



ENERGY REGULATORS  
REGIONAL ASSOCIATION

# **Regulatory Approaches to Revenue Setting for Electricity Transmission and Distribution System Operators among ERRA Member Organizations**

◀ EXECUTIVE SUMMARY ▶

Submitted to  
ERRA by:

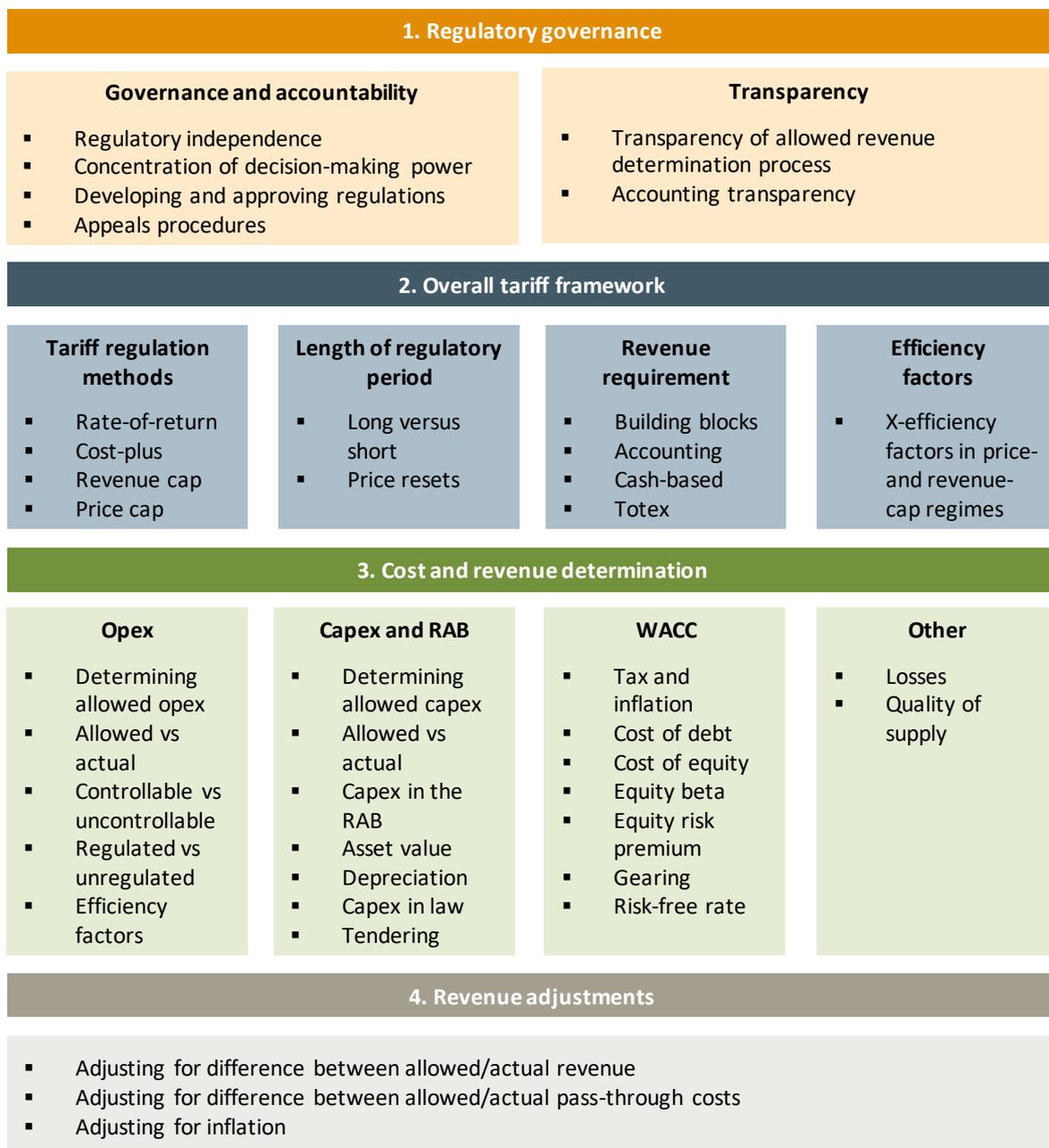


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# Executive summary

This study draws on survey data collected from 20 member organisations (MOs) of the Energy Regulators Regional Association (ERRA) to investigate their approaches for regulating the revenue of electricity transmission and distribution system operators (TSOs and DSOs).

