University of Piraeus

Graduate Program - ENERGY: Strategy, Law & Economics

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Lesson A4

"Putting a price on infrastructure"

Aspects of pricing third-party access to infrastructure

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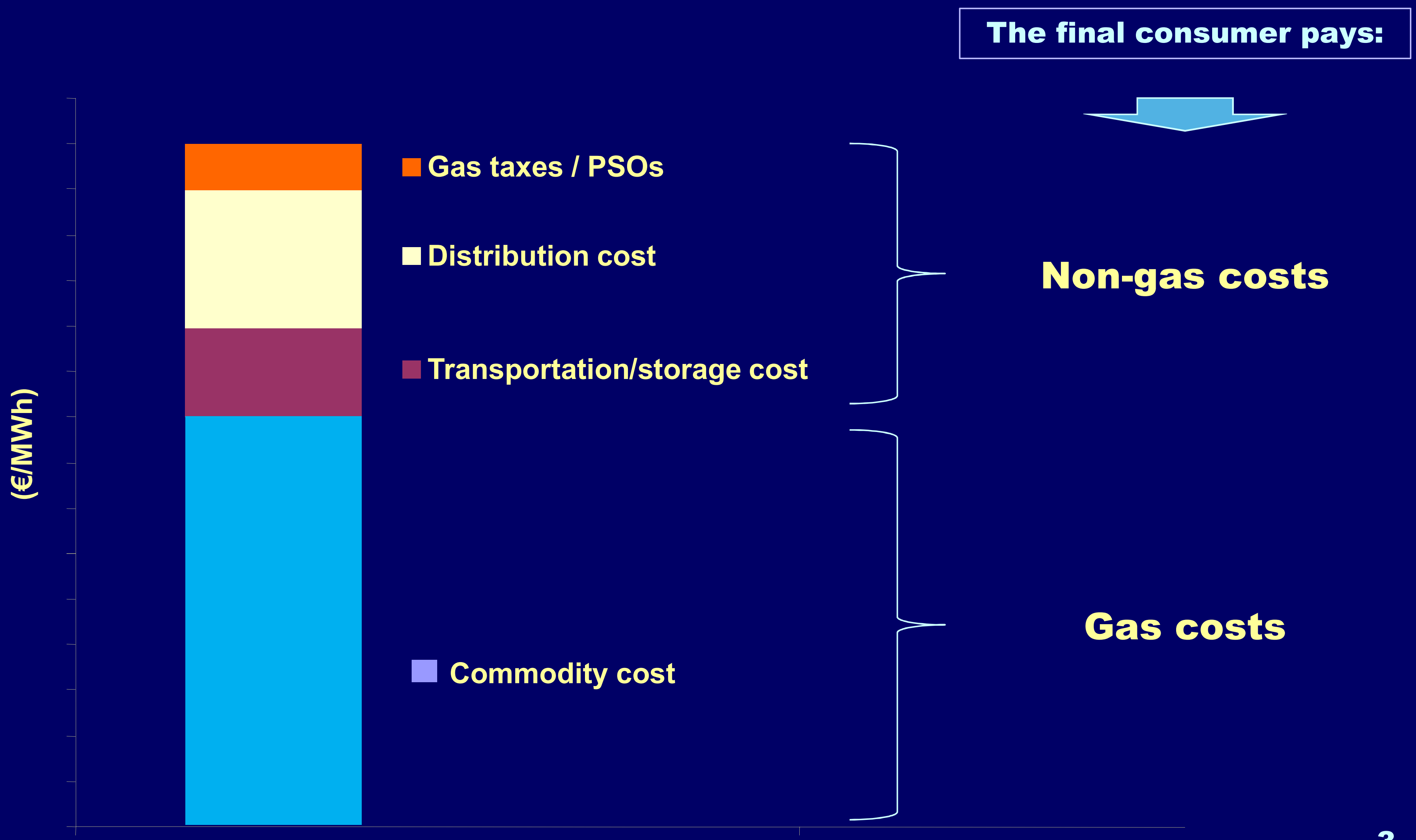
Introduction

Final gas price structure



Final gas price structure II

- In a liberalized and competitive gas market:
  - Non gas costs: Are known in advance (transparency) and are common to all market participants (non-discrimination)
  - Gas costs: Are formed by the market, through the interaction of supply and demand, in conditions of competition between different suppliers

Final gas price structure III

- Cost of gas (commodity)
  - Derived through competition (market value)

- Taxes, levies, Public Service Obligations (PSO)
  - Imposed by the government as a means to achieve public and energy policy objectives

- Cost of using the infrastructure (e.g. transmission, storage, LNG regasification, distribution)
  - Approved by the energy regulator, so that it is transparent and non-discriminatory for the users of the infrastructure "third-party access (TPA) tariff"

- Setting a discreet TPA tariff which is known in advance and is common to every interested party is a fundamental pre-condition for proper market functioning, in order for the competition not to be distorted and being focused on the supply of gas

Third-party access tariffs

TSO activities

- Regulated:
  - Services related to third-party access to the transmission system
- Non- regulated:
  - Related to the transmission system (e.g. certification of metering equipment of industrial installations, gas odorization services etc)
  - Related to the transmission system (e.g. Real estate)
- Strict accounting unbundling rules prevent cross-subsidization between regulated and non-regulated activities

TSO revenues

- Regulated:
  - Sourced from provision of TPA services, through TPA tariffs
  - Approved by the National Regulatory Authority
  - Recorded (along with relevant costs) in a separate account
- Non-regulated
  - Sourced from provision of non-regulated services
  - Relevant tariffs are defined by the TSO based on the competition in the relevant market, generally without any regulatory intervention
  - Recorded (along with relevant costs) in a separate account
- Usually, the non-regulated revenue is a fraction of the regulated revenue

TPA tariffs in general

- Approving of the TPA tariffs is one of the most important regulatory competences (*)
- TPA tariffs are not related to the gas (commodity) cost transmitted through the infrastructure
- TPA tariffs defines the amount of money paid to the TSO by a User of the infrastructure for:
  - Connection of Uses facilities with the infrastructure and/or
  - Use of the infrastructure to transmit gas
- A prerequisite for setting TPA tariffs for a piece of infrastructure is the accounting unbundling of the activity associated with the relevant infrastructure

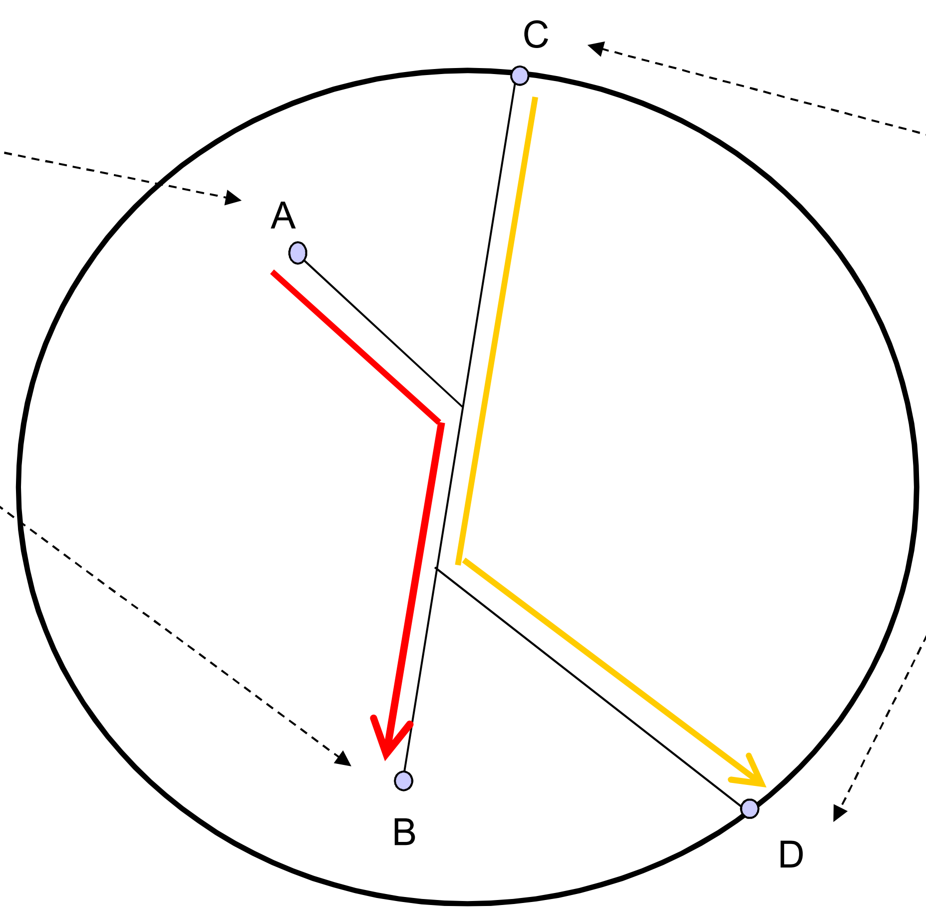
(*) For simplicity reasons, discussion will be limited on transmission system tariffs, since the logic for TPA tariff setting is the same for all gas infrastructures (transmission, distribution, LNG terminals, storage facilities) (in fact, transportation presents more complex issues like locational pricing and transit flows).

TPA: An example case

Recap from previous lectures

ABCD: Transmission System of country X, operated by a TSO

A gas producer/supplier wants to inject gas to entry point A (production site) in order to supply customer in exit point B **for a year** and **for a maximum flow of 2 m3/day (capacity)**



A shipper wants to transit gas through the country by injecting gas to entry point C and offtaking gas at exit point D **for a month** and **for a maximum flow of 1 m3/day (capacity)**

Basic (informal) definitions of a TPA scheme

Recap from previous lectures

- **System Operator (TSO):** The entity responsible for the operation, maintenance, development and exploitation of the infrastructure
- **Third Party:** A user of the infrastructure (for selling or transiting or consuming gas) other than the TSO (a.k.a. *Network User* or *Shipper*)
- **Third Party Access (TPA):** The right of a third-party to connect to and use the infrastructure under certain terms and conditions
- **TPA system:** The terms and conditions for access to the infrastructure (the obligations and rights of the user and the operator of the infrastructure, technical rules, metering etc)
- A TPA system includes:
  - **Price terms** (tariffs) for use of the infrastructure
  - **Non-price terms** (types of services offered, procedures, rights and obligations of the parties etc)
- Two main models for organising a TPA system:
  - The **negotiated TPA model** (*ex-post* regulation)
  - The **regulated TPA model** (*ex-ante* regulation)

Negotiated vs regulated TPA

- Chapter VII of Directive 73/2009/EC

Recap from previous lectures

Negotiated TPA

- The (tariff and non-tariff) terms and conditions of TPA are negotiated between the TSO and the users of the infrastructure
- Negotiations should be performed in good faith, no discrimination between users is allowed
- Transparency in the terms and conditions offered by the TSO
- The market regulator (or competition authority or any controlling authority) will intervene *ex-post* only after and whether a problem has occurred

