DSO ENTITY
DSOs FOR EUROPE

Innovation for regulated companies

AN INITIAL DSO PERSPECTIVE

June 2025

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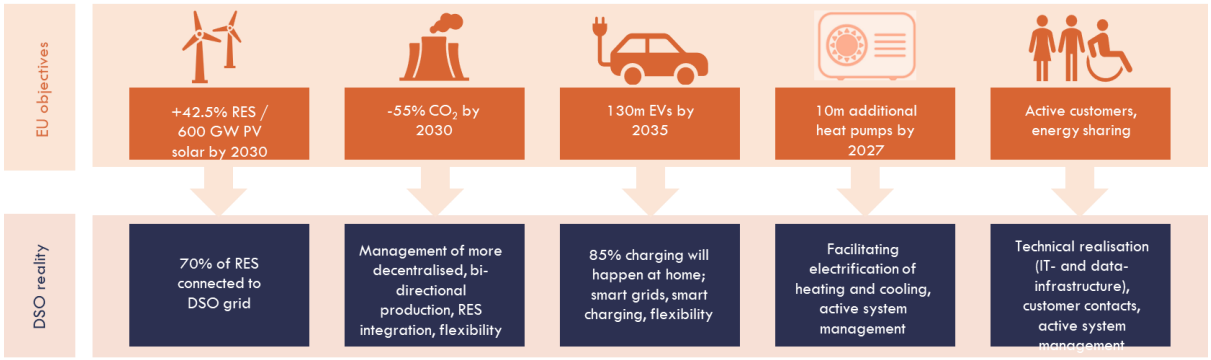
Editorial note: This paper was developed by Task Force in Investment Funding and Finance to deliver on Action 8 of the Grid Action Plan (GAP), with the goal of recommending best practices to promote smart grids and network efficiency technologies, focusing on the consideration of Opex in addition to Capex and benefit sharing. This paper was approved by DSO Entity's Board of Directors on 12 June 2025.

Prelude

The next few years will be crucial to ensure that the EU countries will be able to reach the ambitious net-zero goals set out by the European institutions. The invasion of Ukraine by Russia has underscored the urgent need of accelerating the energy transition, for reaching carbon neutrality and ensuring strategic independence for the continent. To achieve this objective, a few targets have been introduced:



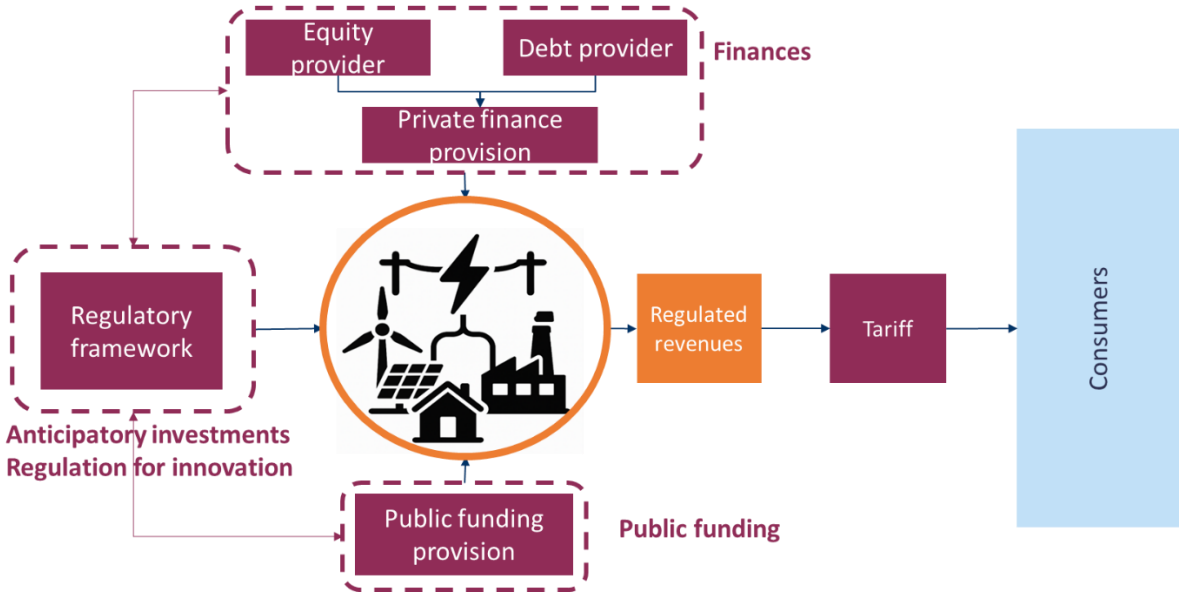
By 2030, with a 42.5% increase in Renewable Energy Resources (RES) and 70% of total RES connected to Distribution System Operator grids, DSOs face a transformative challenge. This "generation" challenge is further amplified by a surge in demand for electricity coming, among other from the electrification of transport (with an estimate 130 million electric vehicles, with 85% of charging occurring at home and a surge on electric busses and trucks) of heating (with additional 10 million heat pumps by 2027) and large industrial process including data centres[1], all presenting an invigorating opportunity for DSOs to innovate and adapt.