The study is presented in four steps: (i) a review of the regulatory governance structures in each country; (ii) a description of the overall tariff framework in each country; (iii) a deeper analysis of the components underlying the broader framework; and (iv) an explanation of the adjustment mechanisms adopted (see diagram below).



## 1 Regulatory governance

The first step in this study is to investigate regulatory governance. We look at two broad areas: (i) governance and accountability; and (ii) transparency.

**Governance and accountability** primarily concern the independence of regulators from government. Independence is considered important for regulators to freely balance the goals of affordability for end users and financial sustainability for utilities. In this study, we find:

- **Regulators are institutionally separate from government in most cases.** Most regulators are institutionally independent from government and report directly to the legislature. There are five exceptions: Peru and Pakistan's are government bodies separate from the energy ministry but report to the executive; Estonia and Azerbaijan's are agencies in a ministry; and Austria is self-described as an independent regulator reporting to the executive.
- **Decision-making powers are well dispersed in most cases.** Most regulators disperse decision-making power across multiple commissioners or bodies. However, Estonia, Hungary, Poland and Slovakia concentrate decision-making in a managing director.
- **Appointment to regulators is influenced by the executive in most cases.** At four regulators, the legislature proposes and appoints commissioners. However, at nine regulators, the executive both proposes and appoints commissioners; at others it handles proposals, appointment, or the open call.
- **Regulators mostly set the allowed revenue methodology.** The only indication of government involvement is in Azerbaijan, where the government must approve the methodology, but the regulator informs us that the strategy of the Government will address this in future.
- **Most regulatory regimes have an appeals process.** Regulatory decisions may be appealed in all jurisdictions except Czechia and Hungary. Of the 18 countries with a right of appeal, courts receive appeals on regulatory decisions in 16; Nigerian and Peruvian courts only consider procedural breach. Azerbaijan is the only to report an administrative appeals procedure via the executive, which is an alternative to appealing through the courts.

**Transparency** is important for the regulator to build trust with end users who pay the tariff and the regulated entities which rely on tariff revenues. It also allows for methodological scrutiny, which ultimately leads to better practice and accountability. In this study, we find:

- **Regulators are highly transparent with key regulatory documents.** The allowed revenue methodology and decisions on approved tariffs are publicly available in all jurisdictions except Azerbaijan.
- **Transparency could be improved for other regulatory documents.** Twelve regulators make tariff proposal consultation papers public. Eleven publicise

tariff calculation models and decisions on allowed revenues (if applicable). Only ten regulators make stakeholder comments publicly available.

- **Auditing of regulatory accounts is widely practised.** Only Hungary and North Macedonia do not legally require the auditing of regulatory accounting statements, while Estonia and Georgia do not legally require regulatory accounting statements to be submitted. However, utilities in Estonia must submit data based on accounts, and Georgia's regulator informs us there will be a legal requirement from 2021.

**Our observations on regulatory governance** are:

- All MO countries have taken steps to create some degree of independence for their regulators.
- The form of governance chosen by the MO countries differs, reflecting explicit policy choices but also the specific institutional characteristics of the relevant countries and the stage of electricity sector reform.
- Effective governance of the tariff setting process requires more than the establishment of independent or semi-autonomous regulators and regulatory rules; it also requires robust scrutiny of the forecasts, assessments and proposals submitted by the regulated companies (which is discussed further below).

## 2 Overall tariff framework

The second step in this study is to investigate the overall framework governing tariffs for TSOs and DSOs in each jurisdiction. We look at four broad areas: (i) tariff regulation methods; (ii) the length of the regulatory period; (iii) the calculation method for determining the revenue requirement; and (iv) X-efficiency factors.

The **tariff regulation method** is the broad approach adopted by the regulator to control the regulated entity's tariffs. In this study, we find:

- **The most common tariff regulation method is revenue cap** (six TSOs and nine DSOs), followed by price cap (four/five), hybrid regimes (four/three), cost-plus (three/two), and rate-of-return (three/one).<sup>1</sup>
- **Hybrid approaches are sometimes used.** Poland uses a hybrid of a revenue cap and cost-plus for the TSO. Pakistan uses a hybrid approach for its TSO and DSO combining rate of return for capex with elements of a revenue cap for opex. Hungary's hybrid approach combines a revenue and price cap (in the sense that there is some volume risk for the networks); the tariffs are capped, but there is a correction if actual revenue differs more than 2% from the required revenue.

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<sup>1</sup> Throughout the report, whenever there is a number of TSOs/DSOs with relation to any quoted statistics, it refers to a number of TSO or DSO regulatory regimes, rather than particular operators.