Only possible (optionally) for storage facilities in the EU

Regulated TPA

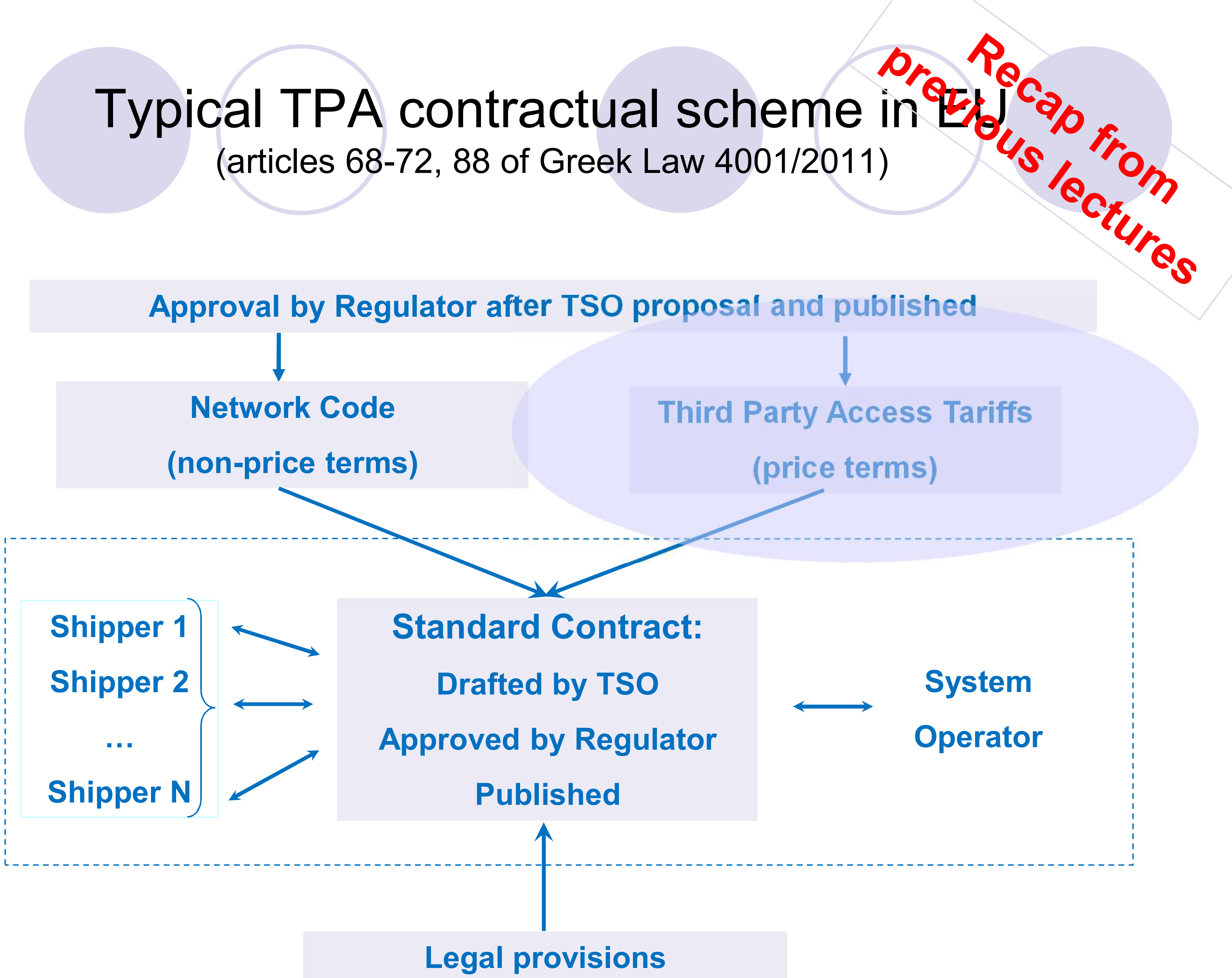
- All price and non-price terms and conditions of TPA are approved in advance (*ex-ante*) by the market regulator
- These terms and conditions are offered to all users of the infrastructure without discrimination – there is no negotiation anymore
- All these terms and conditions are published (e.g. in the official government gazette, in the website of the TSO etc.)

EU model for transmission and distribution systems and LNG facilities

Optional for storage facilities

Typical TPA contractual scheme in EU

(articles 68-72, 88 of Greek Law 4001/2011)



Regulatory competences

- The National Regulatory Authority (NRA) approves *ex-ante* the TPA tariffs for:
  - Transmission, storage, LNG regasification, and distribution gas systems
  - Transmission and distribution systems of electricity

- Following a TSO's proposal, the regulator approves:
  - At least the methodology for setting TPA tariffs and, possibly,
  - The actual TPA tariffs

- References:
  - Articles 32 and 41 Directive 2009/73/EK
  - Articles 32 and 37 Directive 2009/72/EK
  - Articles 88 (gas) and 140 (electricity) of Greek Law 4001/2011

Procedures

- TPA tariffs are set in advance (ex-ante) for the next 3-5 years («regulatory period»)
- It is a common practice to initially set in advance a constant (in real terms) TPA tariff for each year of the regulatory period, which is adjusted every year due to:
  - Inflation
  - Efficiency incentives imposed to the TSO by the regulator
- In the end of every regulatory period there is a regular/scheduled review, in order to set the TPA tariffs for the next regulatory period
- An extraordinary review can be requested by the TSO or initiated by the regulator alone at any time, in case of significant deviation of market conditions from the conditions assumed at the time of tariff setting

Objectives of TPA tariffs design (I/II)

Main objective:

Recovery of the economic cost of the TSO for operation, maintaining and developing the transmission system

Where:

Economic cost = expense (accounting cost) + opportunity cost

Opportunity cost: The "return" (profit) expected from an investment of equivalent risk

Objectives of TPA tariffs design (II/II)

- Regulatory (qualitative) objectives (article 13 Regulation 2009/715/EC):
  - Transparency
  - Non-discrimination between the users of the infrastructure
  - Avoiding cross-subsidies between activities and users
  - Reflecting the (reasonable and efficiently incurred) costs of the TSO
  - Providing incentives for efficient and sufficient development and maintenance of the infrastructure
  - Facilitation of efficient gas trading and competition
  - No-distortion of x-border trade
- In practice, it is impossible to wholly fulfill each of the objectives
- Maximization of the total outcome of the tariffs setting exercise, depending on priorities (imposed by the state of the market)

Main methodological steps

- Tariff setting occurs in two steps:

  1. Calculation of the amount of money the TSO must collect form the users of the transmission system in order to cover its economic cost (Required Revenue)

  2. Allocation of the above amount to the users of the transmission system (Cost-allocation)

- Several methodologies and approaches exist for each of the above steps

- Selection of the appropriate methodology depends on the particular objectives and limitations of each case

Main equation

- For each year (i) of the «regulatory period» the unit tariff is calculated as follows:

$$\text{Unit tariff (i)} = \frac{\text{Required Revenue (i)}}{\text{Volume (i)}} \quad (€/m^3)$$

- where:
  - Required Revenue (in €): the amount of money the TSO has to recover in year (i)
  - Volume (in m3): the volume of natural gas that is forecasted to be transmitted through the transmission system in year (i)

Notes

- Given that tariffs for year (i) are set in advance for the whole regulatory period (*i.e. before the start of each year (i) of the regulatory period*) the previous equation actually refers to the <u>forecast</u> Required Revenue and the <u>forecast</u> Volume for year (i)

- The regulatory review at the end of each regulatory period is setting the tariffs for the next regulatory period, taking into account:
  - The forecast for both the Required Revenue and Volume evolution in the next regulatory period
  - Any difference between the forecast Required Revenue and the actual Required Revenue of the previous regulatory period
  - Any difference between the forecast Volume and the actual Volume of the previous regulatory period

Calculation of Required Revenue

Required Revenue - RR

- The operator of an infrastructure should:
  1. Recover its reasonable expenses for the construction of the infrastructure (recovery of capital invested)
  2. Have a reasonable profit (a “return” on the capital invested)
  3. Recover its reasonable expenses for the operation of the infrastructure (recovery of operating expenses)

- The Required Revenue of the operator of a piece of infrastructure <u>is equal to its economic cost</u> which consists of:
  1. Operating Costs
  2. Capital Costs
     - Recovery of the initial capital investment
     - Return (profit) on the capital invested

Required Revenue calculation

For each year (i) the Required Revenue (RR) is calculated as follows:

$$RR(i) = Depr(i) + RAB(i) \times WACC + Opex(i)$$

Depreciation

Return on Investment (profit)

Operating Expenditure

‘Capital costs’

‘Operating costs’

Regulatory Asset Base (RAB)

- RAB: All assets used in the activity for which tariffs are designed
  - For example, in a transmission system, it consists of the all pipelines, valve stations, metering/stations, compressors etc
- For setting the tariffs, the value of the RAB at the time of calculation of the tariffs is necessary to be defined
  - If tariffs are designed today but are to be applied also in future years, the value of the RAB should also include future assets (new investments)
- The RAB is really the basis of tariff calculation. It affects both aspects of the “capital cost” part of the Required Revenue:
  - Depreciation
  - Return on capital invested
- For that matter, the selection of the appropriate RAB methodology and calculation is a matter of serious negotiations between the owner/operator of the transmission system and the regulator

Methodologies for defining RAB value

- Two main categories:
  - Cost-based methodologies
    - Historic Cost (book value)
    - Indexed Historic Cost
    - Replacement Cost
    - Optimised Replacement Cost
  - Value-based methodologies
    - Fair market value
    - Deprival value
    - Optimised deprival value

Difference between "Asset Base" and "Regulatory Asset Base"

- The "Asset Base" usually refers to <u>all</u> the assets owned by the TSO
- When setting the third-party access tariffs, it is possible for the regulator -at its justified discretion- not to take into account the value of some parts of the Asset Base of the TSO, such as:
  - The value of assets owned by the TSO, but paid directly by the consumers (e.g. the connection between of a final consumer's facilities and the transmission system)
  - The value of any grants issued to the TSO by national/international authorities during the construction of the transmission system
  - The value of any assets considered by the TSO as "inefficient investments"
  - The value of any assets of the TSO not used for the regulated activity for which tariffs are designed (e.g. assets related to non-regulated activities)
- The remaining assets form the RAB

Depreciation

- A schedule of payments during the life of an asset, for the purpose of recovery of the initial RAB of that asset (e.g. pipelines, compressor stations etc

- The duration of the asset's "life" and the rate of recovery of the initial RAB (e.g. constant rate - equal annual payments or accelerated rate as we approach the end of the life of the asset) is a basic regulatory choice

- Accounting life:
  - The accounting life of the asset is defined by the tax legislation of each country and is expressed by the annual depreciation rate. For example, in the case of pipelines, the usual accounting life is 40 years (constant annual depreciation rate of 2,5%)

- Economic life:
  - The real useful (economic) life of the asset can be very different than the accounting life. For example, the useful life of pipelines is no less than 50 years with reasonable maintenance

Example of calculation of initial RAB and depreciation

Assumptions:

- CapEx of 5000 € in year 1 for constructing 100 km of pipeline
  - Capex (capital expenditure): The money spent to construct or acquire the asset
- The initial RAB is calculated as follows:
  - RAB = CapEx, if the regulator chooses to include any grants
  - RAB = CapEx – Grants, if the regulator chooses not to take into account any grants
  - In this example Grants = 0
  - Depreciation rate = 20% per year

Year (i)	**1**	**2**	**3**	**4**	**5**
Initial RAB	**5000**				
Annual depreciation rate	**20%**				
Depreciation for year (i)	**1000**	**1000**	**1000**	**1000**	**1000**
Cumulative depreciation	***1000***	***2000***	***3000***	***4000***	***5000***

