Incentive Regulation of Distribution Utilities

A Primer: Theory and Practice

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• Section 1: Economic and regulatory foundations
Basis for Public Utility Regulation

• *Natural monopoly* – high capital costs, high barriers to entry, cannot move or transfer facilities to gain new markets

• *Economic regulation* substitutes for market competition

• Prevents abuse of monopoly power – protects consumers
Double Task of Economic Regulation

• Determine the sum of revenues that a regulated utility is allowed to collect
  [remuneration challenge]
  – Operating costs
  – Investment costs (return of and on investment)

• Determine how the revenues will be collected
  [tariff challenge]
  – Cost allocation
  – Rate design
Remuneration Challenges

- A regulated utility’s realized costs depend on:
  - its underlying cost opportunities [i.e. whether is it a high-cost or low-cost utility]
  - the decisions made by its managers to exploit cost saving opportunities

Incomplete information introduces information asymmetries

Utility managers know more about their cost opportunities than the regulators

Regulators cannot directly observe managerial effort

Incomplete information introduces information asymmetries
Opportunity for “strategic behavior”

- Utility may attempt to use its information advantage in the regulatory process to increase its allowed revenues and profits (or other objectives)
  - convince the regulator that it is a higher cost firm than it really is
  - take advantage of the regulator’s need to ensure the financial viability of the utility [firm participation constraint]
Firm “Participation Constraint”

By participating in the regulatory process, the regulated firm remains financially sound [viable]

- Reverse game theory
  - the goal (outcome) is given:
    - the financial viability of the firm is never harmed.
  - regulatory mechanisms are selected by the regulator to achieve such goal [e.g. an incentive mechanism]
Regulators face an *adverse selection* problem

Adverse selection occurs when there's a lack of symmetric information prior to a deal between a buyer and a seller [Investopedia]
Economic Efficiency: Definitions

- **Productive efficiency**: the degree to which a firm minimizes the inputs used to produce a given level of output.

- **X – efficiency**: the degree of productive efficiency under conditions of imperfect competition.
  - X-efficiency theory asserts that under conditions of less-than-perfect competition, inefficiency may persist. [Investopedia]

- **Allocative efficiency**: occurs when price equals the marginal cost of production (perfectly competitive market). Monopolies can increase the price above the marginal cost of production (allocative inefficiency).

- **Economic rent**: generally, unearned income.
Regulators attempt to balance the **tradeoff** between:

- Incenting managerial effort to pursue cost savings (**X-efficiency**)
- Minimizing abuse of market power (economic rents) collected from ratepayers (**Allocative Efficiency**)

**Remuneration Challenges Continued**

**Cost-of-service vs Incentive Regulation**
Regulatory Process Definitions

- **Ex post** - Latin “after the fact” – review based on historical costs, revenues, earnings
- **Ex ante** – Latin “before the event” - review based on projections of costs, revenues, earnings or actions planned for the future period
• Section 2: Cost-of-Service regulation and Incentive regulation [contrasted and compared]
Cost-of-Service Regulation Defined

Allowed revenues set equal to realized costs plus a return on investment

In theory

• A regulatory mechanism where the firm is assured that it will be compensated for all of the costs of production that it actually incurs.
  – No “excess profits” left on the table since revenues are equal to “actual” (pro-forma) costs
  – No *ex post* renegotiation [retroactive ratemaking prohibited]

In practice

• The firm is given an opportunity to earn its authorized rate of return – but not a guarantee
  • The “*used and useful*” standard allows the removal from rate-base of net plant that is no longer providing service, [or the level of service intended]
<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>• Minimizes the impact of uncertainty</td>
<td>• Significant x-inefficiency</td>
</tr>
<tr>
<td>— Allowed revenues meaningfully tied to the firm’s realized [pro-</td>
<td>— Blunted management incentive to pursue cost savings</td>
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<tr>
<td>forma] costs</td>
<td>— especially long-term savings</td>
</tr>
<tr>
<td>— Frequent <em>ex post</em> reviews</td>
<td>— Managerial <em>moral hazard</em> issue</td>
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<td>— Limited return</td>
<td>(cost borne by ratepayers)</td>
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<td>— <em>Ex post</em> recovery of CAPEX</td>
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<tr>
<td>• Readily ensures that utility remains financeable [meet the firm</td>
<td></td>
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<tr>
<td>participation constraint]</td>
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<tr>
<td>• Maximizes allocative efficiency</td>
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*Moral hazard* occurs when one person takes more risks because someone else bears the cost of those risks [*Wikipedia*]
Incentive Regulation Defined