To obtain these objectives, estimates suggest that between now and 2050, around € 55-67 billion/year of investments will be required to make the European distribution grid fit for the exponential increase in demand of electricity.[2] Therefore, forward looking planning, able to trigger investments in the right direction, will be of utmost importance.

As part of the work in its Task Force in investment funding and finance, DSO Entity is considering those financial components that could affect the capacity of the companies to deliver these investments. These financial components are shown in the diagram below:

[1] Data centers represented between 1.8% and 2.6% of the total EU electricity use in 2022. Estimate providing in, Kamiya, G. and Bertoldi, P., Energy Consumption in Data Centers and Broadband Communication Networks in the EU, Publications Office of the European Union, Luxembourg, 2024, doi:10.2760/706491, JRC135926

[2] Eurelectric, 2024 Grids for speed. Available in https://powersummit2024.eurelectric.org/wp-content/uploads/2024/07/Grids-for-Speed_Report_FINAL_Clean.pdf



In this paper, the focus will be on the structure of the regulatory framework with the objective of facilitating the innovation required to deliver long-term efficient grids that deliver for consumers while delivering affordable and competitive bills to support the European industry. In addition to including anticipatory investment to ensure a long-term view of the investments, it will be crucial that regulatory frameworks facilitate innovation. Innovation will allow DSOs to obtain more efficient solutions and adapt its grids to future consumers' needs. However, innovation comes with additional risks once that the solutions are not so well tested and they could require different costs and/or deliver different outputs. Therefore, it is important to evaluate the different components of the regulatory framework to ensure they do not hinder innovation.

Background

Facing the objective of delivering the energy transition, DSOs are expected to undertake significant investments in the coming years. These investments will not only be aimed at increasing the capacity of the grid but also to modify its operations to facilitate the connection of distributed generation and support the development of new services. Therefore, to ensure the efficiency of the grid, it is important that DSOs consider two forms of innovation (with innovation being understood as introducing novelties or making changes in something already established, to obtain certain objectives). These two forms of innovation are the introduction of novelties aimed at reducing costs in the operation and the build out of the grid and at facilitating the requirements necessary to develop new services (e.g. data availability).

Innovation, however, brings additional risks once that the output and cost of new technologies is less tested than those of older solutions. Therefore, unless there are potential financial wins from innovation, companies in general (and DSOs in particular) may have limited incentives to test new technologies and prefer to keep using well-tested ones. In competitive markets, however, new technologies and data opportunities can yield substantial cost savings and/or give prospects for new services for consumers which would result in additional profits for the company. On regulated markets such as the one DSOs operate, this effect could be distorted because of the regulatory framework. Therefore, the treatment of innovative solutions (incentivization and/or removing hampering barriers) should be carefully considered as part of the development of a forward-looking regulatory framework.

The objective of this paper is to complement the analysis already presented in our paper on anticipatory investment[3] . That paper indicated that there was no need for specific incentives for anticipatory investments. However, this is not to say that there is no need for incentives in regulatory frameworks but that incentives should be applied to the whole operation of the company. As a result, this paper identifies some examples of how these incentives could be used to facilitate innovation.

This paper focuses on innovation using ready-to-use technologies and not in the development of new technologies via the DSOs own research and development. Therefore, this paper does not consider potential mechanisms regulators could set in place to facilitate research and development by DSOs (e.g. in Austria companies have access to a fund of up to 0.6% of their operating costs with this objective) or the potential access to funds to finance these activities.

Many components of a regulatory framework could affect the companies' innovation capacity. The development of a full list of such components could result in a textbook on regulation which is not the objective of this paper. Instead, this paper has selected three main components that are expected to provide stronger incentives. These components are discussed in more detail in the following sections.

[3] EU DSO Entity Paper on Anticipatory Investments here: https://eudsoentity.eu/news/the-use-of-a-long-term-approach-to-investment-to-ensure-efficiency-paper-anticipatory-investments/

1. Regulatory requirements for companies to invest in innovative solutions

As described in our paper on Anticipatory Investments, DSOs' investment decisions will be affected by the regulatory framework. More concretely, as indicated in that paper, "*in this context, to ensure that DSOs are in a position to deliver consumers' needs while managing effects on competitiveness and affordability, de-risking anticipatory investments (or any investment) is a necessary task but de-risking investments by itself would not be sufficient for DSOs to continue their investments but the overall solvency of the company should be considered, as the capital market expects earnings for the whole RAB that back up the growing debt*".

Therefore, when considering investment, it is crucial that regulatory frameworks are predictable, supportive and provide stability for long-term investments: This would facilitate investment once it reduces the risks perceived by external investors. Furthermore, it also facilitates that DSOs can take efficient investment decisions that are not biased towards traditional solutions instead of innovative ones. To achieve these objectives, it is crucial to develop a regulatory framework based on good regulatory practices (e.g. technological neutrality, transparency, with limited complexity and clear objectives and metrics associated with policy objectives, etc.).