Example of calculation of RAB evolution

For simplicity purposes, the historic cost (book value) methodology is used for the RAB

The value of the RAB each year (i) is the undepreciated (net) book value of the assets

$$RAB_i = RAB_{i-1} - Depr_{i-1}$$

The initial value of the RAB (year 1) is equal to CapEx, unless there are grants and regulator does not allow inclusion of them in the RAB

Year (i)	1	2	3	4	5
CapEx	5000				
Depreciation for year (i)	1000	1000	1000	1000	1000
Value of RAB at the beginning of year (i)	5000	4000	3000	2000	1000
minus Depreciation for year (i)	-1000	-1000	-1000	-1000	-1000
Value of RAB at the end of year (i)	4000	3000	2000	1000	0

Cost of capital

- Capital for the construction of an asset (e.g. the transmission system) is usually provided by:
  1. Equity i.e. money from the owner of the pipeline/private investors
  2. Debt i.e. money provided by banks or other financial institutions
  3. Grants i.e. money offered by national or international organisations to support development activities
- Cost of Capital: The opportunity cost of the capital invested i.e. the return that one would have from the best alternative investment *of equivalent risk*
- Each one of the financing sources has each own cost in providing capital, because the level of risk for each one is different
- The cost of capital for the whole asset should take into account the cost of capital of each financing source (equity, debt, grants)
- Grants are usually considered not to have a cost of capital

Weighted Average Cost of Capital

Weighted Average Cost of Capital (WACC):

WACC =

(% equity in RAB) x Cost of capital of equity +

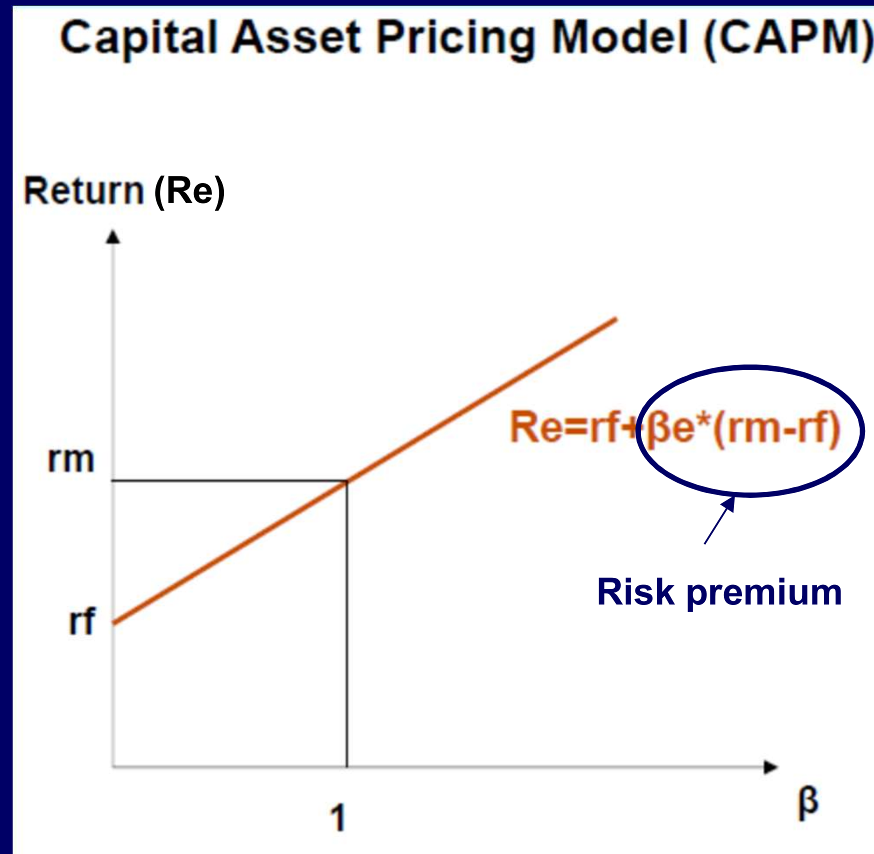
(% of debt in RAB) x Cost of capital of debt

Cost of capital II

- There are several models and approaches in estimating/calculating the WACC
  - The cost of debt can be found by shopping in the financial market
  - The cost of equity is more tricky. The most commonly used model for the calculation of the cost of equity is the Capital Asset Pricing Model (CAPM)
- WACC can be:
  - Nominal, when it incorporates the inflation rate
  - Real, when it does not
- And also:
  - Pre-tax WACC, when it is does take into account taxation
  - After-tax WACC, when it does not
- It is of paramount importance its consistent use

Estimating the cost of equity: CAPM model

- The main concept:
- Cost of equity = Risk Free Rate + Risk premium
  - Risk Free Rate: The profit of an alternative investment with the lowest possible risk
  - Risk premium: An estimation of all the (extra) risk related with the particular investment above the Risk Free Rate



re = required rate of return on equity

rf = risk free rate of return (e.g. treasury bill)

Be = Beta, the relative volatility of the specific stock to the market

rm= market risk

Example of cost of capital calculation

Assume the following financing structure for the previous example:

Initial RAB (€)	5000		
Financing sources	*(€)*	*(% of RAB)*	*Cost of capital*
- Equity	2000	40%	10,0%
- Debt	3000	60%	5,0%

The Weighted Average Cost of Capital (WACC) for this project is calculated as follows:

WACC = (% equity in RAB) x Cost of capital of equity +

(% of debt in RAB) x Cost of capital of debt

In the example: WACC = 40% x 10% + 60% x 5% = 7%

Calculation of Return On Investment – ROI

For each year i, the ROI is calculated as follows:

$$ROI_i = RAB_i \times WACC$$

Year (i)	1	2	3	4	5
Value of RAB at the beginning of year (i)	5000	4000	3000	2000	1000
WACC	7%	7%	7%	7%	7%
ROI_i *[=RABi x WACC]*	350	280	210	140	70

Operating Expenditure (OpEx)

- The annual expenditure of the TSO to operate and maintain the transmission system
- For each year (i), typical Opex items are:
  1. Fixed - not dependent on the quantity of gas transmitted
     - Salaries for the personnel
     - Insurance
     - Bills
  2. Variable - dependent on the quantity of gas:
     - Mostly the cost of fuel for operating the compressors
- OpEx is to the greatest percent consisting of fixed costs
- Some of these costs are escalating over time, e.g. insurance with inflation, salaries with inflation + 2%

Real OpEx categories example

TRANSMISSION SYSTEM OPEX	2004	2005	2006	2007	2008
Operating Cost					
Cost of Transportation Personnel working on the Pipeline	6.954.390	7.847.865	9.258.102	10.027.846	10.713.170
Cost of Support Services Personnel	4.748.101	4.988.355	5.230.590	5.468.581	5.717.402
Own Consumption of Natural Gas	29.847	21.844	0	0	0
Consumables	2.614.470	2.928.137	3.284.373	3.444.817	3.517.192
Insurance Premia	4.530.691	5.074.254	5.691.587	5.969.625	6.095.046
Maintenance	659.149	738.229	828.042	868.492	886.739
Telecommunications	779.698	837.373	924.691	969.014	1.006.903
Rents	1.044.020	1.075.341	1.105.451	1.133.087	1.161.414
Electricity	845.795	871.169	895.561	917.950	940.899
Security	789.498	813.183	835.953	856.851	878.273
Water Supply	15.743	16.215	16.669	17.086	17.513
Taxes - Levies	503.678	541.636	590.279	623.103	648.946
Advertising	769.369	827.350	901.653	951.791	991.267
Miscellaneous Expenses (excl. advertising)	3.413.011	3.665.476	4.047.699	4.241.713	4.407.567
Provisions for Personnel Compensation	823.506	1.081.971	660.989	403.094	373.658
Own Consumption Losses due to Compressors	0	0	0	319.501	494.300
OPERATING COST TRA	**28.520.964**	**31.328.399**	**34.271.637**	**36.212.551**	**37.850.289**

Example Opex

Year (i)	1	2	3	4	5
Inflation	3%	3%	3%	3%	3%
Opex categories (€)					
Salaries	20,0	21,0	22,1	23,2	24,3
Insurance	30,0	30,9	31,8	32,8	33,8
Other	10,0	10,0	10,0	10,0	10,0
Compressor fuel	20,0	40,0	80,0	140,0	160,0
Total Opex$_i$	80,0	101,9	143,9	205,9	228,1

Example assumptions:

Salaries increasing by the inflation rate + 2% per year

Insurance is increasing by the inflation rate per year

Compressor fuel is increasing roughly in proportion with the annual volumes

Calculation of Required Revenue

Recap:

For each year (i) the required revenue should recover:

The initial investment → Depr(i)

+

The operating costs → Opex(i)

+

A return on the investment → ROI(i) = RAB(i) x WACC

Example Calculation of the Required Revenue

Year (i)	1	2	3	4	5
Capital Expenditure for asset	5000				

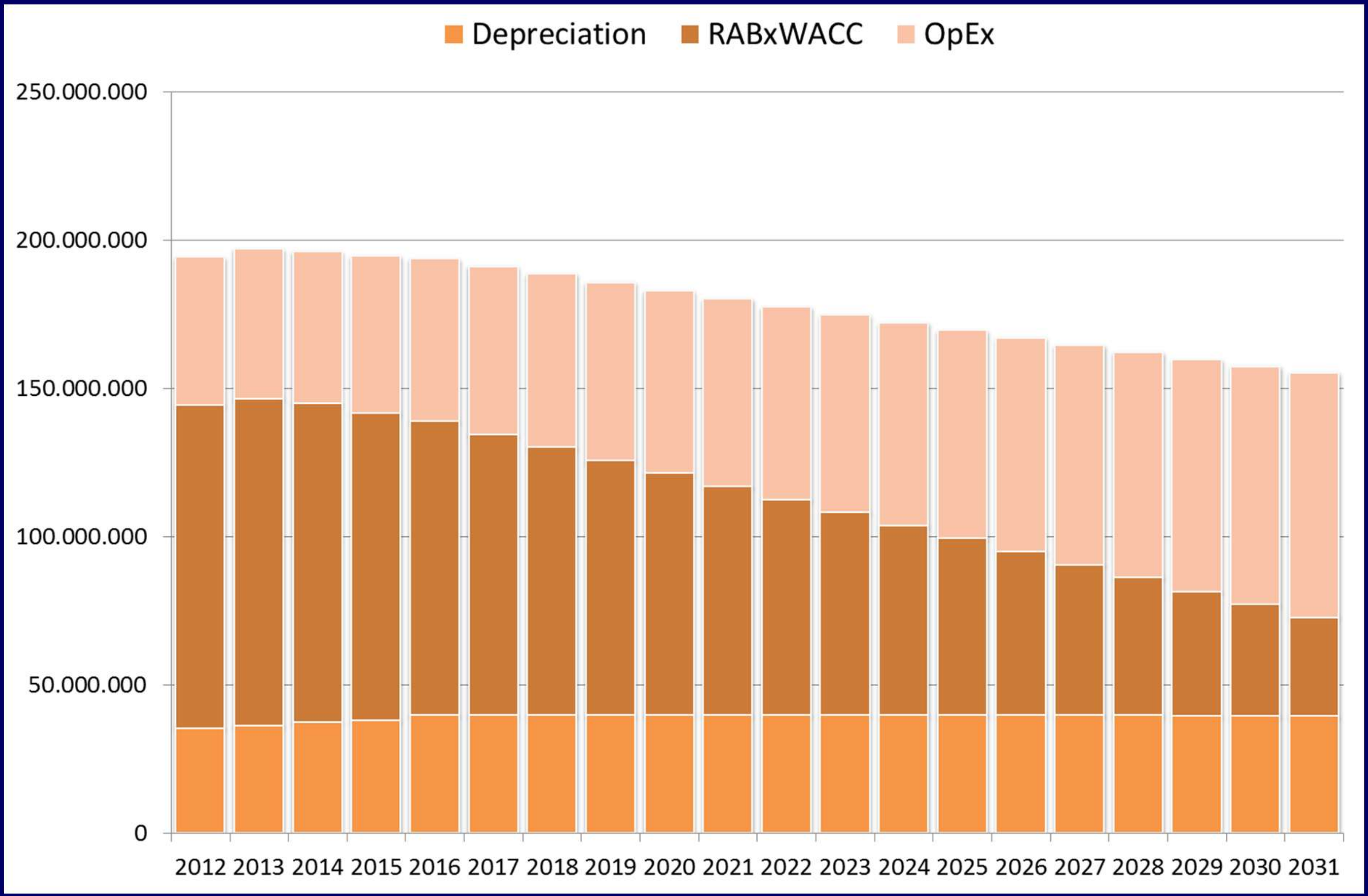
Depreciation rate	20%				
Depreciation (i)	***1000***	***1000***	***1000***	***1000***	***1000***