- Regulatory mechanisms designed to provide powerful economic incentives for regulated firms to:
  - reduce costs
  - make efficient infrastructure investments
  - improve service quality (in a cost effective way)
  - provide efficient pricing of regulated services.
  - introduce new services

- Diverse range of mechanisms
- Weakens the link between utility costs and rates

- Two key attributes:
  - automatic adjustment mechanisms
  - uses external data to set allowed revenues
## Incentive Regulation
### Pros and Cons

<table>
<thead>
<tr>
<th><strong>Pros</strong></th>
<th><strong>Cons</strong></th>
</tr>
</thead>
</table>
| • Powerful incentive to optimize x-efficiencies  
  – Empowers managerial efforts to reduce costs below price or revenue cap  
  – Earnings depend on “beating the cap” | • Reduces allocative efficiency  
  – Potential for significant economic rents  
 • Significant exposure to uncertainty/risk  
  – Allowed revenues based on exogenous (non-utility) metrics  
  – Incurs the full cost of “adverse selection”  
  • Regulator must set high prices to ensure firm participation constraint met |

Regulator caps allowed revenues or prices *ex ante* for a set period
Actual Implementation - Less Distinction Between Approaches

**Cost of Service**

- **Use of fully projected (ex ante) test-year**
  - Disconnects allowed revenues from realized [pro-forma] costs
  - Softens benefits of regulatory lag [associated with use of an historical test-year and with case processing delays]
  - Project pre-approval weakens X-efficiency incentives
  - Increases adverse selection issue
- **“Used and useful” standard rarely exercised**

**Incentive Regulation**

- **Periodic ratchets of revenue or price cap**
  - Realign revenues with actual (x-efficient) cost trends
  - Transfers economic savings from utility to ratepayers [increases allocative efficiency]
- **Revenue sharing**
  - Creates nexus between allowed revenues and actual costs
## Evolution Will Impose New Demands and Increased Competition on Utilities

### Evolutionary drivers:
- Will require utilities to focus on delivering **improved outputs** at a competitive cost [high performance]
- May create substantial future investment opportunities to provide enhanced grid services
  - to connect new DG users, manage bidirectional flows/supply volatility,

### However...
- **COS regulation** focuses on the prudence of **inputs**
  - Challenging to respond to evolving demands for outcomes or improved performance
  - **COS regulation** requires utilities to meet no more than **minimum performance levels**
    - Provides little incentive (reward) for delivering a higher quality of service or new services
Additional Challenges Related to Pure Cost-Plus Regulation

- Key utility-management hurdle is getting CAPEX included in rate-base
  - Backward looking nature of COS regulation can impede utility efforts to innovate
  - Apparent high risk related to investment in emerging technologies [ex post regulatory review]
  - In actuality, difficult for regulators to identify (and disallow) all but the most obvious imprudent or wasteful investments
Trade-offs Between CAPEX and OPEX Under Cost-of Service Regulation

• **After** CAPEX included in rate-base, marginal reward to take full advantage of cost savings opportunities (x-efficiency)

  I. **Utilities only profit from realized savings until the next rate case** [when historical cost savings are folded into pro-forma cost calculation]

  II. **Utilities focus on short-term cost savings [OPEX]**, sacrificing long-term opportunities

  III. **Marginal penalties for failure to take full advantage of capabilities of approved CAPEX.** Regulators are reluctant to remove or reduce plant in service for infraction of “used and useful” standard.
COS and a Regulated Utility’s Strategic Business Model

• When faced with the choice between a capital investment [CAPEX] or an expense [OPEX] a regulated IOU will tend to choose the CAPEX route despite x-efficiency benefits of the latter.