Additionally, companies need to find these investments attractive. In other words, DSOs and its investors need to be able to recover a reasonable return that compensates the risk they are expecting and that is at least as high as the market rate for this type of investment (i.e., the opportunity cost or return on a conventional investment for the DSO or of an alternative non-grid investment of the same risk category for the investors). This return, however, is not only the result of the regulatory WACC remuneration, but a broader concept of allowed return. This concept reflects the overall difference between the cost of investments and the revenues recovered from consumers for those investments. Besides the regulatory WACC remuneration, this includes any additional revenue obtained from an incentive mechanism put in place by the regulator.

This paper focusses on discussing these components in more detail.

2. Components of the regulatory framework to facilitate innovative investments

When considering the effects the regulatory framework can have on innovation incentives, the focus will be mainly on incentive-based regulation which, unlike traditional cost-of-service regulation (which compensates utilities based on costs incurred), motivates network operators to achieve specific outcomes through various mechanisms.

Under this approach, regulators would develop regulatory frameworks aimed at aligning the companies' financial and operational interests with public and policy goals. As indicated above, to align these objectives, regulators would need to ensure that the returns of the companies increase while achieving the delivery of these objectives. Therefore, this can be done via incentives (implicitly or explicitly applied in their regulatory framework) and through the calculation of the return on capital (normally using the Weighted Average Cost of Capital - WACC).

To facilitate innovation, it is important that when aligning incentives between companies and consumers, regulatory frameworks avoid biases between different types of costs (e.g. opex and capex), technologies (i.e. it is technologically neutral (e.g. it does not introduce preferences between the use of flexibility and new assets investment) and forecast horizon (i.e. use an anticipatory investment approach). As indicated by CEER when considering opex/capex neutrality:

> *"The existence of regulatory incentives that promote OPEX/CAPEX neutrality will induce transmission and distribution network operators to seek, right from the planning stage, solutions that allow them to meet the network needs (e.g. capacity for new connections to the network), not only at the most efficient total cost, regardless of whether these costs are more CAPEX or OPEX oriented, but also more quickly, which may contribute for example to reduce the connection times of new network users"*[4]

In this paper, each one of these components is discussed in more detail in the sections below.

2.1 Effect of the implicit mechanisms on innovation incentives

When considering components of the regulatory framework that have been used to incentivise companies to use innovative approaches to improve efficiency, there are two components that have received significant attention when it comes to incentivise innovation: benefit-sharing and totex regulation. Each one of these components will be described in more detail below.

[4] See page 21 in EER, 2025, CEER, 2025, "Incentives in Regulatory Frameworks with a Focus on OPEX/CAPEX Neutrality" Available in https://www.ceer.eu/publication/ceer-paper-on-incentives-in-regulatory-frameworks-with-a-focus-on-opex-capex-neutrality/

Benefit-sharing mechanisms

The first mechanism that most of the literature refers to is the use of benefit sharing mechanisms, providing the capacity to share benefits from cost reductions between companies and consumers, while incentivizing investment and innovation. This interest started with the introduction of the RPI-X (or CPI-X) mechanism inspired by Professor Littlechild in 1983. The mechanism was a real-world application of what became known as "New regulatory economics" (Cf. Laffont, Tirole). A strand of theory argues that most of the regulatory problems can economically be described as an information asymmetry between the NRA and the regulated entity in which the regulated entity is always better informed about its (true) efficiency cost level than the regulatory authority. Under this theory, the NRA will set a maximum price or revenue linked to specific (pre-agreed) outputs. Therefore, if the company can provide the same output at a lower cost they can keep (all or part) of the savings, as a reward for cost reduction. By reducing costs (and increasing its profit) the regulated entity "reveals" its cost saving potential, enabling the NRA to share some or all this benefit with consumers (sooner or later).

Multiple variations and extensions have been provided to this approach with one of the most recent discussed in the table below.

ACER/FSR proposal for benefit sharing

The Florence School of Regulation (FSR) published a study on behalf of ACER in June 2024, developing a proposal for an incentive-based regulatory scheme for TSOs. TSOs are famously difficult to regulate due to a lack of comparators (i.e. there is a small number of them by country and in many cases only one). As a result, multiple initiatives have been developed to compensate for these challenges. This difficulty, however, does not apply to most DSOs as, in most European countries, there are multiple comparable DSOs. Then, the use of a more complex mechanism would not be necessary for DSOs.

FSR/ACER's proposal should:

- address the CAPEX bias (Averch/Johnson effect) and the general weakness of many regulatory frameworks to promote minimum-cost solutions in the TSO context; and
- envisage incentives commensurate a share of the difference between the allowed revenues required to cover the full costs and that of alternative solutions, assessed in net present value (NPV) terms.

To obtain these results, the proposed scheme is such that the NRA shall identify the system needs to be addressed and define the cost of a standard (traditional) way for addressing these needs. In parallel, the TSO will be asked to submit a more efficient innovative proposal to address the specific needs, accompanied by an estimation of associated costs. The allowed revenues are set based on the costs of the more efficient innovative solution and the TSO will receive a share of any positive difference (in NPV terms) between the NRA's estimate and their own proposal.

The effectiveness of this incentive will be determined by the difference in costs between the choice of technologies by the NRA and TSO as well as: the discount rate used to calculate the NPV, the

sharing factor between TSOs and consumers and the period over which the incentive is paid to the TSO.

