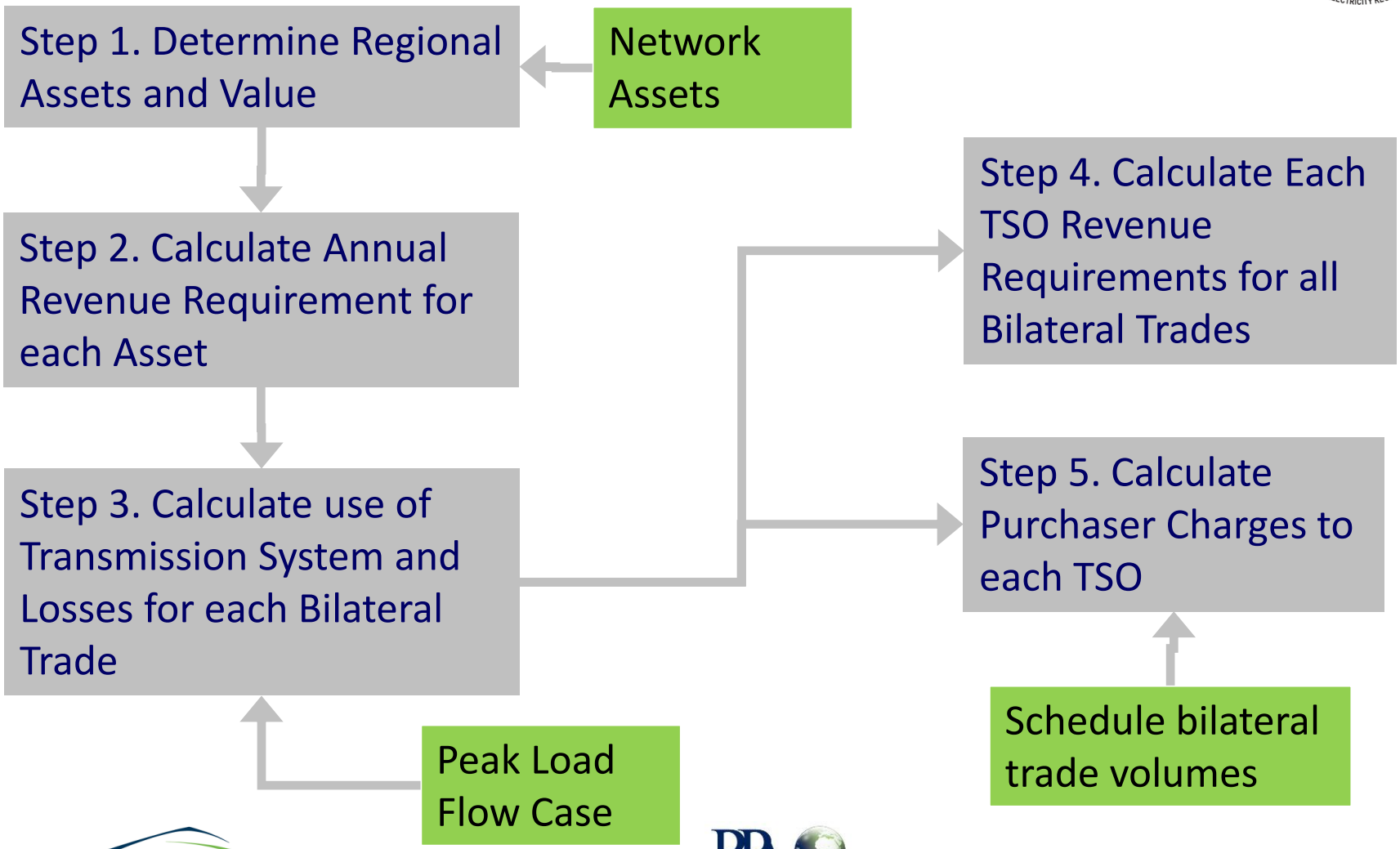
FUNDAMENTAL STEPS IN THE METHODOLOGY

1. Determine regional transmission assets and asset value
2. Calculate annual revenue requirements for each Transmission System Operator (TSO) asset used for regional bilateral trading
3. Calculate use of transmission system and associated transmission losses for each regional bilateral trade
4. Calculate transmission revenue requirements for each TSO for regional bilateral trades
5. Calculate transmission tariff and transmission losses for the purchaser of each regional bilateral trade

TRANSMISSION TARIFF SUMMARY OF STEPS



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Step 1 Determine Regional Transmission Assets and Asset Value

- Regional Transmission Network is all **interconnected** assets greater than 132 kV (or as agreed by ERERA) in the ECOWAS region.
  - Interconnected assets are regionally interconnected
  - There maybe more than one synchronous area
  - Does not include supplying domestic demand from one country to another
  - Does not include supplying a neighbouring demand at < 132 kV (or as agreed by ERERA)

Typical Information Required in the Database

- All regional assets per TSO including.
  - Network branch
  - Line lengths
  - Number of circuits
  - Line type
  - Tower types
  - Voltage
  - Switchgear type
  - Transformer rating
  - Commercial operating date

Determining Asset Value

- There are many variables that affect the cost of transmission assets, particularly transmission lines such as:
  - Type of terrain covered by the line route or substation location,
  - Type/source of the funding,
  - State of the construction market,
  - Source of the materials, etc.
- The asset values can be average values representative of the costs in the region as a whole.
- Costs can be based on data from recent contracts provided by the ECOWAS member utilities.