• Examples:
  – Build out of a private data (mesh) network for smart meters vs. contracting with a public telecommunications carrier for point-to-point cellular service
  – Depreciation unit defines replacement size; may affect repair/replacement decisions
Preferable Regulatory Mechanism

• Balance between a pure cost-of-service and pure incentive regulation
Role of Economic Incentives for Investor Owned Utilities

• **Economic incentives** are the key to signaling that a certain investment or decision is valued or encouraged and another is relatively discouraged

• Holds true irrespective of which regulatory model is used by regulators
Incentive Regulation
Strategic Goal

Incentive-based regulatory mechanisms make it profitable for regulated utilities to make *x-efficiency* improvements and yield consumer benefits (in the long run)

- Regulated firms may earn significantly higher returns than their cost of capital when these “excess” returns are achieved from cost savings beyond the benchmark
- In theory, if the firm over performs against the target, consumers eventually benefit at the next price review “ratchet”
• Section 3: Price Cap regulation is the historical foundation of Performance Based Regulation
Vertically Integrated State Owned Generation Transmission Distribution Retail Sales

Privatization & Separation of Competitive Segments

Transmission

Network Operator

Introduction of Incentive Regulation

Early forms of Price Cap Revenue Cap

Cost Control Yes
Reliability No
Service Quality No
Strategic Behavior Yes
Allocative Efficiency No

+ Performance Incentive Mechanisms
+ Profit Sharing & Menu of Contracts
+ TOTEX Incentive Mechanism

RIIO
Pure Price-Cap
Incurs the Full Costs of Adverse Selection

Pros
• Highest powered incentives to exploit cost opportunities
• Utility can claim in full any variance between the target and actual operating costs

Cons
• Regulator will have to set prices high enough to cover the firms realized costs
  – Regulator must adhere to firm participation constraint despite uncertainty about cost opportunities
  – [must assume that the firm may be inherently high cost]
  – Leaves economic rents to the firm
• Focus on costs may lead to poor quality of service

A pure price cap mechanism does not respond to:
– Changes in managerial efforts (cost savings)
– Ex post cost realization (no reconciliation)
Price-Cap Index (CPI)

Competitive Market Standard

• The long-run trend in an industry’s (output) prices is equal to the long-run trend in its unit costs

\[ \delta \text{ Output Prices} = \delta \text{ Unit Cost} \]

(\(\delta\)) is equal to the long-run growth trend (\%/yr.)

\[ \delta = \frac{\int_{x_i}^{x_f} \frac{dx}{x}}{\int_{t_i}^{t_f} dt} \]

i.e. \(\delta\) Unit Costs = \(\frac{\ln\left(\frac{C_f}{C_i}\right)}{\Delta T}\)

\[ \delta \text{ Unit Cost} = \frac{\ln\left(\frac{C_f}{C_i}\right)}{\Delta T} \approx \left[\frac{(\text{Unit cost index})_{\text{End of Period}}}{(\text{Unit cost index})_{\text{Beginning of Period}}}\right]^{1/n} - 1 \]
Competitive Market Standard
In Terms of Macro-economic Measures

• The trend in the unit cost is equal to the difference between trends in that industry’s input price index and total factor productivity (TFP) index. Same for economy as a whole.

\[
\delta \text{ Unit Cost}_{\text{Industry}} = \delta \text{ Input Prices}_{\text{Industry}} - \delta \text{ TFP}_{\text{Industry}} \quad \text{Eq. a}
\]

\[
\delta \text{ Unit Cost}_{\text{Economy}} = \delta \text{ Input Prices}_{\text{Economy}} - \delta \text{ TFP}_{\text{Economy}} \quad \text{Eq. b}
\]

• Subtract Equation (b) from Equation (a)
General Price-Cap Index (PCI) Formula

Derivation of Productivity Offset

\[ \delta Unit\ Cost_{Industry} - \delta Unit\ Cost_{Economy} = [\delta Input\ Prices_{Industry} - \pi] \]

Where \( \pi \) = macroeconomic inflation measure
What is the Productivity Offset