**Our observations on the overall tariff regulation method are:**

- Incentive-based regimes (revenue and price caps) are used more commonly than rate-of-return or cost-plus regimes among the MOs.
- The main trade-off between these two broad sets of tariff regulation methods is the balance between the **risk** to the regulated entity of not recovering its costs and the **incentives for efficiency**.
- Incentive regulation is generally thought to provide stronger incentives for efficiency. This efficiency incentive, however, involves a trade-off with risk to the regulated business of not recovering its costs. Under rate of return regulation, if a business' costs increase, it can seek a review and its revenues will be brought back in line with costs (albeit with a lag). In contrast, a regulated business subject to incentive regulation, must bear (all or a portion of) cost increases for the duration of the regulatory period.
- The choice of the preferred method of regulation therefore is not unambiguous and depends on both country circumstances and the relative weighting placed on different objectives. **Most MOs in this study seemingly place greater emphasis on efficiency incentives**, given the prevalence of incentive-based regimes.

The **length of the regulatory period** in a price- or revenue-cap regime determines how long the cap applies. A longer duration reduces regulatory burden and provides utilities with the chance to make greater profits by being more efficient, but it also increases the risk that utilities make greater losses. While the regulatory period is often fixed, tariff re-openers may be permitted in certain cases. In this study, we find:

- **The most common regulatory period length is five years** (six TSOs and ten DSOs), followed by four years (three/three), three years (three/two), and one year (six/three). All cost-plus regimes are one year.
- **Regulatory period lengths vary within jurisdictions.** In Turkey, the revenue cap is three years for the TSO and five years for the DSO. Austria and Poland have five-year DSO revenue caps but one-year TSO regimes. In Pakistan, the regulatory period is one year for seven DSOs and five years for three DSOs. In Bulgaria, the revenue cap ranges from two to five years across DSOs; the TSO is governed by a rate-of-return approach.
- **Most jurisdictions permit re-openers if they are applicable.** Albania, Turkey and Peru are the only price or revenue caps that do not permit re-openers.

**Our observation on the length of the regulatory period** is that the MO experience accords with that of regulatory regimes elsewhere. That is, regulatory agencies employing incentive regimes appear to have **largely settled on a three to five-year regulatory period** as representing an appropriate balance between not imposing excessive risk on regulated utilities (or network users), while avoiding too frequent resetting of tariff controls.

**Determination of the revenue requirement** refers to the process used to arrive at the numerical value of the regulated entity's allowed revenue. Different methods include *building-blocks, accounting, cash-based, totex*, among others. In this study, we find:

- **19 TSOs and 18 DSOs use building blocks to determine allowed revenue.** The regulatory framework for the Peruvian DSO deviates from this, instead adopting a totex approach. The Turkish regulator uses statutory accounts in the determination of the revenue requirement of the TSO, but only as a loose guide to assist the building-blocks approach.

**X-efficiency factors** can be used by regulators in forward-looking revenue or price caps to incentivise efficiency improvements over time. A common approach is to allow the cap to grow in line with CPI-X, where CPI is the inflation rate (consumer price index), and X is an efficiency factor. In addition to a general X-efficiency factor for the price or revenue cap, efficiency improvements can be assumed for individual allowed expenditures (eg operating and capital expenses); this is covered later in the discussion on cost and revenue determination (see step three). In this study, we find:

- **Less than half of applicable regimes have X-efficiency factors.** Only four of the ten TSOs and six of the 14 DSOs with a price or revenue cap have an X-efficiency factor.
- **X-efficiency factors vary greatly across and within countries.** Factors range from -2% (Oman's TSO and DSO) to 11.15% (for some of Turkey's DSOs). Within Pakistan and Turkey, X-efficiency factors differ across DSOs.

### 3 Cost and revenue determination

The third step in this study is to investigate cost and revenue determination. We look at four broad areas: (i) operating expenditure (opex); (ii) capital expenditure (capex) and the regulatory asset base (RAB); (iii) the weighted average cost of capital (WACC); and (iv) other revenue determinants.

#### 3.1 Opex

We investigate the following aspects of opex: (a) determination of allowed opex; (b) reconciling allowed opex with actual opex; (c) differentiation of controllable and uncontrollable opex; (d) differentiation of regulated and unregulated opex; (e) opex efficiency improvements; and (f) tools that are used for benchmarking opex.