DETERMINING ASSET VALUE

- International sources of determining asset value
  - World Bank
  - EPRI
  - Cigre
  - Original Equipment Manufacturer's
  - Other international benchmarking

DATABASE MANAGEMENT AND UPDATING

- Database is managed by WAPP
- Each TSO send updated information to WAPP
- Database is updated annually
- Replacement values updated every 5 years
  - Updating values is not an easy exercise
  - 5 years of revenue certainty to TSO's

STEP 2 Calculate annual revenue requirements for each Transmission System Operator (TSO) asset used for regional bilateral trading

- The cost components to be recovered are:
  - Capital costs of network and equipment, and
  - Operating and maintenance costs

DETERMINING ASSET LIFE – SAPP MEMBER COUNTRIES

- Eskom 25 years
- BPC 40 years
- ZESA 25 – 30 years
- ZESCO 15 – 25 years (includes both transmission and distribution assets)
- NamPower 25 – 50 years
- SAPP 30 years

DETERMINING ASSET LIFE – INTERNATIONAL PRACTICE

• NGC, UK		40 years
• Transpower, New Zealand		25 – 55 years
• Transgrid, Australia	Overhead lines:	50 years
•	Cables:	45 years
•	Substations	40 years
•	Transformers	35 years
•	Buildings	30 years
• Nordpool		25 – 50 years
• PG&E, California, USA		27 – 65 years

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				

DETERMINING ASSET LIFE – TYPICAL VALUES

- Transmission lines, 50 years
- Substation equipment, 25 years;
- Substation civil works, 50 years; and
- Transformers, 25 years.
- An average of 30 years is commonly used

CALCULATION OF ASSET VALUE IN SENEGAL

Value of assets in a given year at Ki, which is calculated as follows:

$$Ki = (K_0 + \sum_{j=0}^{i-1} I_j) + \frac{\sum_{j=i}^{i+p-1} I'_j}{p}$$

Where K_0 the value of all assets of the networks as estimated in 1999

I_j the total of real investments in year j

I'_j the total of forecast investments for year j

i the number of years after 1999

p the duration of the period (here p = 3)

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:
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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

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								

Risk Free Rate (Rf) for Nigeria

- The yield on government bonds is regarded as the risk free rate and NERC has had regard to relevant yields on Nigerian Treasury bonds and has selected a risk free rate of 18%
- Many regulators use 10-year bond rates or 10-year (index-linked) bonds or their local equivalent.
  - The longer term also ensures consistency with the risk free rate used to estimate the market risk premium - that is also based on 10-year bonds.

COST OF DEBT FOR NIGERIA

- NERC adopted a nominal cost of debt of 24% to be same level as most companies

$$Rd = Rf + DRP + DIC$$

- Where:
  - R_f is the risk free rate observed in the market
  - DRP is debt risk premium
  - DIC is the debt issuance cost lending in Nigeria

GEARING FOR NIGERIA

- In the past, independent power producers in developing countries were financed with high gearing ratios – commonly 80:20 debt to equity
- World Bank suggested that future ratios would be closer to 60:40
- NERC selected a gearing ratio of 70:30

WACC INPUTS FOR NIGERIA

- risk free rate 18%
- nominal cost of debt 24%
- gearing level (debt/equity) 70:30
- corporate tax rate 32%

WACC Estimate for Nigeria

- Nominal pre-tax WACC 25%
- Nominal post- tax WACC 17%
- Real pre-tax WACC 11%
- Real after tax WACC 7%

WACC INPUTS FOR SENEGAL

- **g** : Estimate of debt/capital ratio = **45%**
- **Rd** : cost of debt after tax
  = policy rate of BCEAO (6.5%)
  + bank operating margin (2%) = **8.5%**
- **Re** : Estimated cost of capital = $Rf + \beta \times Rm$
- **Rf** : Risk-free rate of return after State loans taxes = **6.5%**
- **β**: Sensibility = **0.8**
- **Rm** = Rentability premium of the market = **5%**

- **Ts** = Tax rate on tax settlement = **17%**
- **Tc** = Tax rate on corporate profits = **30%**

WACC Estimate for Senegal

- Nominal pre-tax WACC 11.38%
- Nominal post- tax WACC 9.6%

Operating and Maintenance Costs

- To be recovered by allowing a predetermined margin on the capital costs of equipment
- Annual allowances vary internationally and are typically in the range 2%-5% of the capital cost per annum
- The ECOWAS percentage allowed will be agreed by ERERA
- SPV's or privately owned transmission assets operating costs could be actual operating costs as approved by ERERA

Examples of Impact of WACC and Depreciation Period on Annual Asset Value

- Change in WACC
- Change in asset life
- Depreciating asset life to half the value
- Cost of maintenance as a percentage of asset value

STEP 3 Calculate use of transmission system and associated transmission losses for each regional bilateral trade

- Determines the transmission assets utilised and associated transmission losses for the each regional bilateral trade.
- A load flow methodology is proposed.
  - A load flow, contingency analysis and dynamic stability study is required to be performed for each proposed regional bilateral trade to ensure there is sufficient transmission access for the regional bilateral trade before it is approved.
  - Further each year a load flow is done for the forecast maximum generation hour for the next year and this is the load flow solution proposed for the method.
- The base case is the peak generation case for the following year
- Transmission pricing and losses studies will be performed annually by WAPP planning engineers

STEP 3 method in detail

a Set up base case simulation model with the peak demands and generation in the region including all of the regional bilateral trades.

b Remove a regional bilateral trade by decreasing the consumption by the trade volume at the transmission node associated with the demand.

- The order for the regional bilateral trades is the oldest trade is applied to the methodology first to be aligned with open access rules.
- The associated generator is set to be the swing bus.
- Solve the load flow.

STEP 3 method in detail (continued)

c Add the regional bilateral trade back by increasing the consumption by the trade volume at the transmission node associated with the demand.
  - The associated generator is set to be the swing bus.
  - Solve the load flow.

d As the trade is added the transmission elements that increased by ≥ 1% are noted as the transmission assets utilised for the specific regional bilateral trade.
  - Record the percentage change increase in flow for each transmission asset that increased by ≥ 1%.
  - Need to think about whether there is credit for decreasing flow but for the moment I think this is too complicated.