RAB at the beginning of year (i)	5000	4000	3000	2000	1000
WACC	7%	7%	7%	7%	7%
ROI (i) [=RAB$_i$ x WACC]	***350***	***280***	***210***	***140***	***70***

Salaries	20,0	21,0	22,1	23,2	24,3
Insurance	30,0	30,9	31,8	32,8	33,8
Other	10,0	10,0	10,0	10,0	10,0
Compressor fuel	20,0	40,0	80,0	140,0	160,0
Total Opex (i)	***80,0***	***101,9***	***143,9***	***205,9***	***228,1***

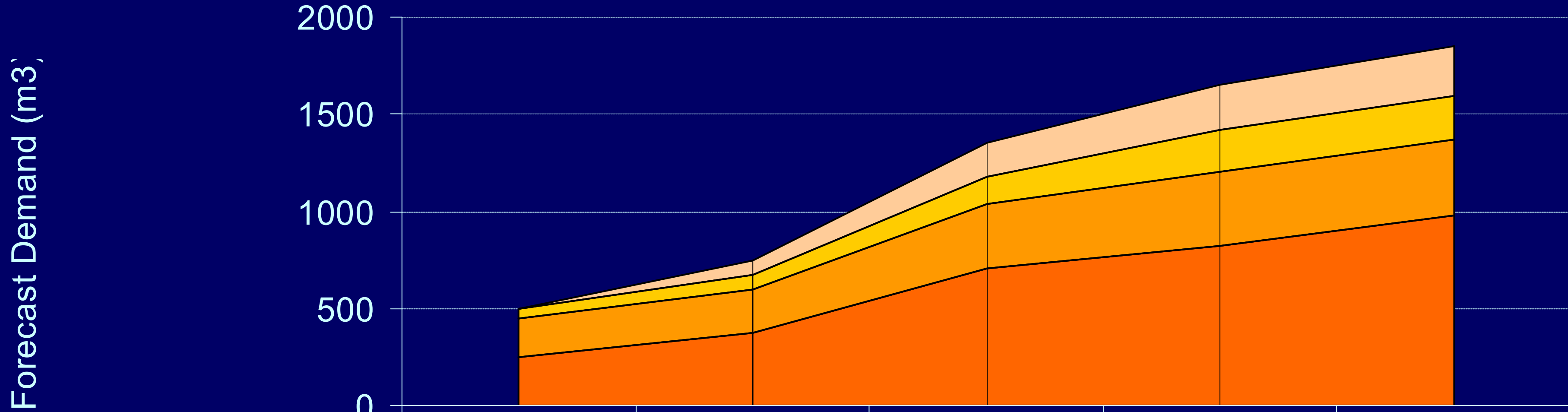
Required Revenue (i)	**1430**	**1382**	**1354**	**1346**	**1298**

Estimated (2012) evolution of the Required Revenue of the Greek Natural Gas System (in €/year)



Calculation of the unit tariff

Forecast Demand



	1	2	3	4	5
Domestic	0	75	175,5	231	259
Commercial	50	75	135	214,5	222
Industry	200	225	337,5	379,5	388,5
Electricity Generation	250	375	702	825	980,5

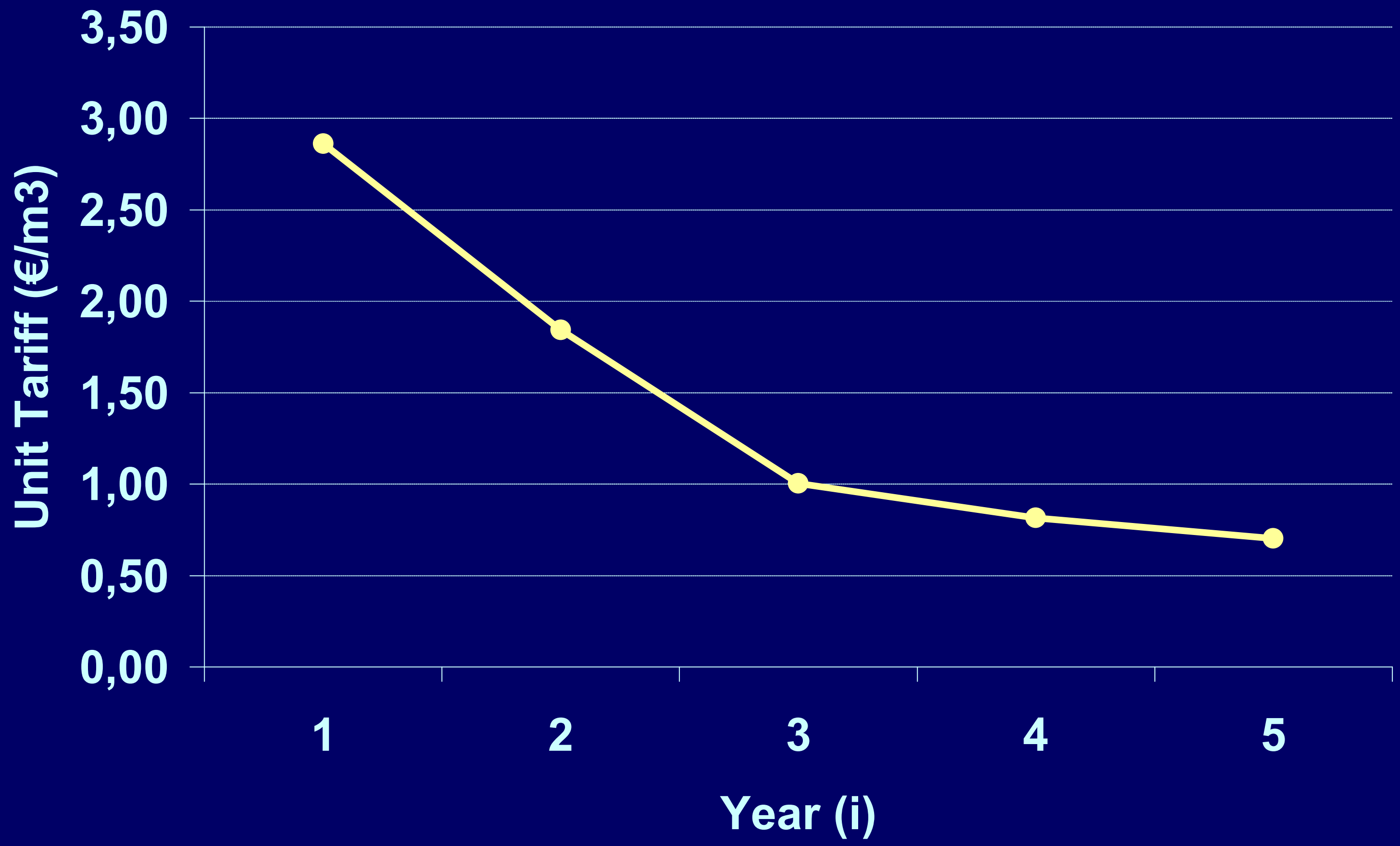
Year (i)

Calculation of unit tariffs

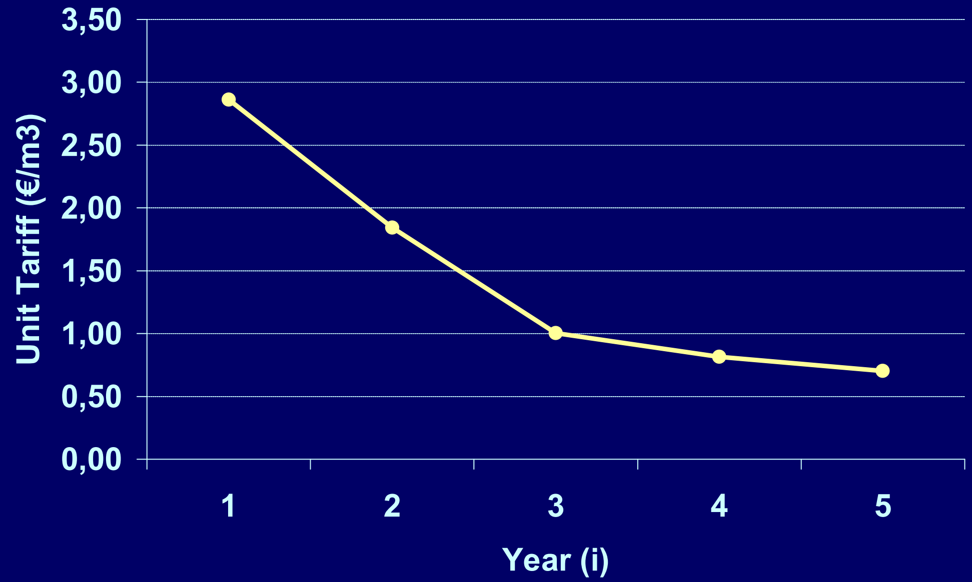
$$\text{Unit tariff (i)} = \frac{\text{Required Revenue (i)}}{\text{Volume (i)}} \quad (€/m^3)$$

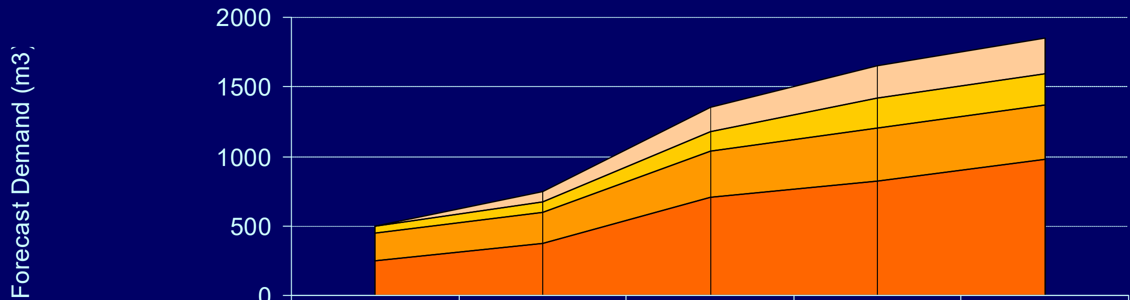
Year (i)	1	2	3	4	5
Required Revenue (€)	1430	1382	1354	1346	1298
(Forecast) Volume (m3)	500	750	1350	1650	1850
Unit Tariff (€/m3)	**2,86**	**1,84**	**1,00**	**0,82**	**0,70**