The **determination of allowed opex** is typically based on one, or a mix, of four methods: *bottom-up, top-down, yardstick, or historical outturn opex*. Some regulators adopt a *totex* approach, in which they determine instead an allowed total expenditure (totex) that encompasses both opex and capex. In this study, we find:

- **The most common approach for determining allowed opex is bottom-up** (ten TSOs and nine DSOs). For TSOs, the other approaches, in order of popularity, are top-down (three), yardstick (two), and historical outturn opex (two). One TSO (Peru) employs what we have termed 'investment opex',

which calculates expenditure as a percentage of investment costs. For DSOs, the other approaches are yardstick (eight), top-down (four), and historical outturn opex (two).

- **Totex is rarely used.** Only three countries consider opex and capex costs jointly (Austria, Azerbaijan, Bulgaria).

**Our observations on the determination of allowed opex are:**

- The focus on bottom-up assessments is to be expected, given the distinct advantages of this approach (such as being less data intensive and more acceptable to the businesses and network users), but also the relative newness of the regulatory regimes meaning that a deep understanding of the regulated entities' business and the companies' own models, data and methodologies has not yet been acquired so that evidence from comparator businesses can be used to challenge regulatory submissions.
- Nevertheless, there are disadvantages with bottom-up assessments, chief amongst which is an inordinate focus on individual cost items rather than considering the overall costs and revenue requirements. This may remove incentives to flexibly manage expenditure and exploit opex substitution possibilities to minimise cost. This is also why some regulators combine bottom-up cost reviews with other assessment methods.

**Whether and how allowed opex is reconciled with realised opex** in forward-looking regimes in which opex is determined *ex-ante* affects the incentives of the TSOs/DSOs. If realised opex differs from what was allowed, there are two main options: for the utility to bear all savings or losses, or for the utility to share these with network users. The value of any future adjustment for the deviation should ideally factor in inflation and discounting. In this study, we find:

- **In most cases the utility bears all savings and losses** (17 TSOs and 18 DSOs). Albania's TSO and DSO and Peru's TSO share savings and losses with customers. Kosovo's TSO and DSO only share savings with the customer.
- **Inflation or discounting is considered wherever adjustments are made.** Albania incorporates inflation in the adjustment, and Kosovo and Peru incorporate a discount rate. Kosovo uses a short-term borrowing rate as the discount rate, and Peru uses a rate set in law.

**Our observations on how allowed opex is reconciled with realised opex are:**

- For those MOs employing revenue or price caps, they almost exclusively make no subsequent adjustments if realised opex is different to actual opex.
- The key weakness of this approach to incentivising efficient expenditure is that it discourages savings late in the regulatory period, because the TSOs/DSOs will 'keep the benefit' for a shorter period and therefore they have an incentive to defer efficiency savings until the beginning of the next regulatory period and retain the benefit for longer.

- This means that efficiency incentives are not constant (and diminish) over time. Ideally, however, efficiency incentives should be constant, that is, they should apply equal incentive strength to spending through time.

**Uncontrollable opex** is opex substantially outside the utility's influence and significant enough to have a material distorting impact on its finances. Regulators often allow this to be passed through, at least partially, to end-users. In this study, we find:

- **Uncontrollable opex is distinguished in just over half of jurisdictions** (11 TSOs and 12 DSOs). Taxes, fees, and levies are the most common type of uncontrollable opex (at ten TSOs and 11 DSOs). Other types include salaries and wages, system losses, ancillary services, costs generated by *force majeure*, fuel costs, and connection charges.
- **Opex identified as uncontrollable is mostly fully passed through.** The only exception is Hungary, which partially passes through this uncontrollable opex to network users for both the TSO and DSO. Lithuania treats some TSO and DSO costs as pass-through only in exceptional cases, such as when there is a legislative amendment.

Regulators often distinguish between **opex incurred in regulated network services and opex from unregulated activities**. This is to ensure that the regulated entity only recovers the cost of regulated services and does not use regulated revenues to cross-subsidise other competitive activities. In this study, we find:

- **Most jurisdictions distinguish regulated and unregulated opex.** Only Turkey's TSO and Peru's DSO are not required to make this distinction.
- **Most exclude unregulated opex altogether from allowed revenues** (12 TSOs and 13 DSOs). Three TSOs and DSOs must deduct unregulated revenues from their opex allowance. Other jurisdictions use alternative approaches.

**Opex efficiency factors** may be adopted in forward-looking regimes where the allowed opex is determined *ex-ante*, for example in the building blocks of a revenue cap. This efficiency factor contrasts with the general X-efficiency factor at the level of the overall price or revenue in the form of CPI-X (see step 2). In this study, we find:

- **Opex efficiency factors are used in just over half of jurisdictions** (ten TSOs and 11 DSOs). Pakistan and Turkey use an opex efficiency factor for DSOs but not for TSOs, whereas Nigeria uses one for the TSO but not for the DSO.
- **Opex efficiency factors range from 1%-4%.** The 4% factor applies to Nigeria's TSO. The 1% factor is used by multiple jurisdictions.
- **Expert opinion is the most common method for calculating the factor** (five TSOs and four DSOs), meaning entities adopt flexibility in their methodological approach. Also adopted are external benchmarking (three TSOs and four DSOs), and internal benchmarking (used in case of Turkey's DSOs).