STEP 3 method in detail (continued)

e The change in transmission losses is calculated by subtracting generator increase from trade volume.
  - If the result is positive then this is the expected transmission losses.
  - If the value is negative then the bilateral trade reduces transmission losses (ERERA to decide on the action in this case)

    Tx losses = Gen Final Value – Gen Initial Value – Regional Bilateral Trade

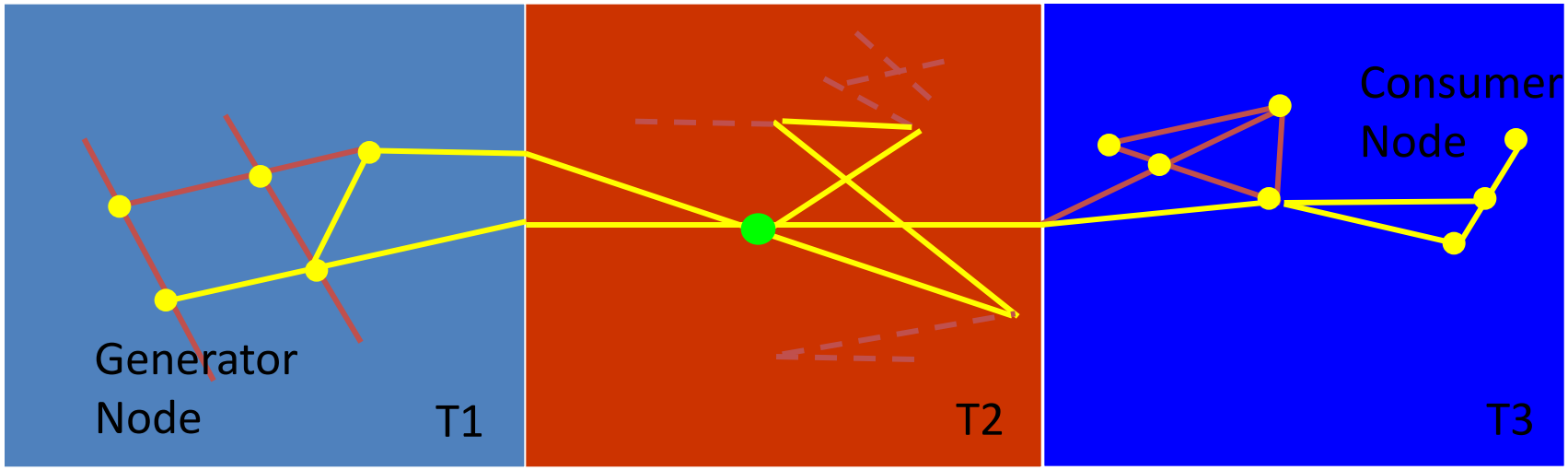
  - The calculation of losses could be done for different periods of the day and year to obtain average losses.

f Repeat steps b to e for each regional bilateral trade in order from oldest trade first

GENERIC STUDIES FOR FUTURE BILATERAL TRADES

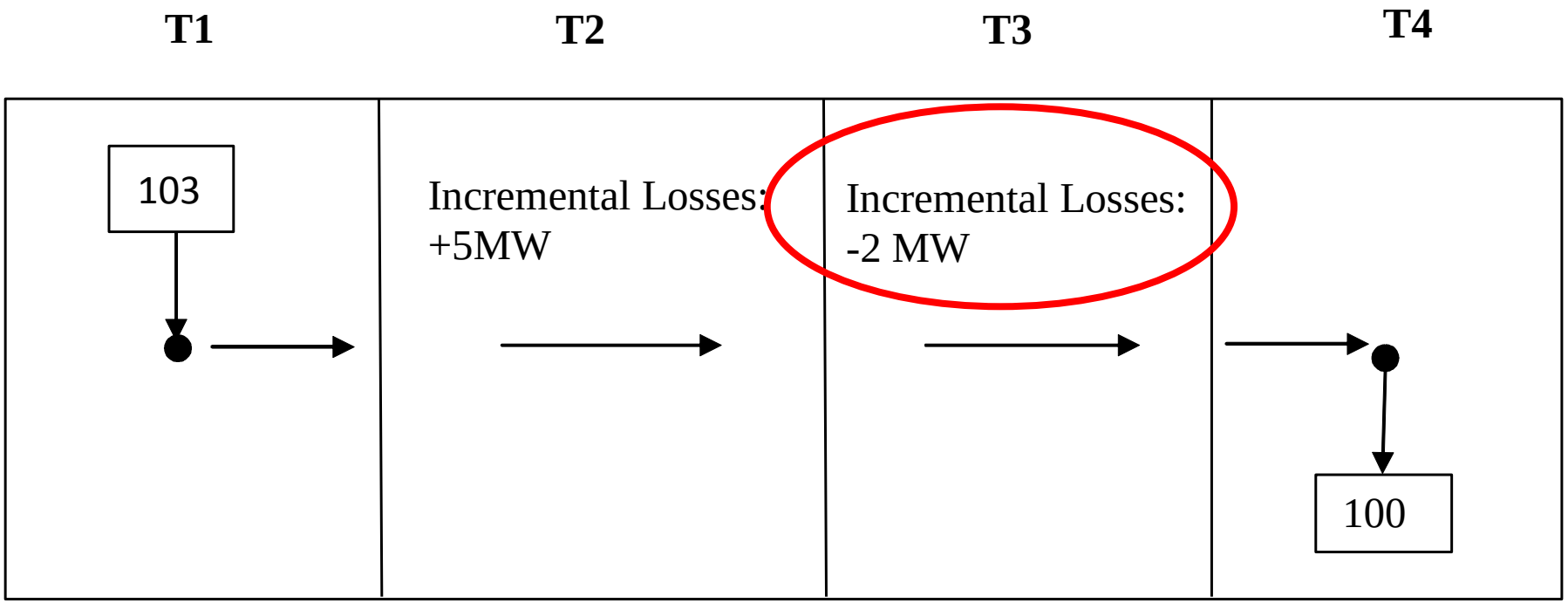
- It would be possible to develop indicative costs for future regional bilateral trades by using the load flow model and simulating generation and off take points throughout the network.
- Most load flow simulation packages allow for macros to be written for multiple studies
- Short term bilateral trades could have a pricing index