• $X$ reflects \{in theory\} the sum of:
  – the difference between the target Total Factor Productivity (TFP) growth rate for the utility and the TFP growth rate for the economy as a whole, and;
  – the difference between input prices faced by firms in the general economy and (expected) input prices of the regulated firm

\[
x = \left( \delta_{TFP_{Target}} - \delta_{TFP_{General\ Economy}} \right) +
\]

Regulated prices should rise at a rate that reflects the general rate of inflation $[\delta_{Unit\ Cost_{Economy}}]$ less an offset $[X]$ for: (1) higher (or lower) productivity growth, and: (2) for higher (or lower) input price inflation
Basic Formula for a Pure Price-Cap Regulation

• For the first year, a full cost-of-service calculation of projected revenue requirements [allowed revenue], a COSS, and rate design is performed
• Thus, $P_0 = f([RR]_0)$
• For the following years:
  • $P_1 = P_0 \times \left[1 + \delta \pi_{Economy} - X\right]_1$
  • $P_2 = P_1 \times \left[1 + \delta \pi_{Economy} - X\right]_2$
  • $P_3 = P_2 \times \left[1 + \delta \pi_{Economy} - X\right]_3$

(proxy RR)$_i = f(P_i)$

Automatic Adj. Mechanism
Section 4: The U.K.’s RPI-X and RIIO PBR Models
RPI-X Price-Control Method

Regulatory Building Blocks

Many similarities to practical COS regulation
[with a fully projected test-year]

• Characterized as a combination of:
  – Cost-of-service regulation [capital and operating cost recovery]
    • Capital investment plan reviewed and approved *ex ante* (projected)
      – reasonableness reviewed *ex post*
    • Determine an allowed *rate-of-return* and compatible valuations of the *
      rate-base* and *depreciation* rates
      • Set *projected operating costs* via indexes or comparative benchmarking
  – Price ratchets setting new starting values for prices (cost-contingent)
  – Performance standards for quality of service (with financial incentives
    for meeting or exceeding performance standards, or penalties for
    failure)
RPI-X Price Cap Mechanism

- \( P_0 \) = initial price, set by allowed revenues over multi-year period
- \( P_1 \) = year 2 adjusted price
- \( n \) = number of periods
- RPI = [Retail Prices Inflation] = \{change in general inflation\}

\[
RPI = \left[ \frac{(Inflation\ index)_{End\ of\ Period}}{(Inflation\ index)_{Beginning\ of\ Period}} \right]^{1/n} - 1
\]

- \( X \) = productivity offset

\[
P_1 = P_0 * [1 + (RPI - X)]
\]
How the Price Cap is Set

$P_0$ is chosen so that the present value of revenues are equal to the present value of the total operating and capital costs (depreciation plus return) that have been allowed during the five-year review period:

$$[PV\text{ revenues} = PV\text{ costs}]$$

PV revenue $= \sum_{i=0}^{4} P_0 [1 + (\text{RPI} - x)]^i (\text{kWh})_i (1 + d)^{-i}$

PV costs $= \sum_{i=0}^{4} [($Total Allowed Expenditures$)_i (1 + d)^{-i}$

Where d is the discount rate; (kWh) is the forecasted demand

Solving for $P_0$:

$$P_0 = \frac{\sum_{i=0}^{4} [($Total Allowed Expenditures$)_i (1 + d)^{-i}]}{\sum_{i=0}^{4}[1 + (\text{RPI} - x)]^i (\text{kWh})_i (1 + d)^{-i}]}$$

- Note that $P_0$ would be a vector of prices for multiple services or rate schedules; and that this simplified calculation assumes a uniform annual commodity charge.
RPI-X Insights

• Contrary to popular misconception, the price-cap formula \[ P = f(RPI, X) \] does not actually determine the level of approved revenues (over the 5-year control period) \textit{Note: a pure price-cap mechanism does}

• The PPI –X mechanisms is actually an \textit{ex ante revenue-control} mechanism. The mechanism requires a full projected cost-of-service (COS) calculation of revenue requirements, a depreciation study, a COSS and rate design.