Unit tariff values per year



Evolution of the unit tariff and demand





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Year (i)

Comments

- In the example, the unit tariff is decreasing significantly over time, due to:
  - A fast growing demand
  - A required revenue decreasing at a low rate
- This is a very real situation in developing markets
- As shown before, transmission cost represents a considerable percentage in the final gas price; a reduction of the transmission tariff may have a considerable effect in gas penetration to the market
  - *Can we expect the forecast demand to become reality with higher tariffs in the first stages of gas penetration?*
  - *Is it fair for future consumers to pay less than the first consumers that they will use the gas?*
  - *Is there anything better to do?*

Levelisation process

- *Objective:* Design a tariff that is stable over time, but also provides the same required revenue as the original tariffs
  - It is not mathematically possible to have the same revenues each year with a constant tariff (and growing volumes…)
  - However, it is possible to have a constant tariff that generates the same total amount of revenues over the whole regulatory period, but through a different time path (in some years we'll recover more than before, in some years less)
  - In that case, we have to take into account the time-value of money!
  - Therefore, it is necessary to work in Present Value terms

Calculation of a levelised tariff

Calculation of a unit tariff for each year (i) of the regulatory period

$$\text{Unit tariff (i)} = \frac{\text{Required Revenue (i)}}{\text{Forecast Volume (i)}} \quad (\text{€}/\text{m}^3)$$

Calculation of a levelized unit tariff that will be constant in every year of the regulatory period

$$\text{Levelized Unit tariff} = \frac{\text{Sum of PV of Required Revenues}}{\text{Sum of PV of Forecast Volumes}} \quad (\text{€}/\text{m}^3)$$

PV: The Present Value calculated using the WACC as the discount factor i.e.
The discount factor for year (i) is calculated as:

$$\frac{1}{(1 + \text{WACC})^{i-1}}$$

Calculations

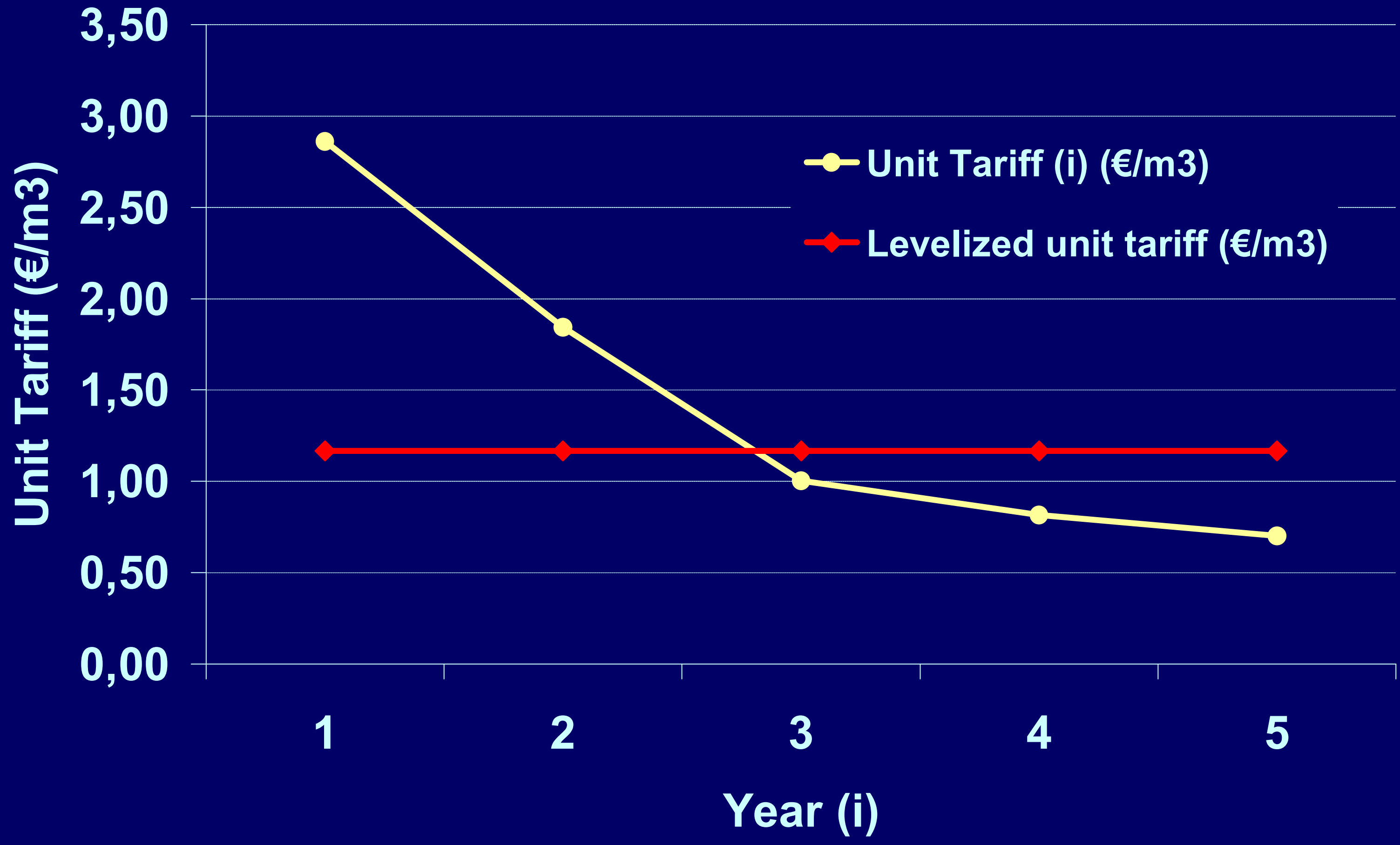
Year (i)	1	2	3	4	5

Required Revenue (i)	1430	1382	1354	1346	1298
Discount factor (i)	1,000	0,935	0,873	0,816	0,763
PV of Required Revenue (i)	1430	1291	1183	1099	990
Sum of PV of Required Revenues	*5993*				

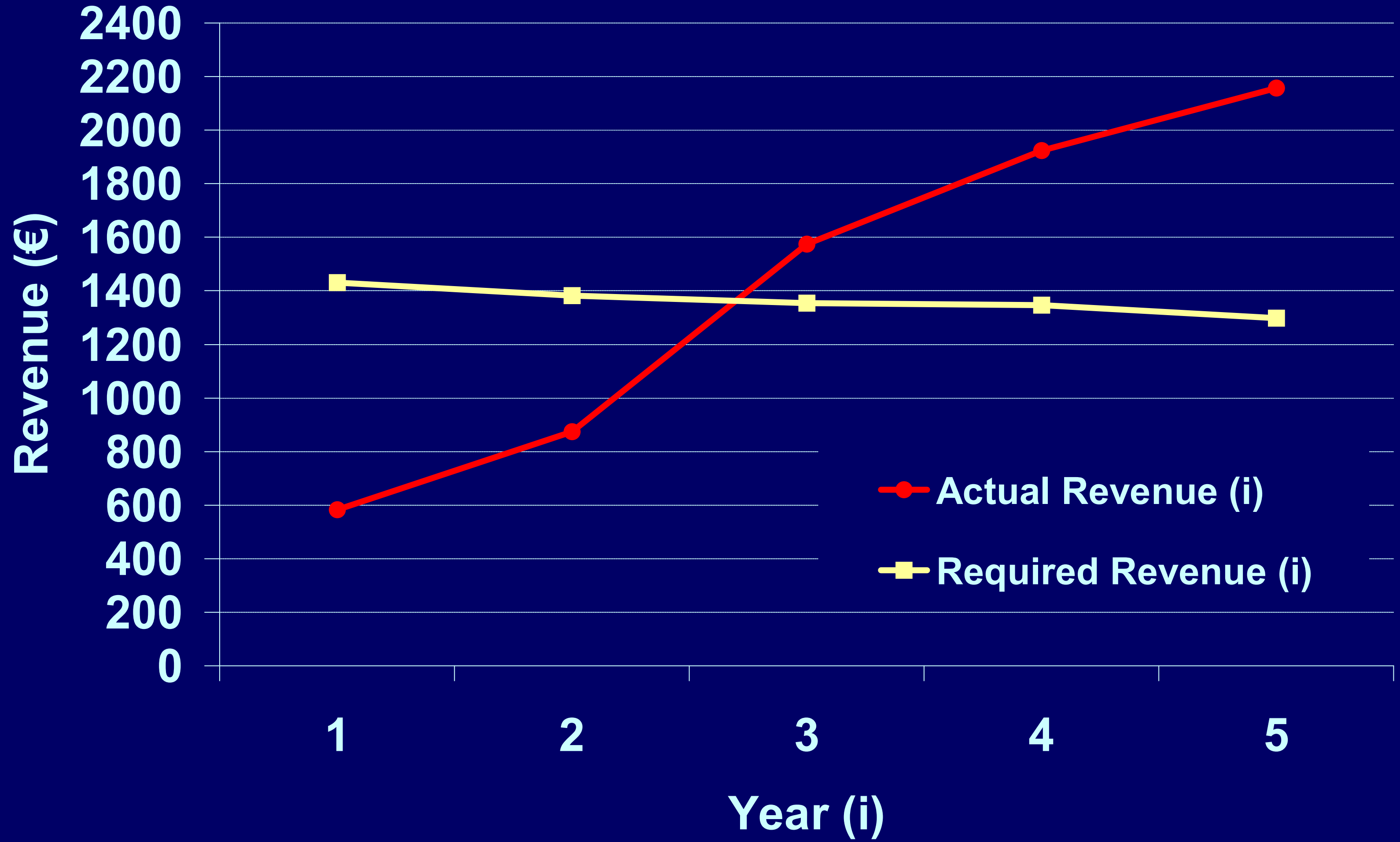
Forecast Volume (i)	500	750	1350	1650	1850
Discount factor (i)	1	0,935	0,873	0,816	0,763
PV of Forecast Volume (i)	500	701	1179	1347	1411
Sum of PV of Forecast Volumes	*5138*				