Summary of Simulations to Determine Assets Used



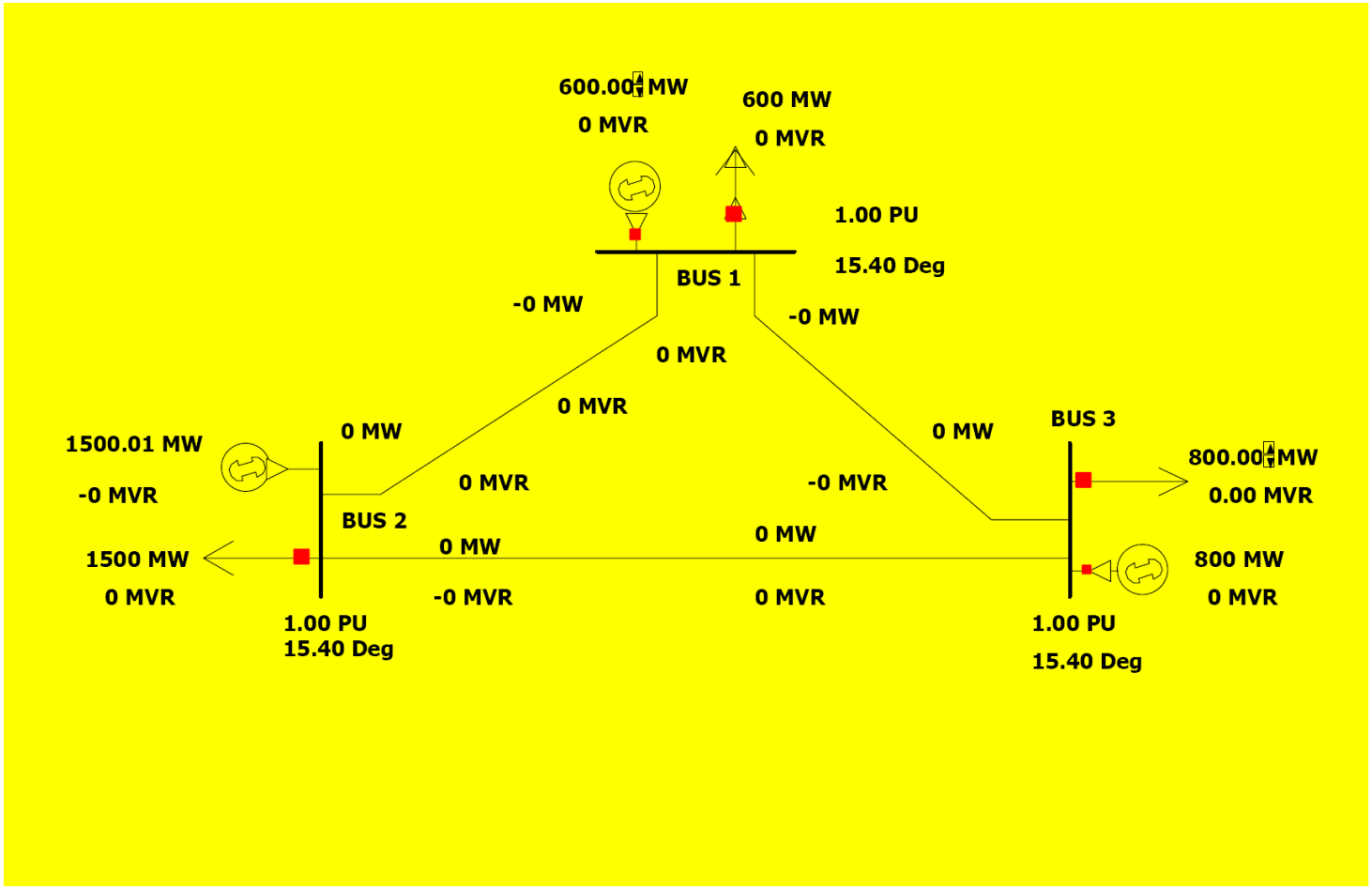
- Yellow shows assets that change by more than 1%
- Flows on each line can be measured
- Losses in each TSO can be simulated