• The regulated firms ability to determine the structure of prices under an overall revenue cap is \textit{limited}
UK (United Kingdom) Price-Cap Implementation Issues

• Large increases in investment approved for the next multi-year price control period would result in a price spike between the end of the prior “price control” period and the beginning of the next. 
  [price shock]

• **UK Regulators “smoothed” the price increase** by building in a steeper escalation of the retail price [resulted in a lower initial price $P_0$ and back-loading of the revenues toward the end of the period]
  – *Productivity offset X set to zero*, thus retail price escalation during price control period only reflected general inflation: $P_1 = P_0 \times (1 + \text{RPI})$; $P_2 = P_0 \times (1+\text{RPI})^2$ etc.
  – Improvements in operating cost efficiency ($X$) rolled into the cost-plus-return calculation [benchmarking] of “targeted” revenue requirements
  – Typically initial price $P_0$ set in a range from [-10% to +10%] from the last price control period, with a mean of ~+1%

• **Lesson learned: Practical implementation may require deviation from theory - nothing is set in stone!**
Original Impact of RPI – X Price Curve

Levelized 5 year Cost vs. Price Curve

Price Spike

Price Curve
Levelized Cost
Levelized Cost V.S. RPI-0 Price Curve

Levelized 5 year Cost vs. Price Curve

- Price Curve
- Levelized Cost
Comparative Benchmarking of Operating Expenses (OPEX)

• Assessment of efficiency of distribution company operating costs
• OPEX subjected to comparative regression-based benchmarking
• Benchmarking allows regulators to project the efficient level of operating expenses
• [RPI – X] e.g. x-efficiency implicitly reflected in forecasted OPEX
Practical Capital-Cost Recovery Issues

- **Significant efforts** required to develop the **target** capital expenditure schedule during the next [five-year] price control period
  - Utility presents its proposed investment budget, and regulators evaluate using its staff (or outside engineering consultants) and third parties’ evidence **[expert appraisal]**
  - **Traditionally highly contested**
    - Increasing importance of future distribution investments due to: (1) aging of the grid; (2) related reliability and service quality issues; and (3) infrastructure enhancement projects
Performance Based Regulation
Foundations for Further Evolution

Under pure COS regulation

\[ Rev_{Allowed} = f(C_{Realized/Historical}) > C_{X\text{efficient}} \]

- Poor Managerial Efficiency
- Poor Allocative Efficiency
- Good Allocative Efficiency
- Good Managerial Efficiency

- full impact of managerial moral hazard
- full impact of adverse selection

\( C^* = [\text{regulator’s assessment of efficient costs of the highest cost type}] \)
Performance-Based Regulation
Essential Foundations

Greater economic efficiency derived from a regulatory mechanism in which allowed revenues are: (1) partially fixed \( \text{ex ante} \), and (2) partially responsive to changes in realized costs

\[
R_{\text{allowed}} = f(\text{costs}_{\text{ex ante}} + \text{costs}_{\text{realized}})
\]

Profit sharing Mechanism

\[
R_{\text{allowed}} = R_{\text{ex ante}} - [R_{\text{ex ante}} - C_{\text{realized}}](1 - \theta)
\]

\( \theta \) = sharing factor
Example: Price Cap + Profit Sharing

Trade off \textit{X-Efficiency} for \textit{Allocative Efficiency}

- \( R_{\text{allowed}} = R_{\text{ex ante}} - [R_{\text{ex ante}} - C_{\text{realized}}](1 - \theta) \)

Let \( C^* \) = [regulators assessment of efficient costs of the highest cost type]; \( \theta \) = profit sharing level, \( 0 < \theta < 1 \)

- \( R_{\text{allowed}} = C^* - \{ [C^* - C_{\text{realized}}](1 - \theta) \} \)

Thus:

- \( R_{\text{allowed}} < C^* \) where \( C_{\text{realized}} \geq C_{X \text{efficient}} \)

Reduced Impact of Adverse Selection

Increased Allocative Efficiency

Revenues

Costs
Performance-Based Regulation
Essential Foundations

• **Even better** economic efficiencies may be obtained with a *sliding-scale* menu of *profit-sharing* “contracts”

• Prices are partially fixed *ex ante*, and partially responsive to realized costs

• The utility “picks” a contract from the menu by filing their ex ante forecast. The ratio of their request to the regulator’s base estimate determines the allowed revenue, and the level of sharing