**Our observation on efficiency factors** is that there is currently limited use made of efficiency factors either at the level of the tariff or revenue control (discussed earlier) or in setting cost allowances (as shown here). While determining efficient costs and/or defining the magnitude of any efficiency gaps is not straightforward, this is at the heart of what regulators are tasked with and therefore we would suggest this needs to feature more prominently.

**Tools for benchmarking opex** refer to statistical methods that aim to establish a reasonable efficient opex for the utility by observing other utilities, the utility's own performance over time, or a hypothetical, efficient utility. They are typically used in yardstick or top-down approaches for determining allowed opex. In this study, we find:

- **A frontier shift is usually assumed when statistically benchmarking opex** (three of four TSOs and four of eight DSOs that report the use of statistical benchmarking tools). Other tools adopted are data envelopment analysis, partial productivity indices, and total factor productivity.

### 3.2 Capex

We investigate the following aspects of capex: (a) determination of allowed capex; (b) reconciling allowed capex with actual capex; (c) when capex should be included in the RAB; (d) capital works in progress (CWIP); (e) working capital; (f) asset value; (g) depreciation; (h) whether capex assessment is embodied in law or regulation; and (i) tendering capex.

The **allowed capex** could be approved either before (*ex-ante*) or after the project has begun (*ex-post*). There are various means for deciding whether to approve capex, including based on technical necessity of the project, financial or economic aspects of the project, or whether the project has a net impact on the tariff. Before *ex-ante* approval, the regulator may even calculate the efficiency of the project. In this study, we find:

- **Most regulators approve capex *ex-ante*** (16 TSOs and DSOs). Only Austria, Czechia, Hungary and Slovakia approve TSO and DSO capex *ex-post*.
- **Technical necessity is the most common means for approving capex** (20 TSOs and 19 DSOS), followed by financial aspects (12/12), economic aspects (11/ten), and the impact on tariffs (five/four). In Nigeria, the impact on tariffs is considered when approving TSO capex, but not DSO capex. In Hungary, the impact on tariffs will be considered for the TSO and DSO from 2021.
- **Project efficiency is measured *ex-ante* mostly by observing unit cost** (ten TSOs and DSOs). Cost-benefit analysis is also used, but this is only practised in Pakistan and Kosovo.

**Our observation on the determination of allowed capex** is as follows. Given that electricity networks are characterised by large fixed costs and therefore sizeable and lumpy investment which in turn drives a significant component of the network business' allowed revenues, we would suggest that regulators ought to be **subjecting material capex proposals to greater scrutiny, both to ensure that the proposed investments are needed (and those that best meet objectives compared to alternatives), and that they are**

**delivered at the lowest possible cost.** This could include a requirement that substantive investment projects or programmes are necessarily underpinned by economic justification and assessing different capex categories (refurbishment, expansion, etc) by different (and category-specific) cost drivers.

**Whether and how allowed capex is reconciled with realised capex** determines the incentive properties of the regulatory regime. If adjustments are made, the value of any such adjustment for the deviation should ideally factor in inflation and discounting. In this study, we find:

- **In most cases, the utility bears the full impact of capex deviation** (12 TSOs and 11 DSOs). That is, if the utility overspends on capex, it makes a loss. If the utility underspends, it makes a profit. In Albania, gains and losses are shared between the utility and customers based on a pre-set sharing factor, but only if the reason was within the utility's control. For the TSO and DSO of Georgia, the customer bears the full impact of gains and losses. In Moldova, TSO and DSO overspends exceeding the rate of inflation are covered by the utility.
- **Time value is rarely considered in capex reconciliation.** Only three TSO and two DSO regimes adjust for the time value of money when reconciling actual and approved capex. For two TSOs and DSOs, adjustments are made in the next review without compensating for the time value of money.
- **Deferred capex is denied allowed depreciation or returns in most cases** (nine TSO and DSOs).
- **Most regulators allow a deviation from approved capex.** However, this is not permitted at the TSOs and DSOs of Azerbaijan, Bulgaria, Latvia and Moldova. For Moldova, this is because they approve capex annually.