IDENTIFYING PORTION OF ASSET USAGE

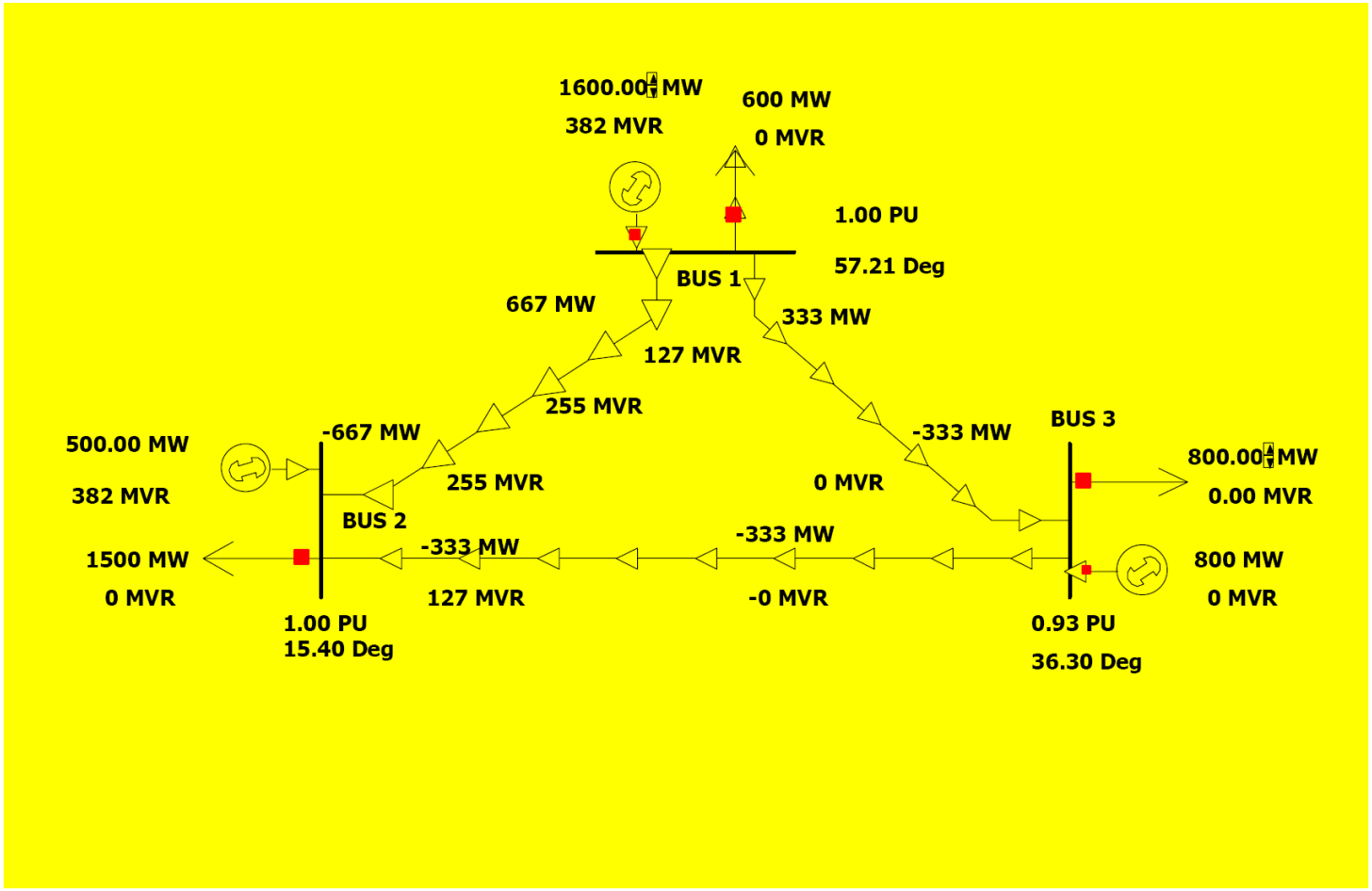


- What happens if there is a decrease in the losses?

3 Bus Example



3 Bus Example

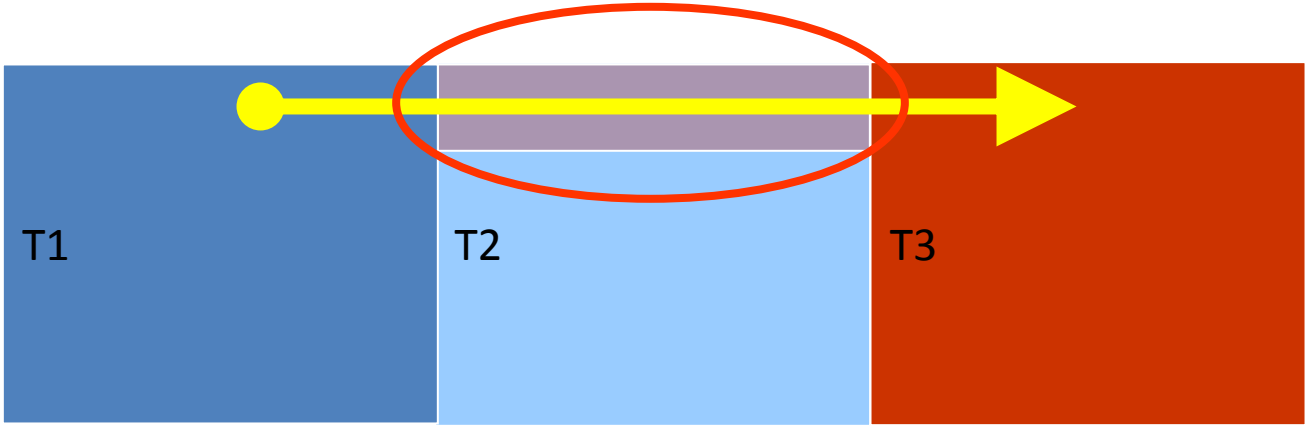


DIGSILENT EXAMPLE

STEP 4 Calculate Transmission Revenue requirements for each TSO for Regional Bilateral Trades

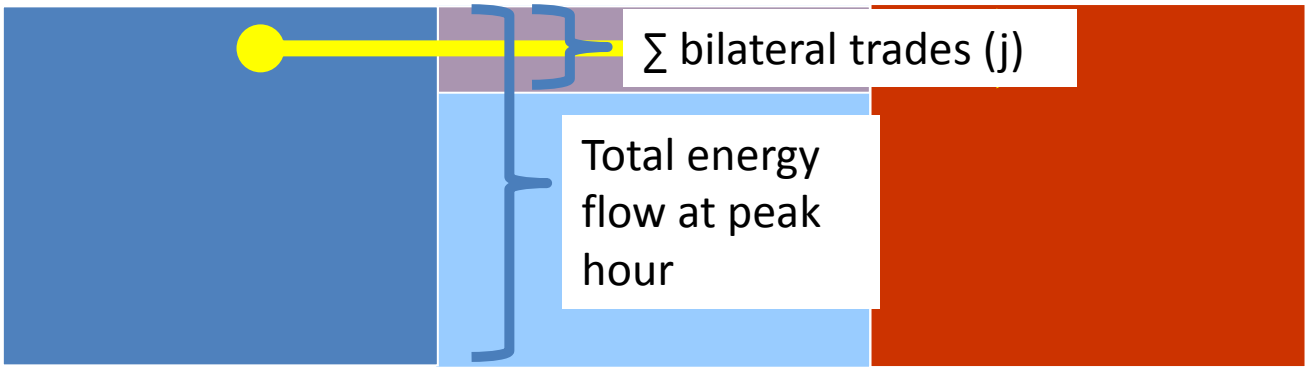
- The calculation of the revenue requirements to each TSO and to ensure they receive their full revenue requirement is to apportion the costs to each user of the system.

IDENTIFYING PORTION OF ASSET USAGE



- Point to point
- What happens when there is more than one user?
- How to apportion?

IDENTIFYING PORTION OF ASSET USAGE



- The apportioning is calculated on the percentage use of each asset for regional trades of the transmission network to the total energy flow

$$\sum_{j=1}^{m} (\text{TSO regional bilateral trade percentage for asset (i, j)}/100)$$

Where:

j is a regional bilateral trade,

m is the total number of regional bilateral trades

i is a transmission asset used for regional bilateral trades in TSO

TSO Revenue Calculation per Asset

$$\text{TSO bilateral asset revenue (i)} = \sum_{j=1}^{m} (\text{TSO regional bilateral trade percentage for asset (i, j)}/100) * \text{TSO revenue requirement for asset (i)}$$

Where:

j is a regional bilateral trade

m is the total number of regional bilateral trades

i is a transmission asset used for regional bilateral trades in TSO

TSO Revenue Calculation for all Assets

The sum of all the bilateral assets portions in TSO is the total revenue due to the TSO:

$$\text{TSO annual revenue (k)} = \sum_{i=1}^{n} (\text{TSO bilateral asset revenue (i)}$$

Where:

i = transmission asset used for regional bilateral trades in TSO

n = the total regional interconnection assets in the TSO (k)

Revenue for Dedicated Regional Transmission Assets

- For a transmission asset that is specifically built for a single regional trade.
- The TSO regional bilateral portion will be 1 each and every TSO transmission asset.
- The TSO regional bilateral trade assets revenue = TSO total assets revenue requirements for each and every TSO transmission asset.
- The full TSO costs are covered and revenue is guaranteed.