When considering this proposal, the main challenges identified with this approach are:

- **Identifying system needs (even more in medium and low voltage)**: identifying the needs is a complex exercise even for DSOs. Therefore, delegating that exercise on the NRA would not be necessarily feasible. Furthermore, as indicated in our paper on Anticipatory Investments, "The significant changes in the sector discussed above will increase the complexity of these considerations as it will require to consider the evolution of a more uncertain future."
- **Valuation of the approach proposed by the NRA**: NRAs will not only need to identify the relevant need but also the most efficient project to deliver those needs. Costing that project is a significant challenge once NRAs will not necessarily have the expertise and necessary resources and if they need to repeat this for many projects.
- **Achieve the balance between the risk and the reward for the SOs**: Investing in innovative solutions will be riskier than investing in well-established technologies. Therefore, for SOs to have the incentives to invest in these technologies the reward they can expect to achieve should compensate for the additional risk.

From the point of view of facilitating innovation, this mechanism can play an important role as regulated companies would be able to appropriate part of the benefits that arose due to this innovation for a certain period (i.e. until the end of the regulatory period), aligning their incentives with those of consumers.

Some variations of this mechanism include the possibility that if regulated companies spend above their regulatory allowance, they could also recover part of that overexpenditure from consumers. This provides additional protection to innovation, because innovative solutions have usually a higher level of uncertainty. As a result, there is a possibility that they prove to be more expensive than initially expected and/or they do not deliver according to expectations, and the company needs to make additional investments to deliver the outputs required by consumers. Therefore, by being able to recognize and share with consumers part of these extra costs (efficiently incurred and well-justified towards to NRA), the regulatory framework provides additional de-risking of innovation.

In all variations of a benefit-sharing mechanism, however, the effect of innovation and investment will depend on a number of factors. Without entering details, those factors include:

- **Duration of the regulatory period**: Longer regulatory periods would allow regulated companies to keep their share of an improvement of efficiency/innovation for a longer period which would increase the incentives to invest. Linked with this, it is also worth noting that the incentives to innovate will be reducing the closer to the end of the regulatory period as companies will be able to keep the benefits for a short period of time.
- **Sharing factor**: This factor will represent the share of any under/over expenditure that regulated companies will be able to keep/pass to consumers. Therefore, the larger the sharing factor, the lower level of risk faced by the company and the higher the incentives to innovate.

- **Symmetry**: Regulators could decide to put forward different sharing factors for over and under expenditure. This could affect the incentives to innovate depending on the expected effect of the innovation.
- **Complexity**: Regulators have considered and implemented different benefit-sharing mechanisms (based on CPI-X). The complexity of some of these mechanisms has limited their implementability (e.g. the FSR/ACER proposal above) and/or their success (e.g. menu regulation or Information Quality Mechanism in the UK). As a result, when setting a benefit sharing mechanism, a simpler option could be more effective as it would allow companies to have clarity about potential effects.

Total expenditure (Totex)

In recent years, the use of total expenditure (instead of capex and opex separately) in the regulatory framework has also received significant attention. By focusing on totex, a regulatory framework would avoid potential distortions on company's decision making because of differences in the regulatory treatment of different expenditures and/or technologies.

However, when speaking about totex regulation, it is possible to use different definitions depending on the part of the regulatory framework where totex are considered. Three examples of commonly used totex regulatory approaches are:

- **Totex-based regulatory allowance**: the regulator determines the total allowed expenditure (necessary when setting a revenue or a price cap) without distinguishing the type of costs underpinning that total. Therefore, companies are allowed an amount of revenue without a precise distinction between opex and capex.
- **Totex-based capitalisation**: the regulator determines the amount to be included in the RAB/capitalize based on a ratio being set ex-ante (this ratio can be company specific or sector-wide). Therefore, the regulatory treatment of incurred expenditure is independent of its distinction between opex and capex.
- **Totex-based efficiency analysis**: the regulator develops an efficiency analysis that introduces the same efficiency challenge for all kinds of expenditure (i.e. opex, maintenance and all types of capex). Therefore, this removes potential biases in investment decision making as DSOs face the same efficiency challenges independently of the type of expenditure. Equally, it facilitates innovation as innovative solutions would face the same efficiency challenge regardless of if they are opex or capex-based solutions.

Given those (non-exclusionary) definitions, the effect of the introduction of totex on innovation will depend on what the regulator considers as totex regulation (i.e. which one of these definitions it introduces). For example, if a regulatory framework considers totex allowance and finance but the efficiency analysis is different between opex and capex, this could still distort the companies' decision-making process.

Introducing totex, however, does not come without its complications. For example, when undertaking a benchmarking exercise, care must be taken to ensure that data at the appropriate level of detail is available as the results will depend strongly on the identification of the relevant cost drivers (i.e. variables that explain the evolution of the costs being analysed. If the cost drivers need to become

less specific the benchmarking becomes less precise which could result in the identification of inefficient costs that are generated by a cost driver that has not been considered. In conclusion, we could say that the introduction comes with additional regulatory risk.