**Once capex enters the RAB,** the utility may raise revenues to cover depreciation and return. One key consideration is at what point capex should enter the RAB: once the money is spent; once the asset is constructed; or once the asset is commissioned. Another consideration is how to deal with contributions and grants from third parties for investment projects, as the utility has not incurred that capex. A third consideration is that, if capex does not enter the RAB as spent, the utility may have to wait a substantial period to raise revenues to cover expensive capex. A common compromise is to allow construction work in progress (CWIP) to enter the RAB at a grossed-up value that includes financing costs during construction. In this study, we find:

- **Capex most commonly enters the RAB when commissioned** (nine TSOs and DSOs). Seven TSOs and DSOs have capex entering the RAB as spent or incurred, providing it has been approved. At five TSOs and four DSOs, capex enters the RAB when assets are purchased or constructed.
- **Projects of common interest (PCI) are distinguished in Latvia.** A PCI is a cross-border infrastructure project that links the energy systems of EU countries. For these projects, capex enters the RAB as it is incurred. For other projects, capex enters the RAB when assets are purchased or constructed.

- **The majority fully deduct capital contributions from the RAB** (14 TSOs and 13 DSOs). Three TSO and DSO regimes allow the utility only to recover depreciation expenses on the capital contributions, while two TSOs and three DSOs are allowed to recover both depreciation expenses and a return.
- **The most common approach is not to allow any return on CWIP** (seven TSOs and DSOs). Two TSOs and one DSO are permitted to recover debt interest during construction, but not the full allowed return. North Macedonia allows the TSO and DSO to recover the full allowed return on the value of the CWIP. Other countries use other approaches.
- **Large projects are distinguished in CWIP considerations in Czechia.** In Czechia, the TSO and DSO are permitted to recover the full allowed return on the value of the CWIP, but only for large projects. Large projects carry the highest capex, which is what CWIP is intended to address.

**Working capital** is capital which is not invested in long-term assets but in various short-term items required for the day-to-day operations, such as cash and inventories. Where working capital is funded from equity or debt, then this represents a commitment by the owner which should in theory be remunerated. In this study, we find:

- **The most common approach for calculating working capital is lead-lag** (two TSOs and three DSOs), followed by a formula approach (two TSOs and DSOs) and the balance sheet method (one TSO and DSO).
- **Some countries use unique approaches for calculating working capital.** Estonia, for both the TSO and DSO, calculates working capital as 5% of the arithmetic average of the last three calendar years' revenue. Pakistan calculates the working capital amount for the TSO as the sum of 3% of gross fixed assets, one-month revenue requirement, and monthly average cash balance. In Latvia, they set working capital equal to the value of items in stock.
- **The short-term borrowing rate is the most common remuneration rate** (three TSOs and DSOs). The WACC is used at two TSOs and DSOs. Nigeria uses the allowed cost of debt, determined in the WACC calculation. Pakistan employs the historical cost of debt. A rate set in law is used for the Peruvian DSO.

**Depreciation** is intended to spread the cost of investments over time. Because it is important that depreciation reflect the costs of investments across their useful lives, economic asset lives are generally used rather than accounting asset lives. In this study, we find:

- **The average life for different asset categories varies across respondents.** This variation is greater for TSO assets. For example, the regulatory asset life for TSO overhead lines and wires ranges from 15 to 55 years. For DSOs, this ranges from 20 to 40 years.
- **The overwhelming majority use straight-line depreciation** (18 TSOs and DSOs). Only Slovakia adopts a units-of-production approach for their TSO and DSO, and no respondents adopt accelerated depreciation.

There are two additional points on capex that were explored in the ERRA survey. First is **how or whether capex rules are specified in law**. Second is whether or not to make it a legal requirement for the competitive **tendering of capex**. In this study, we find:

- **Capex rules are most commonly provisions in the general tariff rules** (seven TSOs and eight DSOs). Six countries outline them only as broad principles within the general tariff regulation for their TSOs and DSOs. Five have a separate detailed regulation for this purpose for their TSOs and DSOs. In two TSO and one DSO regime, the capex rules are not specified in the framework.
- **Competitive tendering of investment projects is most commonly required by law** (ten TSOs and seven DSOs). For six TSOs and seven DSOs, it is mandatory only for projects above a certain cost. For three TSOs and four DSOs, it is not mandatory. In Georgia, it is only mandatory for government-owned utilities.

### 3.3 WACC

We investigate the following aspects of WACC: (a) the definition of WACC adopted in terms of tax and inflation; (b) the cost of debt; (c) the cost of equity; (d) the risk-free rate; (e) the equity risk premium; (f) the equity beta; and (g) the gearing ratio.