Revenue Apportioning Regional Transmission Assets

- In the case where the whole transmission network is used for a regional bilateral trade then the portion paid by the TSO regional bilateral trade is in proportion to the energy flowing on each element.
- The proportion might be higher or lower than what will be recovered using the current postage stamp methodology in most by ECOWAS countries.
- The methodology will ensure no cross subsidisation for actual usage.

TSO Transmission Losses Revenue Calculation for all Trades

Transmission losses are paid as the TSO loss factor multiplied by the regional bilateral trade times the price for the energy lost. ERERA will determine the tariff for losses.

$$\text{TSO transmission losses revenue (k)} =$$

$$\sum_{j=1}^{m} (\text{transmission flow for bilateral trade (j)} * \alpha\,(j) * \text{energy price})$$

Where:

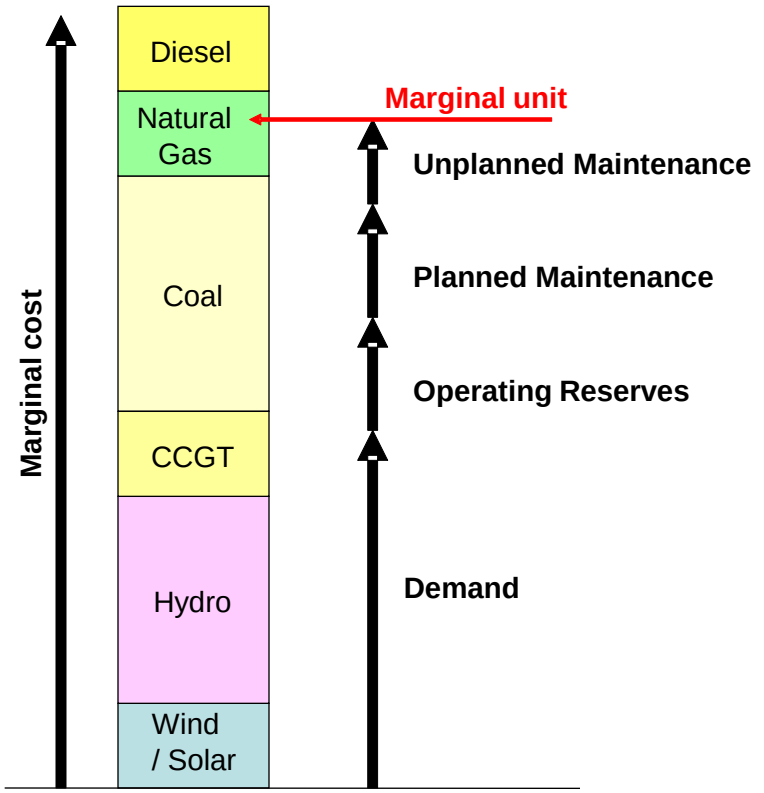
α (j) is the loss factor for bilateral trade j

DETERMINING ENERGY PRICE

- The energy price for calculating losses can be based on three methods:
  - Energy Price in bilateral agreement
  - Spot Market Energy Price
  - Cost Based Energy Price

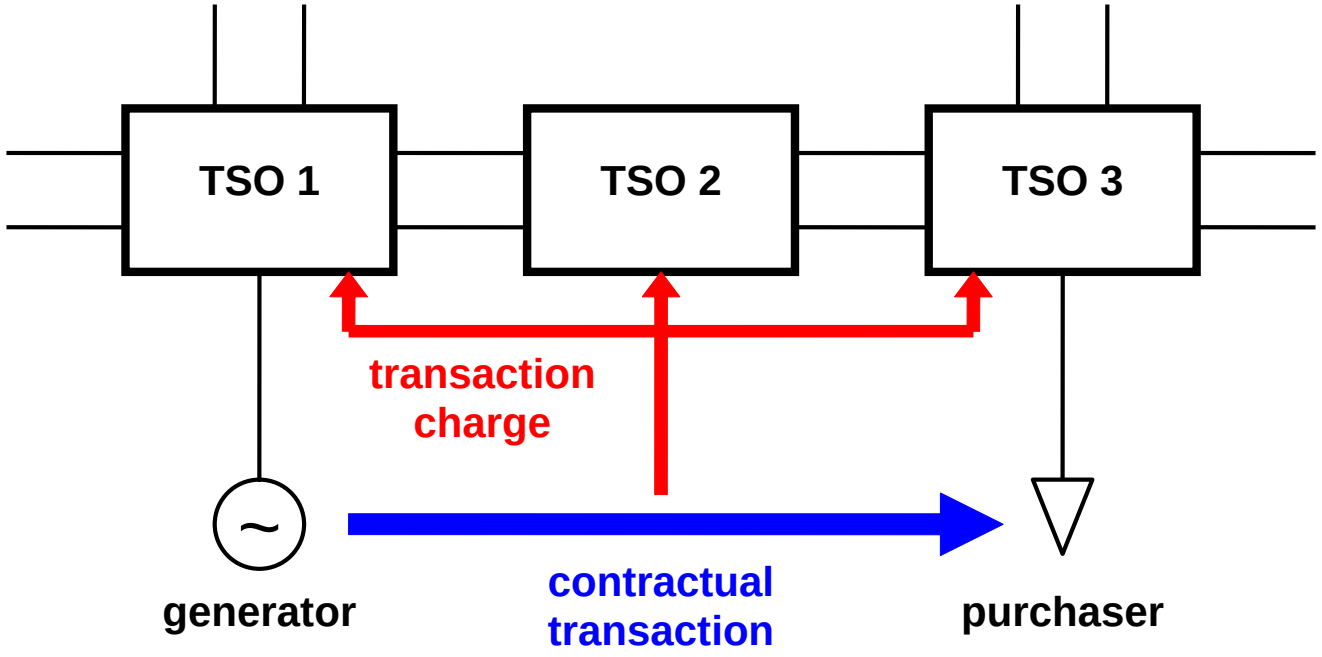
EXAMPLE OF COST BASED ENERGY PRICE

- The energy price determine by the marginal generator type for period of the day



STEP 5 Calculate Transmission Tariff and Transmission Losses for the Purchaser of each Regional Bilateral Trades

- The sum of the individual asset costs for each bilateral charge is paid by the purchaser of the regional bilateral trade.