Levelized unit tariff (€/m3)	*1,17*

Levelised tariff

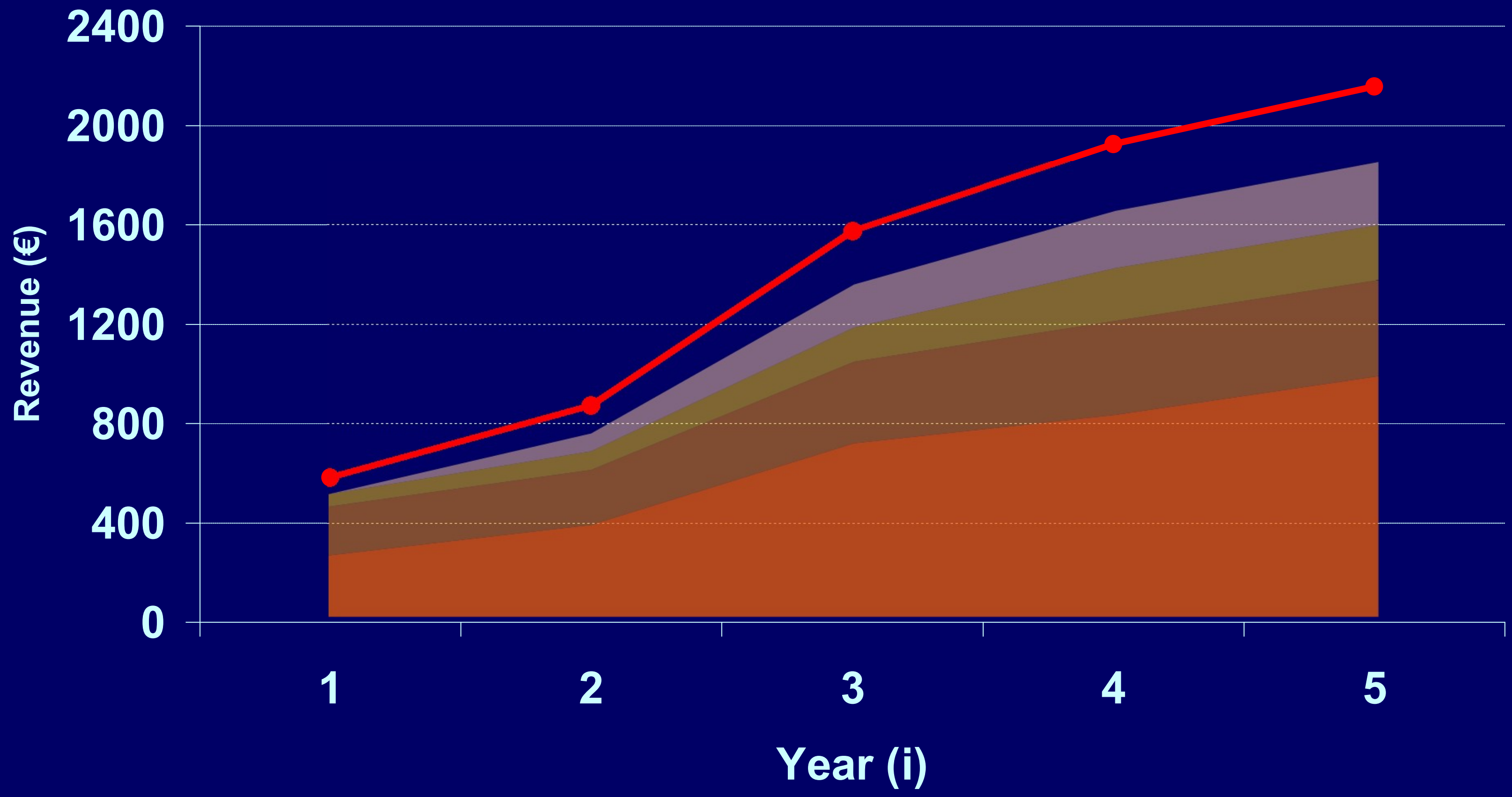


Actual vs required revenues



$$PV(\text{Actual Revenues}) = PV(\text{Required Revenues})$$

Actual revenues



After levelisation, the actual revenues better follow the evolution of forecast volumes and also:

$$PV(\text{Actual Revenues}) = PV(\text{Required Revenues})$$

Models of regulation of Required Revenue

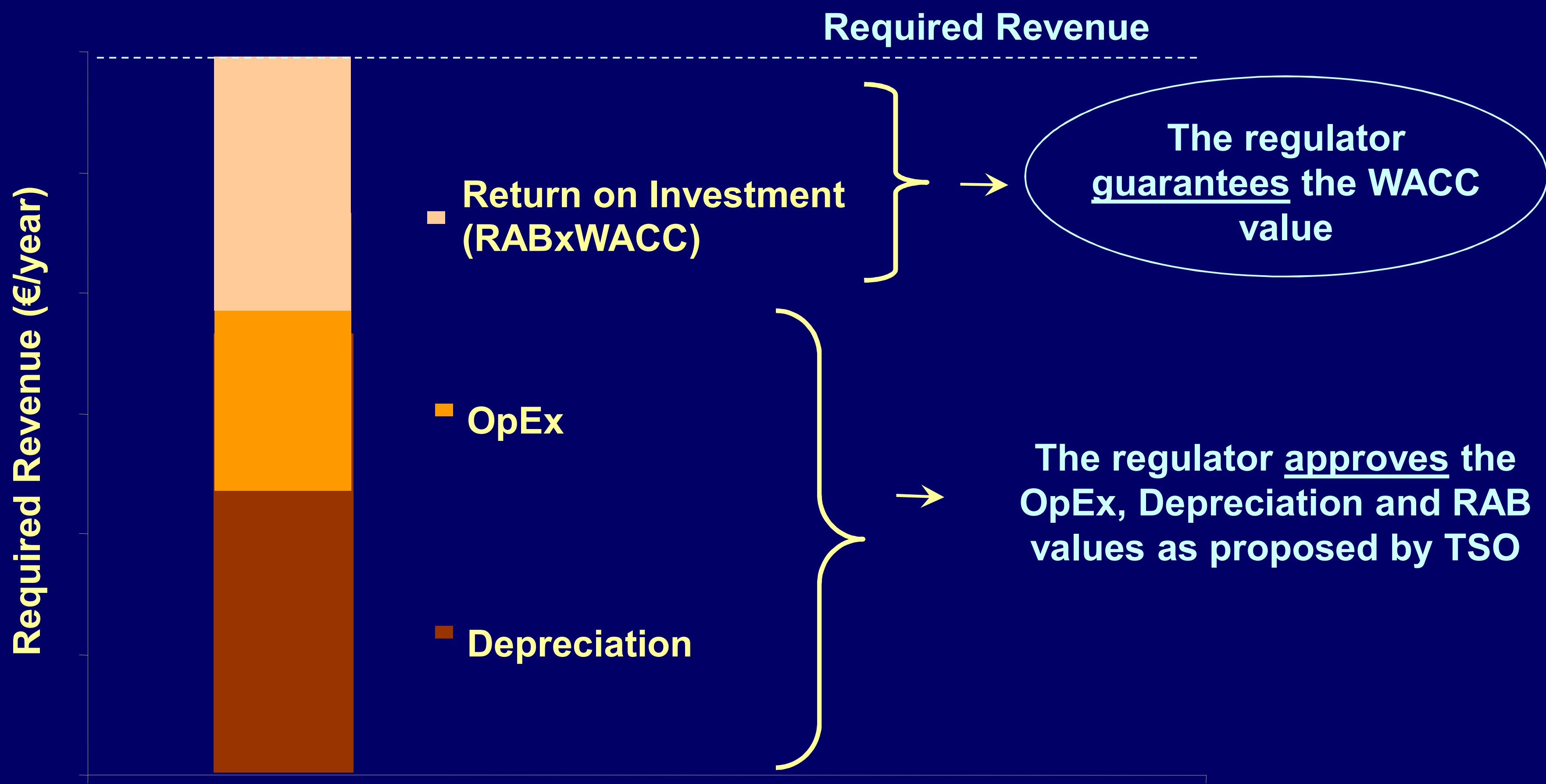
Overview

- Rate-of-return regulation
  - The simpler and, historically, the most-widely used model
  - Criticised as inefficient due to "information asymmetry" between TSO and regulator
- Incentive-based regulation
  - More modern and perhaps more efficient approach in regulation of natural monopolies
  - Definitely more complicated than the "rate-of-return"
- Benchmarking
  - Possible under certain terms and conditions
  - Inherently difficult to apply properly
- Combination of the above

Rate-of-return

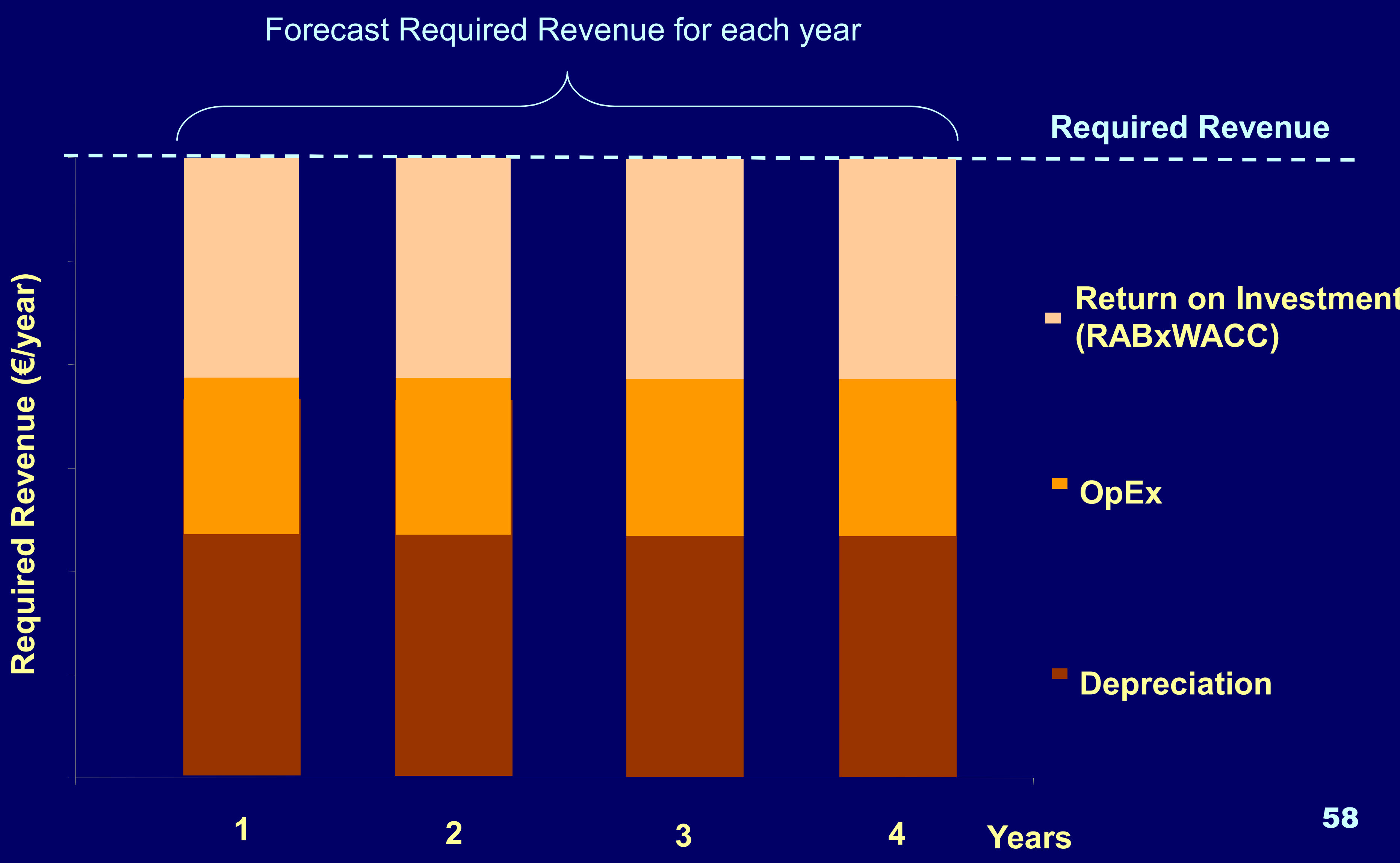
- Under this model, the regulator:
  1. Approves all elements of cost (capital and operating) proposed by the company and included in the required revenue
  2. Sets and guarantees the rate-of-return (WACC) of the company
- On the basis of this, tariffs are calculated in the normal way
- Tariff reviews address any problem of over- or under- recovery of the required revenue by the regulated company, while keeping the (guaranteed) WACC (profit) constant
- The main problem of the model is the “information asymmetry” between the regulator and the regulated company
  - The regulator has only a rough idea of what the cost base of the company really is
  - The company has a much better knowledge of its cost base, its actual performance and its limits of efficiency and can give the wrong picture to the regulator