Italy's Regulatory by Objectives (ROSS)

The **ROSS (Regulation by Objectives)** scheme in Italy is a forward-looking regulatory framework introduced by ARERA (Italian NRA), starting from 2024 for the electricity distribution sector. It emphasizes simplicity, efficiency, and incentivizing DSOs to meet performance and investment goals while controlling costs.

Key elements:

1. **Totex-based regulation**:
    - ROSS adopts a total expenditure (TOTEX) revenue cap approach instead of the previous "hybrid" tariff regulation (Rate of Return on Capex, Price Cap on Opex). This eliminates eventual biases toward capital-intensive projects and allows DSOs to focus on cost-effective solutions.
    - Fixed recognized OPEX-CAPEX shares based on historical data and DSOs business plans: A pre-defined split of the recognized total costs is made between CAPEX ("slow money") and OPEX ("fast money"), based on a capitalization rate defined by ARERA considering historical and prospective costs reported by the DSO. The Slow Money component is remunerated through WACC and depreciation, while the Fast Money is recognized in the year in which expenses occur. This system ensures DSOs maintain efficient capex/opex spending, coherent with historical data and the expectation of their business plans. It also allows DSOs to focus on cost-effective solutions.

2. **Efficiency mechanisms**: determined considering the difference between the regulatory opex baseline and the actual opex, thus operating both as a reward (if actual opex are lower than the regulatory baseline) and a penalty (vice versa). When the regulatory framework is fully implemented, the efficiency mechanism will consider both Opex and Capex, thus incentivising DSOs to spend below their allowed Totex, reducing the overall costs.

3. **Incentive mechanism**: even if not part of ROSS, the Italian regulation includes also performance-based incentives to encourage DSOs to achieve specific objectives:
    - Performance Goals: Penalties or rewards linked to meeting reliability, service quality.
    - Premium for Development Investments, such as resilience, hosting capacity, electrification etc.)

These incentive mechanisms are subject to regular reviews of DSO performance against targets.

Inclusion of these mechanisms in the broader regulatory framework

The effect of these mechanisms on innovation would depend on how they fit inside of the broader framework used by the regulator. This section aims to identify the main approaches to regulation and identify how benefit-sharing and totex regulation could be applied in each case. This is presented on the table below.

Name	Description	Effects on investments and innovation
Price cap regulation	The NRA sets a maximum price (or a price formula[5]) that electricity DSOs can charge to their customers. This decision will be linked with a series of deliverables that the company needs to provide while charging those prices. This approach allows for benefit sharing as any cost savings achieved can be (fully or partially) retained by DSOs until the next regulatory period, while customers are protected against excessive prices. When setting prices, the regulator could use all different definitions of totex.	Under this approach DSOs face demand uncertainty (i.e. the revenues of the company will vary with demand). Therefore, companies face this uncertainty when forecasting the returns of (innovative) investments. Once companies can retain part of improvements in efficiency (benefit sharing[6]), this approach can provide incentives to invest and innovate using technologies that would allow them to reduce costs. Equally, the use of totex regulation would also facilitate innovation.
Revenue cap regulation	The NRA sets a maximum allowed revenue that a DSO can recover over a regulatory period. This decision will be linked with a series of outputs that the company needs to provide while staying inside of the envelope of the revenue allowance.	Under this approach DSOs are partially protected against demand uncertainty[7] (i.e. the revenues of the company will not vary with demand). This approach allows for benefit sharing, which can result in incentives to invest and innovate using technologies that would allow them to reduce costs.

[5] The cap might also be relevant for a basket of products thereby creating a kind of hybrid between a price and a revenue cap.
[6] Benefit sharing schemes to retain OPEX/CAPEX savings, measured against a forecast made by NRA.
[7] Many regulatory systems that work via revenue caps feature so called “regulatory accounts” or some other feature that controls for over- or under revenue (over or under recoveries) and corrects future revenues in the light of past deviations.

	This approach allows for benefit sharing as any cost savings achieved can be (fully or partially) retained by DSOs until the next regulatory period, while customers are protected against excessive prices. This approach mitigates the risks of overcharging consumers as prices could increase but always inside the revenue cap.	The use of totex regulation could also provide incentives to invest and innovate.
Cost plus methodology	The NRA approves the company's efficient cost. On top of those costs, the NRA approves a certain mark-up aimed at compensating the capital cost of the regulated company. This methodology would put special emphasis on the costs of the company that will be scrutinized to ensure they are efficient. Once they are identified as efficient, companies can recover all their costs from consumers. Therefore, there is no benefit sharing mechanisms.	Under this approach regulated companies would be able to recover their costs only if the NRA deems them efficient. As a result, only if DSOs have the assurance of full cost recovery, they will invest and innovate. In addition, this framework is not consistent with the use of benefit-sharing mechanisms. Therefore, there is a limited incentive to innovate. Furthermore, companies would face the risk of innovation as, in the case of failure or under-delivery, those costs would be fully considered inefficient, and the company will not be able to recover them. Therefore, considering that companies do not get benefit sharing and that there is an additional risk about the cost recovery, this approach is likely to reduce incentives to innovate in comparison with other mechanisms.

This table shows that those forward-looking regulatory frameworks (i.e. price and revenue caps) would be able to incentivise innovation better than those considering only past costs.