TSO Asset Revenue for a Bilateral Trade

The sum of all the bilateral assets portions in TSO is the total revenue due to the TSO:

$$\text{TSO bilateral asset revenue (j)} = \sum_{i=1}^{n} (\text{TSO regional bilateral trade percentage for asset (i, j)}/100 * \text{TSO revenue requirement for asset (i)})$$

The costs are charged at rate per kwh based on hourly scheduled (contracted) energy.

TSO Losses Revenue for a Bilateral Trade

- The transmission losses is paid by the purchaser of the regional bilateral trade.
- The price payable for the energy is determined by ERERA.
- Alternatively the seller of the regional bilateral trade's generation schedule is increased by the transmission losses percentage.

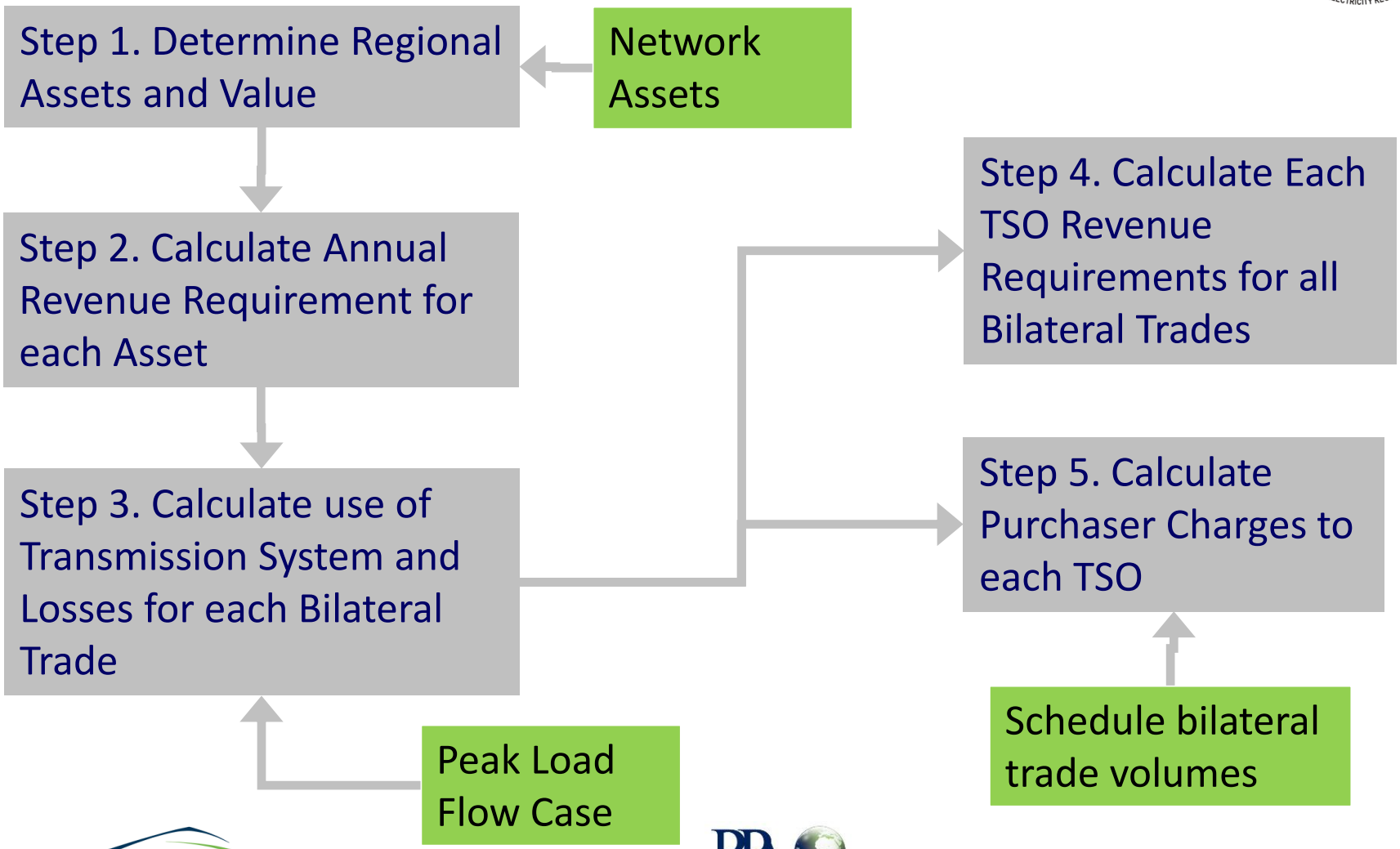
ERERA ROLE AND ERERA FUNDING

- ERERA (or WAPP on ERERA's behalf) will collect from purchasers of bilateral trades for transmission tariff and transmission losses.
- A percentage mark up will be allowed to pay for banking charges and ERERA revenue requirements.
- The percentage mark up will be agreed by the ERERA board.
- ERERA (or WAPP on ERERA's behalf) will pay TSO's their allocated transmission tariff and losses revenue.

BILLING AND SETTLEMENTS

- Billing and settlements is based on energy schedules and schedules will be provided by the purchaser of the regional bilateral trade.
- Billing and settlements will be done monthly.

TRANSMISSION TARIFF SUMMARY OF STEPS



ARTELIA

PPA energy

CONGESTION MANAGEMENT

- Congestion is managed on a first come first serve basis.
- The latest signed regional bilateral trade will be the first to be curtailed.