Example rate-of-return

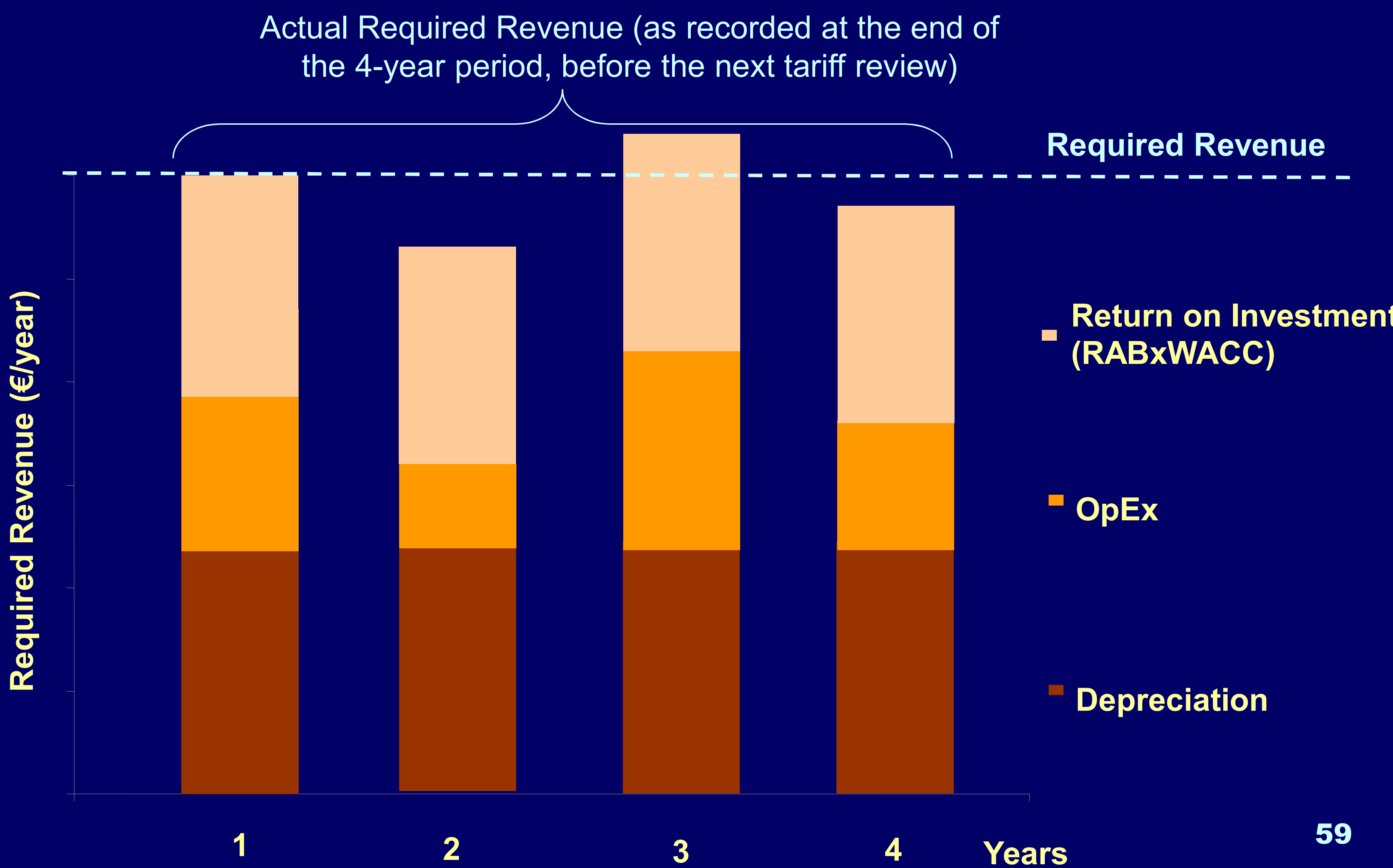


RR(i) = Depr(i) + RAB(i) x WACC + Opex(i)

Example rate-of-return II



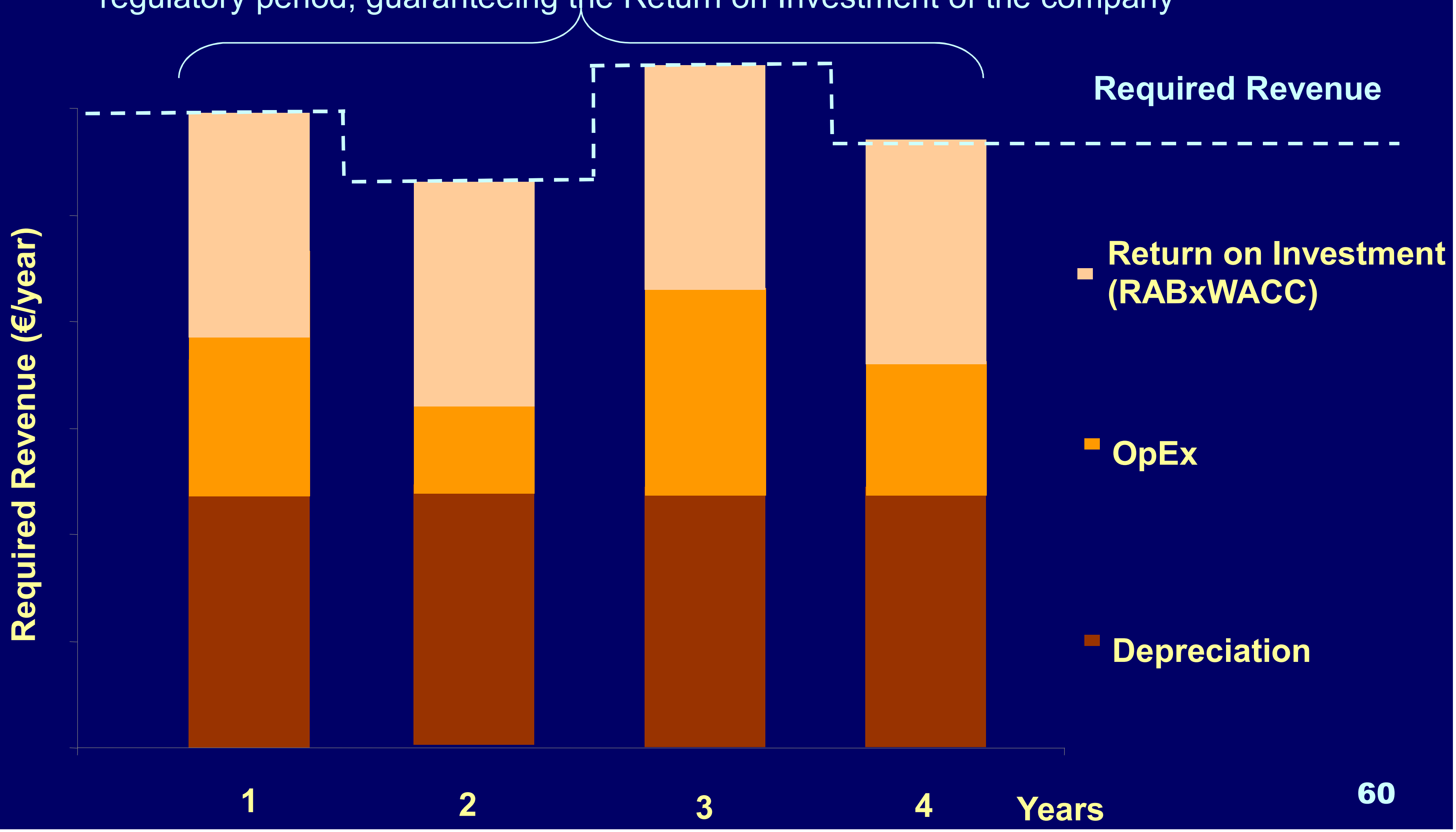
Example rate-of-return III



Example rate-of-return IV

Revision of required revenue by the regulator:

Any over/under recovery will be taken into account when setting the tariffs for the next regulatory period, guaranteeing the Return on Investment of the company



Rate-of-return II

- The consequences of this information asymmetry are:

1. The TSO tends to "over-invest": Since the revenue of the TSO depends heavily on the RABxWACC factor, and the WACC is set by the regulator, the TSO tends to increase the RAB by:
   - Investing in new infrastructure that may not be necessary at all or may be not necessary yet
   - Increasing the cost of the new infrastructure (e.g. by putting unnecessarily strict safety rules or "custom" specifications)
2. The TSO has no incentive to reduce operating costs
   - If the regulator cannot control this costs the TSO has no reason to put effort in reducing its operating costs, because it will be compensated for them anyway
3. There are high costs of monitoring the performance of the TSO
   - The regulator, in order to estimate accurately the cost base of the TSO is trying to "simulate" the way the TSO is run
   - This has a cost in the resources used by the regulator (personnel etc)