2.2 Explicit incentives and output-based regulation

As part of an output-based regulatory framework, the NRA sets performance targets based on specific Key Performance Indicators (KPIs). When setting these KPIs, it is crucial that the NRA follows good regulatory practices such as ensuring that reaching the target for each KPI is mainly under the control of DSOs, as competent to find the optimal solutions (i.e. no reward/penalty result due to third party actions) and that the target level of each KPI accounts for the starting position of the different DSOs (i.e. feasibility of the changes is considered when setting the targets).

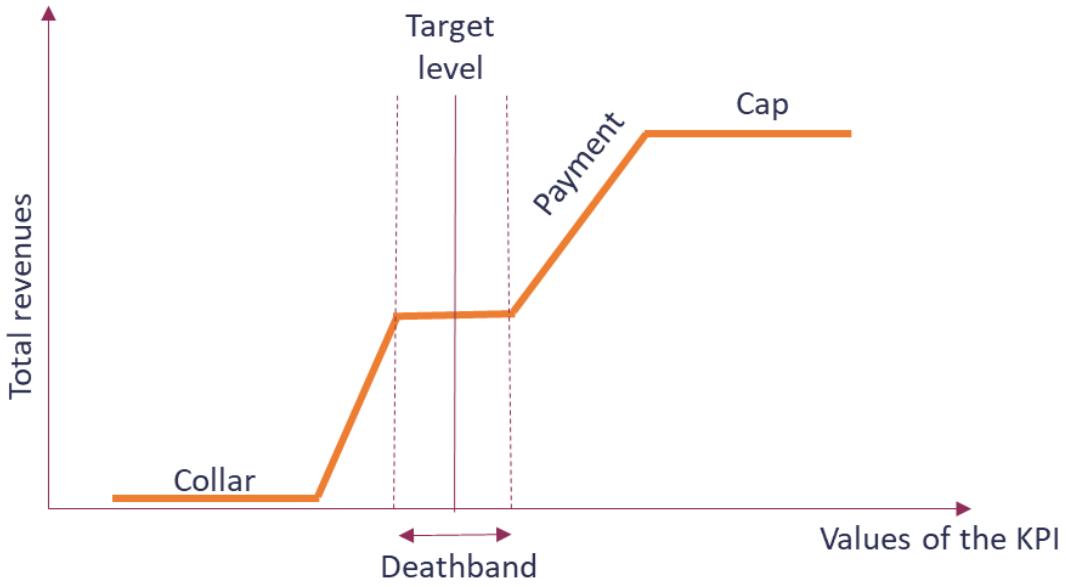
The first stage when setting these incentives is for the NRAs to choose between those based on input (i.e. specific deliverables a DSO needs to deliver, like for example the number of new connections) and/or on outputs (i.e. specific services to be delivered to consumers such as minutes of interruptions) When considering innovation and efficiency in investments, a focus on output would facilitate that DSOs can identify the most efficient way of delivering the services required by consumers.

In addition, to promote additional results, regulators can tie (all or part) of the DSO's revenues to their achievements, with the objective of further aligning the incentives of the DSOs with the interests of the consumers. These incentives are normally tailored to the needs of each specific situation.

When designing these incentives, NRAs need to have clarity about the objective to be achieved and based on that develop the necessary structure. For these structures, NRAs need to decide whether it will include reward and/or penalties, or it will be reputational (e.g. DSOs may obtain rewards for surpassing targets i.e. reducing outages or receive penalties for failing to meet standards.). Equally, it will need to be considered whether the KPIs are evaluated individually or whether they use a certain combination system. For example, operational outputs (like reducing outage frequency) might be one component of a broader performance-based regulatory framework that also considers customer satisfaction, cost control, and environmental impact.

With these objectives, the NRA could set a financial incentive. When setting these incentives NRAs should consider the following values:

- **Target level**: Value of the KPI the DSO is required to achieve.
- **Cap and collar**: Maximum and minimum value of the KPI linked to financial incentives. This is to ensure that the incentive does not affect DSO's capacity to finance its operations in case of penalty (collar), while protecting consumers in case of reward (cap).
- **Deathband**: Range of value of the KPI without financial effect. This will be set to recognize and calculate the uncertainty around the delivery of a set value of the KPI (i.e. that the DSO can go higher/lower by reasons outside of its control and/or because of quantification errors).



When designing these incentives, NRAs should consider the negative effect a penalty system would have on innovation. When considering an innovative solution, DSOs face the risk that the solution could under-deliver, requiring an additional expenditure to achieve the target level. If the DSO faces the risk of paying a penalty (negative incentive) despite this additional investment, it is less likely to undertake the innovative investment to avoid the double penalty.

Spain's incentives on digitalisation

Prior to 2019, distribution companies had no incentive to invest in network digitalization (sensors, advanced monitoring, data analysis software, etc.) as they risked the non-reward of such investments. As a result of Circular 6/2019, which updated the remuneration model, investment in digitisation is allowed with a wide range of typologies that can be developed, in addition to being able to allocate part of the investments in pilot projects to boost innovation.