**Tax and inflation** matter because the *real, after-tax* return on the RAB motivates investment. Different definitions of the WACC capture this idea: *pre- or post-tax, real or nominal*, and *vanilla*. In this study, we find:

- **The most common WACC used is pre-tax real** (nine TSOs and DSOs), followed by pre-tax nominal (eight TSOs and DSOs).
- **Some regulators use non-standard WACC definitions.** Peru uses a real rate set in law for both the TSO and DSO. For the TSO, Pakistan uses a post-tax nominal return on equity, setting financial charges as pass-through costs.
- **In most cases, the pre-tax real WACC sits within the 4%-8% range**, after deflating nominal WACCs and removing tax where applicable.

The **cost of debt** is the interest payable to lenders. The regulator could calculate the cost of debt through various approaches: a market-based estimate (ie the sum of the risk-free rate and debt premium); an embedded estimate based on the utility's historical cost of debt in financial accounts; benchmarking the cost of debt at comparable companies; or something else. In this study, we find:

- **The most common approach is market-based**, ie the sum of the risk-free rate and debt risk premium (nine TSOs and ten DSOs). Five TSOs and four DSOs use embedded estimates, and two TSOs and DSOs use benchmarking.
- **Some regulators use other approaches for estimating cost of debt.** Latvia determines the cost of debt for its TSO and DSO as the average interest rate issued to non-financial corporations in the country in the last ten years. Lithuania uses the actual cost of the debt for the utility, capped at the market

interest rate. Moldova determines the cost of debt annually, equating it to the average rate on credits granted in foreign currency in the year of the tariff calculation, based on the figures published by the central bank.

- **There is considerable variation in the cost of debt across TSOs and DSOs,** which is expected given the dependence of lending costs on country and firm circumstances.

The **cost of equity** is the opportunity cost of using the equity in the investment rather than in other ventures. It is the return that the equity could earn in other projects. The regulator could calculate the cost of equity through various approaches: the capital asset pricing model (CAPM) (ie the sum of the risk free rate and the product of the equity risk premium and the equity beta); a dividend growth model (ie the present value of future dividends from investing elsewhere); benchmarking the cost of equity at comparable companies; or through completing an investor survey. In this study, we find:

- **The overwhelming majority use the CAPM for determining cost of equity** (16 TSOs and 17 DSOs). None use the dividend growth model or an investor survey. For the TSO's cost of equity, Moldova uses the risk-free rate plus a country risk premium; for the DSO, it uses the CAPM. Azerbaijan does not include the cost of equity in the WACC, because the government owns 100% of the equity. Bulgaria uses benchmarking for both its TSO and DSO.
- **There is considerable variation in the cost of equity across TSOs and DSOs.**

The **risk-free rate (RFR)** is the return an investor would expect to receive from an investment with zero risk over a given period. In this study, we find:

- **Most regulators use the government's borrowing rate as a proxy for the RFR** (14 TSOs and DSOs). The other approach is to use a foreign government's borrowing rate as a proxy (five TSOs and DSOs). Austria and Oman use both national and foreign governments' borrowing rates as proxies; for example, Austria uses the borrowing rate within the Euro area.
- **Some countries make slight variations to the standard approaches.** Austria, Estonia and Oman apply an inflation differential for the foreign proxy, and Hungary includes credit default swaps (CDS).

The **equity risk premium** in the CAPM approach to estimating the cost of equity is the return, on top of the risk-free rate, expected in a balanced portfolio of investments in the investment market. Regulators typically use historical data reflecting actual investment returns in international or national markets, or precedents set by other regulators. In this study, we find:

- **Most regulators employing CAPM use historical data reflecting actual investment returns to estimate the equity risk premium** (11 TSOs and 12 DSOs). For eight TSOs and nine DSOs, historical data are used reflecting investment returns in the international market, and for three TSOs and DSOs the equivalent data from the national market are used. For three TSOs and DSOs, precedents set by other regulators are used. Lithuania uses an approach

of summing the equity risk premium in the US (ie a developed capital market) and Lithuania's country risk premium.