Calculating Available Transmission Transfer Capacity

- Total Transfer Capacity (TTC) allowed for normal secure operation
- Transmission Reliability Margin (TRM) is capacity margin for unintentional exchanges, emergencies, inaccuracies
- Net transfer capacity NTC = TTC – TRM
- AAC is already allocated capacity
- ATC is available for use capacity
- ATC = NTC – AAC
- Results collated and published to bilateral trade participants

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.

ANCILLARY SERVICES

- Any specialised transmission device deemed an ancillary service will be settled by the trading parties directly.

FEEDBACK FROM ERERA

Discussion and feedback from workshop delegates

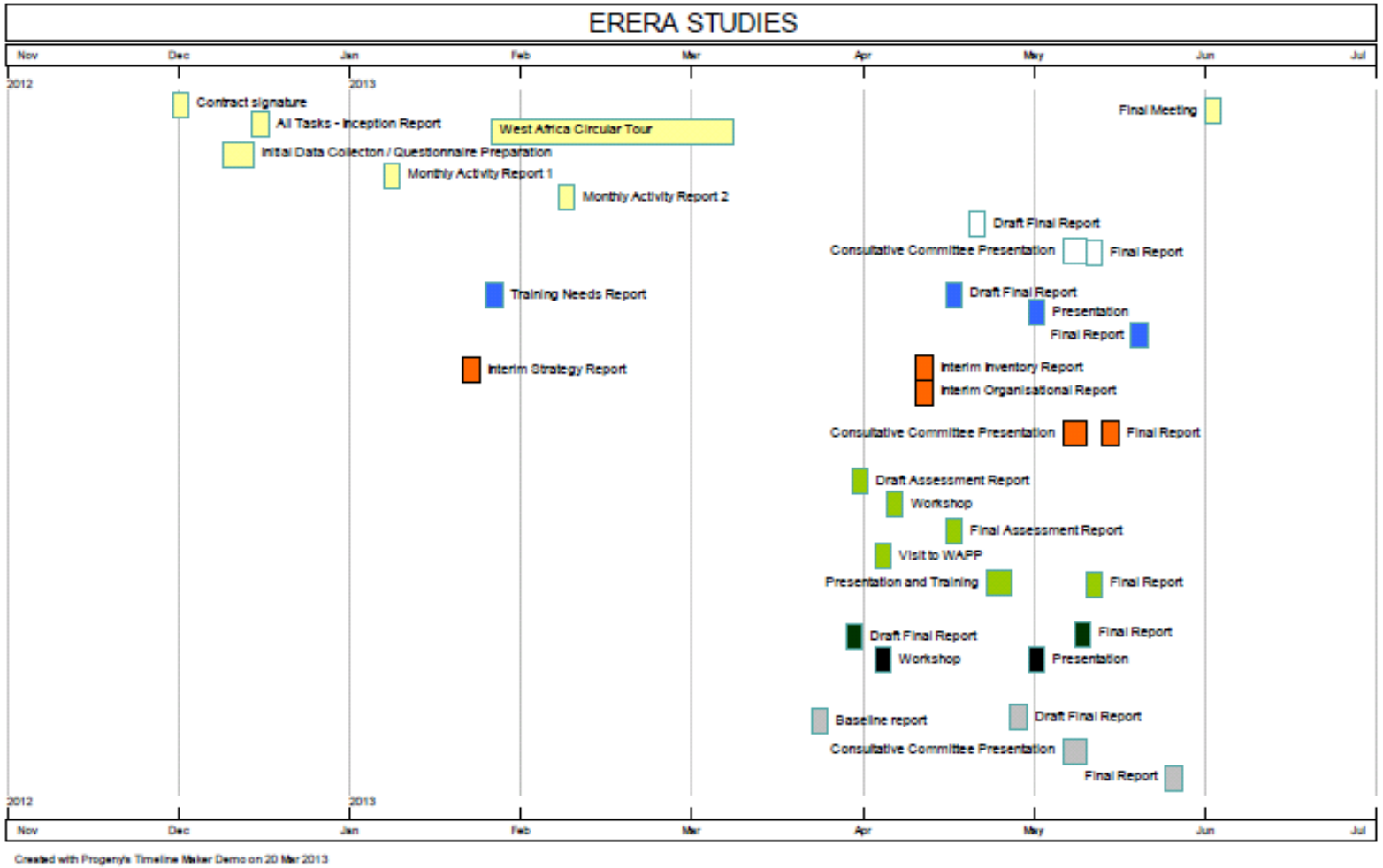
PROGRAMME FOR FRIDAY, 10 MAY

08.30 – 11:30	Introduction to proposed ECOWAS regional transmission pricing and losses methodology
11.30 - 11.45	COFFEE BREAK
11:45 – 12:45	Training on steps to regional transmission pricing and losses methodology
12.45 – 14.00	LUNCH
14:00 – 15:45	Training on steps to regional transmission pricing and losses methodology (continued)
15.45 – 16.00	COFFEE BREAK
16:00 – 17:00	Training on steps to regional transmission pricing and losses methodology (continued)
17:00 – 18:00	Discussion and feedback from workshop delegates

PROGRAMME FOR SATURDAY, 11 MAY

08:30 – 10:30	Review of comments received from workshop delegates
10.30 - 10.45	COFFEE BREAK
10:45 – 11:45	Discussion of impact of proposed method on existing arrangements
11:45 – 12:45	Finalisation of regional transmission pricing and losses methodology
12.45 – 14.00	LUNCH
14:00 – 15:45	Finalisation of Activity 4 – Review and Agreement on Final Report
15.45 – 16.00	COFFEE BREAK
16:00 – 17:00	Closing ceremony and any other business

NEXT STEPS


ERERA STUDIES
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
2012
2013
Contract signature
All Tasks - Inception Report
Initial Data Collecton / Questionnaire Preparation
West Africa Circular Tour
Monthly Activity Report 1
Monthly Activity Report 2
Training Needs Report
Interim Strategy Report
Final Meeting
Draft Final Report
Consultative Committee Presentation
Final Report
Draft Final Report
Presentation
Final 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 Progenyis Timeline Maker Demo on 20 Mar 2013

ACTIVITY 4 PROVISIONAL PROGRAMME

- Final Assessment Report
  - 15 April 2013
- Presentation and Training
  - 10 & 11 May 2013 – Lome
- Final Report
  - 24 May 2013

THANK YOU

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