Key elements:

Investment in network digitalisation (smart grids, sensorisation, electric vehicle infrastructure, network digitalisation, cybersecurity, etc.). These investments are amortised in 5 - 12 years, which means that investments can be recovered in a shorter period (distribution assets are amortised over 40 years). In addition, incentives are provided for this type of investment through the PRTR program (recovery, transformation and resilience funds) in which 50% of these investments are subsidised and the maximum investment volume is increased by the same volume that is allocated to the digitisation of grids.

2.3 Return on capital (WACC)

When considering the return on capital, most regulators use an approach based on the Capital Asset Pricing Model (CAPM). Since its development in the 1960s, CAPM has not only become a theoretically recognized model for determining the expected, risk-adjusted cost of equity, but has also become established as the most widely used method in practice and especially in regulatory contexts.

Based on this model, regulators estimate the Weighted Average Cost of Capital. In this model, the imputed cost of capital is calculated as a weighted average of the cost of equity and the cost of debt based on the respective shares of equity and debt capital. Therefore, the following formula is used:

WACC = Cost of Equity * Equity Ratio + Cost of Debt * Debt Ratio[8]

In the classic CAPM, the empirical estimation of the individual model parameters is not defined. This question does not even arise in the original theoretical model approach. CAPM as a theoretical model is generally recognized in science and practice. In practice, however, the challenge is to estimate the parameters of the CAPM using suitable methods and data as reliable and accurate as possible.

The use of the CAPM as a recognized capital market-oriented model therefore does not immediately lead to a clear, generally accepted result. In practice, empirical data must be used to operationalise CAPM, and the required model parameters must be consistently estimated. There is neither a generally recognized procedure for estimating all parameters nor a generally recognized database. There is no scientific consensus on the derivation of the market risk premium, where both the orientation of the estimation methods (e.g. historical market risk premium, historical market return, ex-ante analyses) and the appropriate data basis and the procedure for aggregation via averaging (geometric, arithmetic) are concerned. The various methods can lead to considerable differences in the resulting estimates.

The selection made in each case is therefore not a purely theoretical point of discussion but rather involves wide scope for discretion and has an impact on the results in practice. As a result, regulators need to choose inside of that range the allowed cost of capital of the companies.

With this regulatory allowance, companies (and their investors) need to decide the level of risk they are willing to take given the expected compensation. As a result, if the WACC is too low, companies could need to reduce their investment to maintain their risk low. The opposite would happen with a high WACC as riskier options would be possible. Once that innovation and investment in new technologies brings a higher risk, one would expect that companies will be more inclined to innovate if the WACC is such that it is compensated for this additional risk.

As a result, it is crucial that to facilitate investment in general and innovation in particular, NRAs develop a robust calculation of the WACC and choose the correct point in the calculated range. To mitigate this risk for investment and innovation, some regulators have used an approach of “aiming-up”. Under this approach, NRAs prefer to target higher values of the estimated WACC range to incentivise investment. This is considered as a way of protecting consumers from potential errors in

[8] For a fuller discussion about the approach to the development of each one of these components, please see annex 1.

the estimation of the WACC (i.e. consumers are better off with slightly higher tariffs than without the necessary investments).

In other cases, as is shown in the box below, regulators could decide that certain innovative projects could require an additional return to ensure timely implementation. This mechanism, however, has as a strong limitation the identification of specific projects and the remuneration of their expenditure. Given their standard size, it is difficult to identify DSOs' projects large enough to qualify for this approach. One notable exception could arise in the introduction of smart meters as shown in the table below.

Efficiency Analysis and Improvement in Electricity Distribution in Austria

The Austrian regulatory framework includes different components aimed at facilitating innovation. In addition of a mechanism aimed at creating a fund that DSOs can use to develop innovative solutions (outside of the scope of this paper), this regulatory framework includes benefit-sharing mechanisms (discussed later in the paper) and incentives for innovation in the WACC.

As the base of these two incentives, the Austrian NRA, undertakes a benchmarking analysis that compares the actual costs of DSOs against peers using selected inputs (mainly costs) and outputs (such as performance and structural parameters like line lengths, peak loads, number of meters, etc). The study includes 38 Austrian DSOs and uses input-oriented methods, focusing on minimizing inputs (DSOs costs) for a fixed output level.

The results of those benchmarks affect both capital and operating expenditure allowances:

- **Efficiency-based WACC**
  DSO companies receive an individual WACC based on their specific efficiency performance. A company with median efficiency (compared to all electricity distribution operators) is granted an average pre-tax WACC on its existing regulated asset base. The WACC can vary by ±0.93 percentage points, depending on the DSO's efficiency score.
- **Efficiency of allowed OPEX**
  Benchmarking directly impacts the annual allowed operating expenditures (OPEX):
  - ✓ Each DSO receives an efficiency score ranging from 80% to 100%, with the national average for the current period at 95.2%.
  - ✓ A score of 100% means the DSO is fully efficient.
  - ✓ A lower score implies inefficiency and triggers a mandatory annual cost reduction, up to 2.93% of the allowed OPEX.

DSOs that outperform the benchmark can retain cost savings as profit, reinforcing a strong incentive for efficiency. Conversely, DSOs with persistent inefficiencies face revenue reductions, pressuring them to optimize operations. This framework promotes efficient behaviour by linking a DSO's efficiency score to both its allowed return and expenditure trajectory.