The **equity beta** in the CAPM approach to estimating the cost of equity is a measure of risk associated with a specific investment relative to the market (of all investable assets). An equity beta less than one means an investment is less risky than the market and a lower return is appropriate; an equity beta greater than one means an investment is riskier than the market and a higher return is appropriate. In this study, we find:

- **The most common approach is to use the equity beta of other electricity regulators** (six TSOs and DSOs) **or to benchmark against similar industries** (four TSOs and six DSOs). Three TSOs and two DSOs measure the volatility of comparator TSO companies' stocks against market volatility.
- **Some regulators use other approaches for estimating the equity beta.** Nigeria fixes the equity beta for its TSO and DSO at zero, stating a lack of benchmarking data for similar industries; this effectively sets the cost of equity equal to the RFR. Conversely, North Macedonia fixes the equity beta of the TSO and DSO at one, again due to a lack of benchmarking data; they state that they use this value because expected return should equal the market return. Kosovo also sets its TSO and DSO equity beta at one, based on the regulator's own judgement. While Albania claims to use a CAPM approach for the determination of the cost of equity, they state that 'there is no beta predicted in the methodology'; it is unclear what value they use for the beta in their CAPM equation.
- **Most regulators with an equity beta report a value of less than one.** Only Albania, Pakistan, and Turkey report values of greater than one for some of their equity betas.

**Gearing** in the WACC can be defined in two main ways. *Actual* gearing is the capital structure (debt divided by total capital) of the company as it is currently or is expected to stand over the regulatory period. *Notional* gearing is a capital structure the regulator considers typical, objective, or efficient. In this study, we find:

- **Most regulators use a notional gearing ratio** (14 TSOs and DSOs). Albania uses actual gearing for the TSO and DSO. Bulgaria uses the actual gearing ratio, provided it lies in a 'reasonable range', for its TSO and DSO. Azerbaijan, the gearing ratio is irrelevant, given that equity is not separately remunerated.
- **Most gearing ratios are in the 40-50% range.**

### 3.4 Other revenue determinants

We investigate two other key elements of the regulatory regime that could impact allowed revenues: (a) technical losses; and (b) the quality of supply (for DSOs).

Procurement of energy to cover **technical losses** in transporting electricity on the network can be the responsibility of the networks, or generators and suppliers. In all the ERRA sample, the network operators are responsible for technical losses. We find that:

- **In most cases, regulators set a level of allowed losses** (14 TSOs and 16 DSOs).
- **Most entities with specified allowed losses then bear the full impact of deviating from this** (nine TSOs and 11 DSOs), ie any costs resulting from overshooting this cap are borne by the utility. For two TSOs and DSOs, the utility and customer share the impact. For Peru's TSO, this is shared through a pre-set sharing factor. For Albania's TSO and Czechia's DSO, this is shared through general adjustments during the next regulatory period. For Moldova's TSO, the customer gets the gains, while the utility bears the losses.

**Quality of service** is important to monitor or target. This is because operators may cut key spending in order to increase profits in the short-term at the expense of short- and long-term impacts on the quality of service. Such expenditure could include customer service, investment projects and maintenance. Quality of supply is measured through pre-defined key performance indicators (KPIs). In this study, we find:

- **17 DSOs monitor medium voltage levels** for supply and voltage reliability, **13 monitor low voltage**, and **two monitor neither**.
- **Most DSOs ignore extreme events when assessing KPIs against targets** for supply reliability and voltage quality against targets (12). Peru's DSO does not factor for extreme events. Estonia's DSO caps the KPI at a maximum value to mitigate against extreme events.
- **Some DSOs differentiate KPI targets by location**. Six differentiate the target according to the region or DSO area.
- **The most common approach is to only set penalties for missing KPI targets** (seven), followed by setting both penalties and rewards (six). Only Turkey sets rewards but not penalties, and only Austria does not set financial incentives for achieving KPI targets. In Lithuania, both penalties and rewards apply to the four DSOs with fewer than 100,000 customers, but only penalties apply to one DSO with more than 100,000 customers.
- **Most scale the size of the penalty or reward relative to performance** (12). Only Albania gives a fixed penalty or reward. For those scaling the incentive in line with performance, six set a cap on the penalty only, and five set a cap on the penalty and reward. Turkey only sets a cap on the reward. Nigeria sets no limit for its penalty.

#### 4 Revenue adjustments

The fourth step in this study is to investigate revenue adjustments. Between regulatory reviews, costs and revenues may diverge, given that revenues are based on forecasts or actual costs at the time of the review. In the preceding steps, we have discussed how the regulator can reconcile pre-approved opex and capex with their actual values. However, the regulator could also consider: inflation; deviation from allowed revenues; and deviation from allowed pass-through costs. In this study, we find:

- **Just over half of regulators automatically adjust revenue in line with inflation between reviews** (12 TSOs and 11 DSOs).
- **Just over half of regulators reconcile the difference between actual and allowed revenues** (12 TSOs and 11 DSOs).
- **Only ten TSOs and eight DSOs reconcile the difference between allowed and actual pass-through costs.**