• The menu of contracts satisfies the *incentive compatibility constraint*
  – Utilities with low cost opportunities choose a high profit-sharing contract, and those with high cost opportunities choose a low profit-sharing contract
  – For any realized cost, the utility earns the most income when its filed forecast equals the realized cost
Sliding-Scale Menu of Profit Sharing Contracts

Performance Based Regulation

- Allowance for future CAPEX required to meet reliability targets subject to increased scrutiny and contention
  - Large amount of infrastructure has reached (or nearing) end of its useful life (retirement, replacement, and early retirement issues)
  - Increased importance of reliability
  - Emergence of new technologies

Utility given **choice of incentives** depending on their ability to control costs

| Most Control | Least Control |
Sliding Scale Mechanism
For CAPEX

Sliding scale menu at discretion of utility management

- Menu forces the utility to reveal its type ex post
  - [type means high-cost or low-cost]
- Resolves the asymmetric information problem facing regulators
- Choice between 100% and 100+ y% of base capital expenditure allowance

Regulated firm can choose from a menu of contracts:

- A lower capital expenditure allowance
  - High sharing factor
  - Higher expected return
- A higher capital expenditure allowance
  - Low sharing factor
  - Lower expected return
- The sliding scale mechanism applies to capital cost variations but not operating cost variations
U. K Sliding Scale Incentive Mechanism
Calculation of Allowed Ex Ante CAPEX

Overweighting of Regulator’s Ex Ante Estimate

\[ C_{Allowed} = 0.25 \times C_{Firm} + 0.80 \times (C_{Base})_{Regulator} \]
U. K Sliding Scale Incentive Mechanism for CAPEX

Profit Sharing Factor as a % of CAPEX Savings:

\[ \text{Savings} = SF \times [C_{\text{Allowed}} - C_{\text{Realized}}] \]

\[ SF = -0.50 \times \left[ \frac{C_{\text{Firm}}}{C_{\text{Base}}} \right] + 0.90 \]

\[ SF_{\text{Reference}} = 0.40 \]

\[ \left[ \frac{C_{\text{Firm}}}{C_{\text{Base}}} \right] \times 100 \]
U. K Sliding Scale Incentive Mechanism for CAPEX

Bonuses are calculated as a percentage of allowed expenditure using the formula:

\[ \text{Bonus Incentive/Penalty} = -0.0933 \times \left( \frac{C_{\text{Firm}}}{C_{\text{Base}}} \right) + 11.833 \]

Here, \( C_{\text{Firm}} \) is the expenditure of the firm and \( C_{\text{Base}} \) is the base expenditure. The graph shows the bonus percentage for different levels of expenditure.
UK Sliding-Scale Incentive Calculation For CAPEX

\[ I_{\text{CAPEX}} = [(\text{Allowed CAPEX} - \text{Actual CAPEX}) \times \text{Sharing Factor}] + \]
Relationship Between CAPEX/OPEX and Service Quality

• Problem:
  – Cost-control incentive mechanisms inherently create unintended consequences – economic incentives to reduce service quality or compromise reliability
  – Deferred maintenance (e.g. tree trimming) and deferred capital expenditures may lead to deterioration of reliability and service quality

• Solution:
  – Regulators reserve the right to capture-back cost savings if they were not the result of efficiencies but rather efforts to cut services
  – Introduce service-quality performance incentives [to maintain or enhance reliability and service quality]
Service Quality Incentives

1) Service interruption – number of outages
2) Interruption duration – minutes per outage
3) Quality of phone responses
   1) Ordinary
   2) Storm (outage or restoration of service request)
4) Discretionary award based on surveys of customer satisfaction
5) Customer payment obligations targeted at utility response time during severe weather events
6) Other incentives set by regulator

Structure incentives to: (1) maintain, and; (2) enhance performance
Theoretical Calculation of Penalty or Reward formula for Customer Outages

• Customer surveys indicate that customers value reducing the (minutes per outage) more than the (number of outages)
• Difficult to separately value number of outages (n) and outage minutes (hrs)
• Calculate value of lost load (VLL)
• \[ VLL = \sum_n \left( \frac{\text{Value}}{\text{kWh}} \right) \times \left( \frac{\text{kWh}}{\text{hour}} \right)_{\text{Residential}} \times (\text{Duration})_{\text{Hrs}} \]
# Service Quality Incentive Examples (UK)