Even the least efficient DSOs still receive a return above their cost of debt, maintaining overall financial stability.

Greece's incentive on Smart Meters roll-out

The NRA provides HEDNO with the incentive of a "premium return" on "Major Projects", according to the Regulated Revenue Methodology (Decision E-158/2024). According to this Methodology, "Major Projects" are defined as the projects that benefit the distribution network users, and have a positive impact on the electricity market, and in general the economy, contributing to the national and European Clean Energy Transition goals. Considering Major Projects' positive impact, the NRA incentivizes HEDNO to complete such Projects on time, by allowing HEDNO to earn an additional return (on top of the allowed WACC), the so-called "premium return".

Key elements:

- **"Smart Meters roll-out" Major Project**: HEDNO has planned the replacement of traditional meters with Smart Meters during the years 2021-2030. The Project is expected to lead to important benefits for both HEDNO and distribution network users (e.g., decrease in network losses and their cost).
- **Cost-Benefit Analysis (CBA)**: HEDNO is obliged to execute a CBA study verifying the benefits that the Project brings to end-users. The CBA study is submitted to the NRA for review and recognition of the project as Major Project.
- **Premium return**: The Greek NRA approved a premium return of 1.5% on Smart Meters roll-out for 4 years. The recovery of this premium return by HEDNO, is subject to the timely completion of the Project.

3. Regulation and innovation: proposed principles

Building on the findings in our paper on anticipatory investments and the issues discussed above, this paper identifies a series of principles aimed at facilitating not only investment but also innovative investment. First, it will be important to reiterate some of the principles that were identified when considering anticipatory investments and that can be extended to cover most investments (including innovative):

- **Regulatory frameworks should be predictable, supportive and provide stability of long-term investments:** This would facilitate investment once that it reduces the risks perceived by external investors. Furthermore, it also facilitates DSOs can take efficient investment decisions that are not biased towards short-term solutions instead of using an anticipatory investment approach.
- **Regulation needs to be clearly defined at the outset and balance risk and reward:** Investing implies that there could be a mismatch between planning and actual development. The regulatory framework needs to define at the outset clearly and unambiguously how deviations (underinvestment or overinvestment) are going to be taken care of and that it evolves from facilitate the management of uncertainties that arise from innovation.
- **Treat all comparable investments alike**: DSO Entity considers that it is important that the regulatory frameworks ensure an equal treatment of all investment possibilities to avoid biases. This includes all components of the regulatory framework. For example, regulators providing flexibility in the evaluation of capital plan to address uncertainty around these plans could include a bias in innovation as modifications to opex allowances would not be addressed equally.
- **Use the DNDP as a mechanism to develop robust information:** The DNDP serves as a tool for information exchange and refinement between NRA, the DSO community and the public. The DNDP therefore clarifies the probable investment needs in some transition scenarios.

Those high-level principles can then be brought one step lower to focus on the promotion of innovation in the DSOs investment plans. Some principles that have been identified above are the following:

- **Explicit and implicit incentives to innovate should be considered jointly in the development of a regulatory framework**: The effect of the regulatory framework in innovation will be the result of the combination of all its components. Therefore, the introduction of explicit incentives will only deliver innovation if they are supported by the implicit incentives contained in the regulatory framework.
- **Totex regulation can create a better environment for innovation, but its effectiveness will depend on its implementation:** There can be different totex regulatory approaches, as a result, its effect on innovation will depend on the degree of implementation and the evaluation of the overall effect different implementations can have. Accounting for the degree of implementation, it is necessary to be aware of any opposing effects from parts of the regulation where opex and capex may be treated separately.

- **Output based regulation should complement the overall revenue framework to facilitate innovation:** To facilitate innovation, a focus on the outputs that grids provide to consumers would provide grids with the capacity to innovate in the way that those services are provided. This would allow a larger flexibility in the selection of new and innovative solutions that could require changes in the inputs required.
- **Benefit sharing mechanisms, totex and outputs should be carefully introduced to ensure the removal of potential regulatory biases**: As indicated by CEER (2025),[9] benefit sharing mechanisms, totex regulation and output-based regulation, when fully and properly implemented, could provide an equal treatment among different types of costs[10]. By removing those biases, these regulatory tools would facilitate innovation as it allows companies to choose the most efficient solution without considering the effect this could have on their capacity to recover these costs.
- **European focus on regulation to support the delivery of the necessary innovation required for the energy transition:** Innovation being a fundamental driver to deliver an efficient energy transition could support a more active role of the European Union in the promotion of regulatory frameworks to support that innovation.

[9] CEER, 2025, CEER, 2025, "Incentives in Regulatory Frameworks with a Focus on OPEX/CAPEX Neutrality" Available in https://www.ceer.eu/publication/ceer-paper-on-incentives-in-regulatory-frameworks-with-a-focus-on-opex-capex-neutrality/

[10] In CEER's paper this focus on equal treatment of opex and capex, but it should also consider other types of regulatory biases such as between short-term and long-term deliverables (i.e. using an anticipatory investment approach) as well as innovative and traditional solutions.