<table>
<thead>
<tr>
<th>SERVICE QUALITY MEASURES</th>
<th>INCENTIVE AS A % OF REVENUE</th>
</tr>
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<tbody>
<tr>
<td>Interruption (frequency &amp; duration)</td>
<td>+/− 3.0% (Combined)</td>
</tr>
<tr>
<td>Quality of Phone Response</td>
<td>+ 0.05% to -0.25%</td>
</tr>
<tr>
<td>Quality of Phone Response (during storms)</td>
<td>+/− 0.25%</td>
</tr>
<tr>
<td>Discretionary Awards</td>
<td>up to 1 million £</td>
</tr>
<tr>
<td>Storm Compensation (customer payments)</td>
<td>-2%</td>
</tr>
<tr>
<td>Other Standards of Performance</td>
<td>Uncapped</td>
</tr>
<tr>
<td><strong>Overall Cap</strong></td>
<td>-4% on downside</td>
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<tr>
<td></td>
<td>No cap on upside</td>
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UK Quality of Service Incentive

• Each distribution company is disaggregated by distribution-circuit voltage
• Performance targets are developed for each voltage level
  – Based on historical data and benchmarking of performance
  – Performance targets are set by re-aggregating targets for each type of circuit

An estimate of the aggregate cost of improving service quality is built into the allowed revenue calculation
RIIO Incentive Regulation Model

Revenues = Incentives + Innovation + Outputs
• **RIIO:** Revenue set to deliver strong Incentives, Innovation and Outputs; or \[\text{Revenue} = \text{incentives} + \text{innovation} + \text{outputs}\]

• Change needed to foster greater innovation and investment
  – in light of new climate policy demands and aging infrastructure.
  – Realization that security of supply and de-carbonization are no longer just add-ons

• Regulatory goal: reward companies that innovate and run their networks to better meet the needs of consumers and network users.

• Change from former RPI-X price control framework:
  – Move from a five (5) year, to an eight (8) year price-control period
  – Expand the RPI-X methodology
Challenges Facing the UK Energy Sector

Electricity Networks
- Offshore Networks
- Electric Vehicles
- Advanced Electric Heating
- Electricity Storage
- Renewable Energy
- New Nuclear

Natural Gas Networks
- Smart Grids
- Local Generation
- Energy Efficiency
- District Heating
- Climate Change
- Adaptation
- Energy Service Companies

- Carbon Capture Seq.
- European Hub
- LNG
- Uncertain Demand

Aging Assets — Security of Supply — Affordability
RIIO Changes Relationship with Regulators

- Not a price control system set unilaterally by the regulator [as was RPI-X]
- RIIO price controls are the product of negotiated settlements
- Result in regulatory contracts between Ofgem and regulated utilities
Key changes from RPI-X

• Base revenue requirements calculated using forecasts of efficient total expenditures (TOTEX) rather than distinguishing between capital (CAPEX) and operating (OPEX) costs
  – TOTEX benchmarking uses statistic (regression) models
  – Includes both replacement investment and incremental investment
  – CAPEX no longer based on engineering analysis

• (TOTEX) presumably balances the goals of reducing costs and increasing investment, (which are often at odds)
Performance Incentives

• Under RPI-X performance incentives were disconnected from the price review

• Under RIIO, performance incentives are integrated into the review process
  – Six outputs are integrated into performance incentives
  – Mid-period review
  – End of period review
RIIO Output Goals

1. Customer satisfaction
2. Reliable and available network services
3. Safe network services
4. Timely and non-discriminatory network connection and access terms
5. Limited environmental impact
6. Social obligations (that the network companies are required by the government to deliver)
The key deliverables that the regulatory framework should encourage from network companies are:

1. Outputs that manage network risk
2. Projects to deliver outputs in the future
3. Innovation

RIIO Objectives
- Play a full role in the delivery of a sustainable energy sector
- Deliver long-term value for existing and future consumers

Output Categories
The key deliverables that the regulatory framework should encourage from network companies.

Primary Outputs
Outputs in each category that reflect what customers of network services want delivered.

Secondary Deliverables
1. Outputs that manage network risk
2. Projects to deliver outputs in the future
3. Innovation
RIIO Output Incentive Details

Output Categories

- Customer Satisfaction
- Reliable and available network services
- Safe network services
- Timely and non-discriminatory network connection and access
- Limited environmental impact
- Social obligations (required by the government)

Primary Deliverables

- Outputs set on a sector level
- Common industry metrics
- Multiple outputs within each category

Secondary Deliverables

- Outputs set on an individual company basis
- Relate to costs within business plan
- Relate to management of long-term risk
RIIO Incentive Structure

Totex Incentive Mechanism

Outputs Framework

Proportional Treatment

Innovation

Stimulus Package

Fast Track Approval

Low Carbon Fund 3rd Party Ownership

Primary and Secondary Outputs (Performance Incentive Mechanisms)

Statistical Benchmarking Annual Cost Sharing Menu of Incentive Strengths
RIIO Innovation Provision

- Productivity efficiency gains $[\delta TFP_{target}]$ emanating from investments in innovative new technologies will be shared between the utility and the ratepayers
RIIO Enhances Long Term Value of Innovation

Innovation Stimulus Package

- Low Carbon Networks Fund Innovation Grants
- Third-party *delivery* and *ownership* of “large and separable” network projects
Utility Business Plan

• The utility files a business plan (cost-benefit analysis) covering the six performance outputs

• Funding included in the price control calculation [if business plans are well justified]
Figure 1: Elements of the RIIO model

Reflecting stakeholder views

- Engagement
  - Ofgem enhanced engagement
  - Network engagement
- Ability to seek redress
  - Request for a CC reference

Revenues

- Well-justified business plans
- Proportionate treatment
- Assessment toolbox
- Market testing in assessing business plans
- Financeability

Price control

- Ex ante revenue constraint
- Eight year control
- RAV based

Revenues adjustment during period

- Output incentives
- Efficiency incentives
- Uncertainty mechanisms

Elements outside price control

- Innovation stimulus package
- Option to give third parties a voice

Outputs led framework

- Objectives
- Output categories
- Primary outputs
- Secondary deliverables

Revenue raised from consumers

Source: Ofgem
TOTEX Benchmarking
Regression Modeling

• TOTEX models only control for differences in utility scale and regional labor variation

• Assumes a common & synchronous investment cycle among utilities

• Differences not controlled:
  – Regional topography
  – Population density
  – Network design

• Issue: system enhancement “lumpy”
  – Solution: BOTEX = Base TOTEX: limit to operating and capital maintenance - system enhancement excluded
• **Michigan has a long history of cost-plus ratemaking** and the current rate-setting process is well developed

• **The UK’s RIIO model of PBR is innovative and highly aggressive** in attempting to extract optimal x-efficiencies and output-based objectives

• **The RIIO PBR model is applied to a utility industry that has been restructured** to exclude competitive segments, and Michigan is likely to continue with a vertically-integrated regulated utility structure [significantly complicates RIIO type PBR]

• **Full implementation of a RIIO type PBR** in Michigan would entail significant cost and human resources

• **Current direction of the electric utility industry** in Michigan will continue toward further grid automation, expanding renewable energy, distributed generation, and ultimately a high level of de-carbonization

• **Output based PBR mechanism such as Performance Incentive Mechanisms (PIM’s)** may be considered as a means of achieving policy objectives at most reasonable cost to ratepayers
Building Blocks To PBR For Consideration

**Existing Programs**
- Energy Waste Recovery Program
- Renewable Portfolio Standard
- Integrated Resource Planning
- Distribution Planning Initiative
- Demand Response & Load Control

**New Programs**
- Benchmarking & Best Practices Process
- New Performance Incentive Mechanisms
- Expanded Stakeholder Engagement

**PIM’s**
- System Efficiency PIM’s
- System Reliability PIM’s
- Service Quality PIM’s
- Technology Innovation PIM’s
- Environmental & Social Impact PIM’s
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