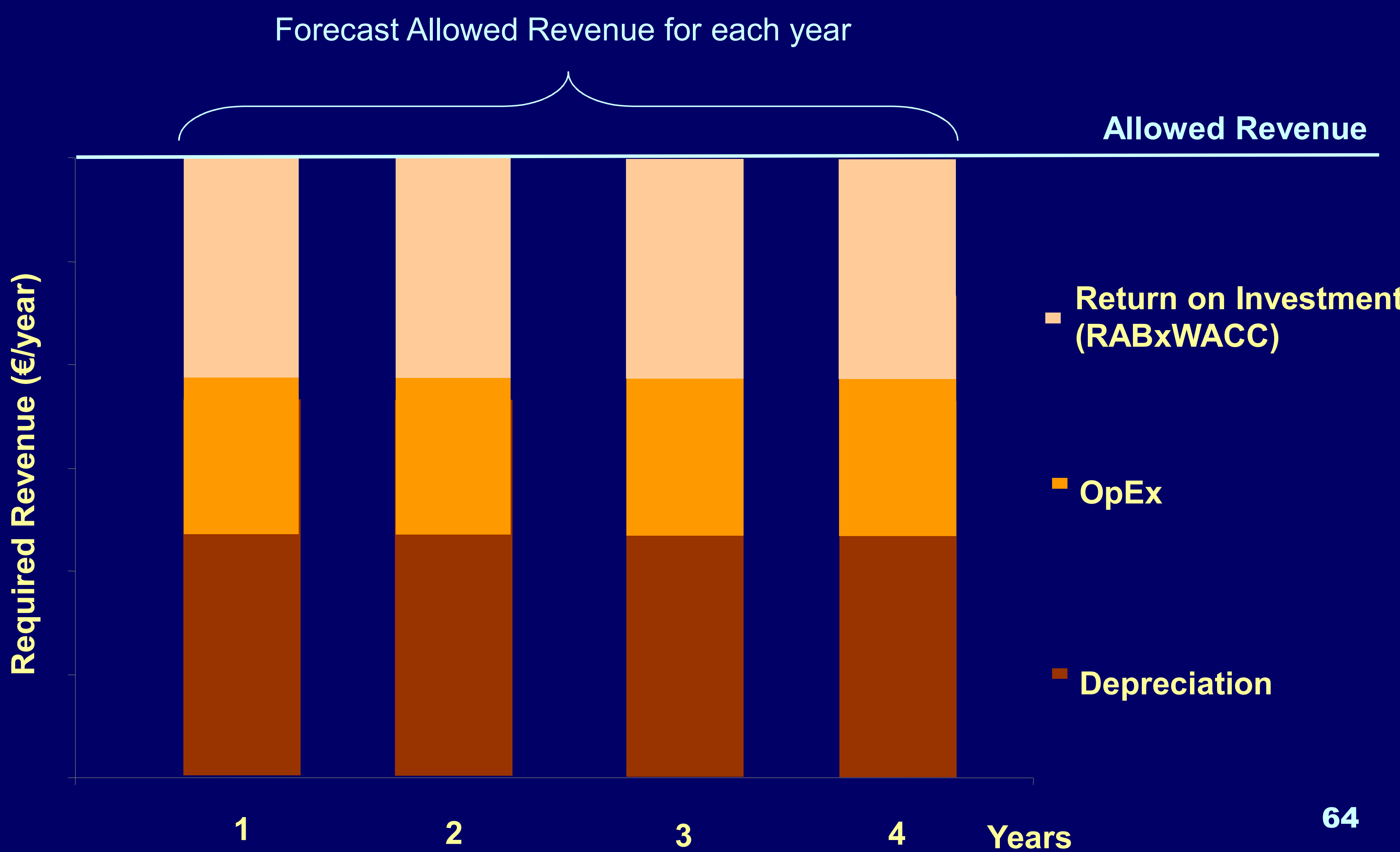
Incentive based regulation I

- Incentive (or performance) based regulation is trying to address the “information asymmetry” problem by incentivising directly the regulated company to be more efficient
- The most common schemes work like this:
  - The regulator sets for the each year of the “regulatory period” the maximum prices that the company may be allowed to charge (price-cap regulation) or the maximum revenue that the company is allowed to recover (revenue cap regulation) for this period (Allowed Revenue)
  - It then allows the company to set the actual tariffs as it wishes
  - At the end of the period, there is a tariff review to examine the performance of the company
  - If during this period the company manages to be more efficient (has less actual costs than forecasted) the company retains (whole or part of) the gains
  - If the company did not manage to be efficient it will be responsible for the losses

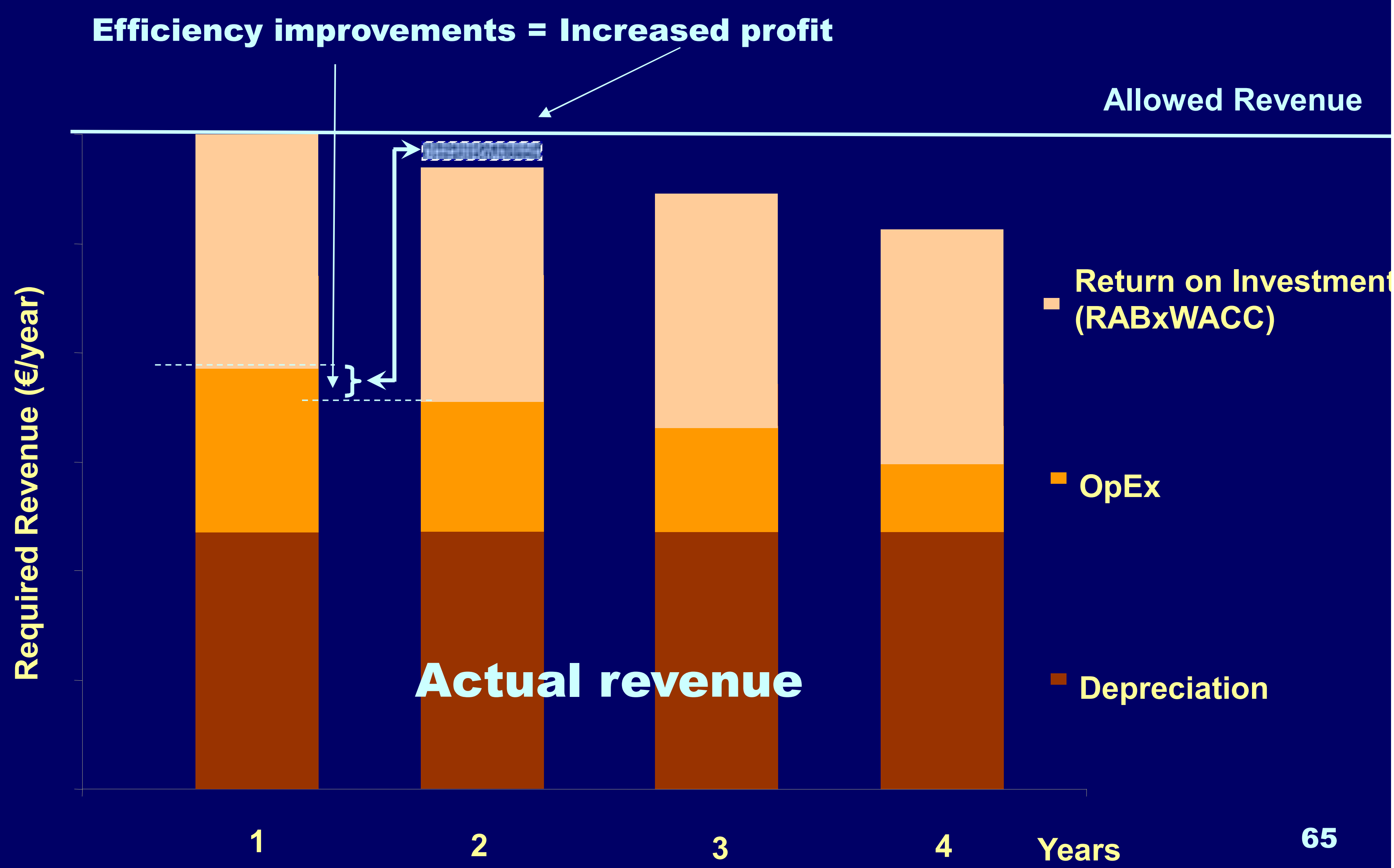
Incentive based regulation II

- The main logic is that prices are not based strictly on actual costs, thus
  1. The regulator is not any more necessary to have the same information as the regulated company because…
  2. …the company by itself has an incentive to operate at the most efficient level in order to reduce its actual costs and retain the difference between costs and caps
- Nevertheless:
  - The regulated company still needs to earn an appropriate return on capital invested
  - Tariffs must ultimately cover this return, plus all the efficiently incurred operating costs
- In fact for setting the price or revenue cap, the regulator estimates a reasonable required revenue in the traditional way

Incentive regulation example I



Incentive regulation example II



Incentive based regulation III

- The main advantages of this scheme is that it solves (partly) the problem of information asymmetry and reduces the monitoring cost of the regulator
- On the other hand, the drawbacks of this scheme are:

1. Increased complexity (specially in the case of new regulators)
   - Regulator has to identify accurately the areas of operation of the TSO where efficiency improvements are possible. Setting unrealistic targets may jeopardise the viability of the TSO
2. Problems of underinvestment:
   - Contrary to the previous case, the company wants to reduce its costs to retain the difference between costs and caps. While reducing OpEx is generally desirable, reducing the CapEx (investments) may lead to not serving demand in a proper way
3. Problems of quality of service:
   - In order to reduce OpEx, the company may offer poor service to the consumers. To avoid this, usually incentive regulation is complemented by specific “quality of service” standards

Benchmarking

- The required revenue (or even tariffs directly) are set by comparison with similar/comparable company/ies nationally or internationally
- It is more a market-based model not easy to apply in most cases
- The model has been used in the US and Germany, where there are many pipeline operators and there seems to be "*pipe-to-pipe competition*"
- It seems difficult for the regulator to investigate if the situations are actually comparable:
  - When did the similar company constructed the transmission system?
  - Where the costs efficiently occurred?
- Nevertheless, benchmarking can be used by the regulator or the TSO in a way complementary to the actual tariff setting methodology, either to confirm or doubt the proposed tariff

Choice of model

Gas Regulation 715/2009/EC

Article 13

Tariffs for access to networks

1. Tariffs, or the methodologies used to calculate them, applied by the transmission system operators and approved by the regulatory authorities pursuant to Article 41(6) of Directive 2009/73/EC, as well as tariffs published pursuant to Article 32(1) of that Directive, shall be transparent, take into account the need for system integrity and its improvement and reflect the actual costs incurred, insofar as such costs correspond to those of an efficient and structurally comparable network operator and are transparent, whilst including an appropriate return on investments, and, where appropriate, taking account of the benchmarking of tariffs by the regulatory authorities. Tariffs, or the methodologies used to calculate them, shall be applied in a non-discriminatory manner.

Tariffs, or the methodologies used to calculate them, shall facilitate efficient gas trade and competition, while at the same time avoiding cross-subsidies between network users and providing incentives for investment and maintaining or creating interoperability for transmission networks.

- Regulation makes reference to aspects found in more than one model
- In practice, around the world, both pure application of a single model and –most commonly- a combination of the characteristics of different models can be found in differebet tariff setting regimes

Cost-allocation to users

Main methodological steps of tariff setting

- Tariff setting occurs in two steps:

1. Calculation of the amount of money the TSO must collect form the users of the transmission system in order to cover its economic cost (Required Revenue)

2. Allocation of the above amount to the users of the transmission system (Cost-allocation)

Introduction

- Different methodologies and tariff structures attempt to allocate the total economic cost of the network (Required Revenue) to its users, in the most accurate way possible and depending on their contribution to that cost (cost-reflectivity of tariffs), as well as fulfil to some extent the rest orf regulatory objectives (non-discrimination, transparency etc).
- Two main cost-allocation criteria:
  - The amount of capacity booked and the extent to which booked capacity is utilised ("capacity/commodity split")
  - The part of the system used by a Network User: entry/exit points, flow or contract path, distance etc ("locational cost-allocation")
- These two main cost-allocation criteria are used in parallel to each other
- *(Another cost-allocation criterion that is getting growing attention but no robust methodology exists so far, is the duration of the capacity booking i.e. for one day, one month, 1 year etc. This will not be discussed)*

Capacity/commodity split (two-part tariffs)

Capacity/commodity split (two-part tariffs)

Introduction

- Things to keep in mind:
  - Gas transmission is a business dominated by *fixed costs*
  - The critical aspect of transmission system design and operation is the *capacity* of the system i.e. the maximum flow of gas that can be transported through the system at a given time period (m3/hour or m3/day)
  - Third party access is about capacity booking i.e. a certain amount of capacity booked, for a certain amount of time, in certain entry/exit points etc, irrespectively if this capacity is used or not
- It makes economic sense to link these elements when designing the tariffs…

Two-part tariff structure

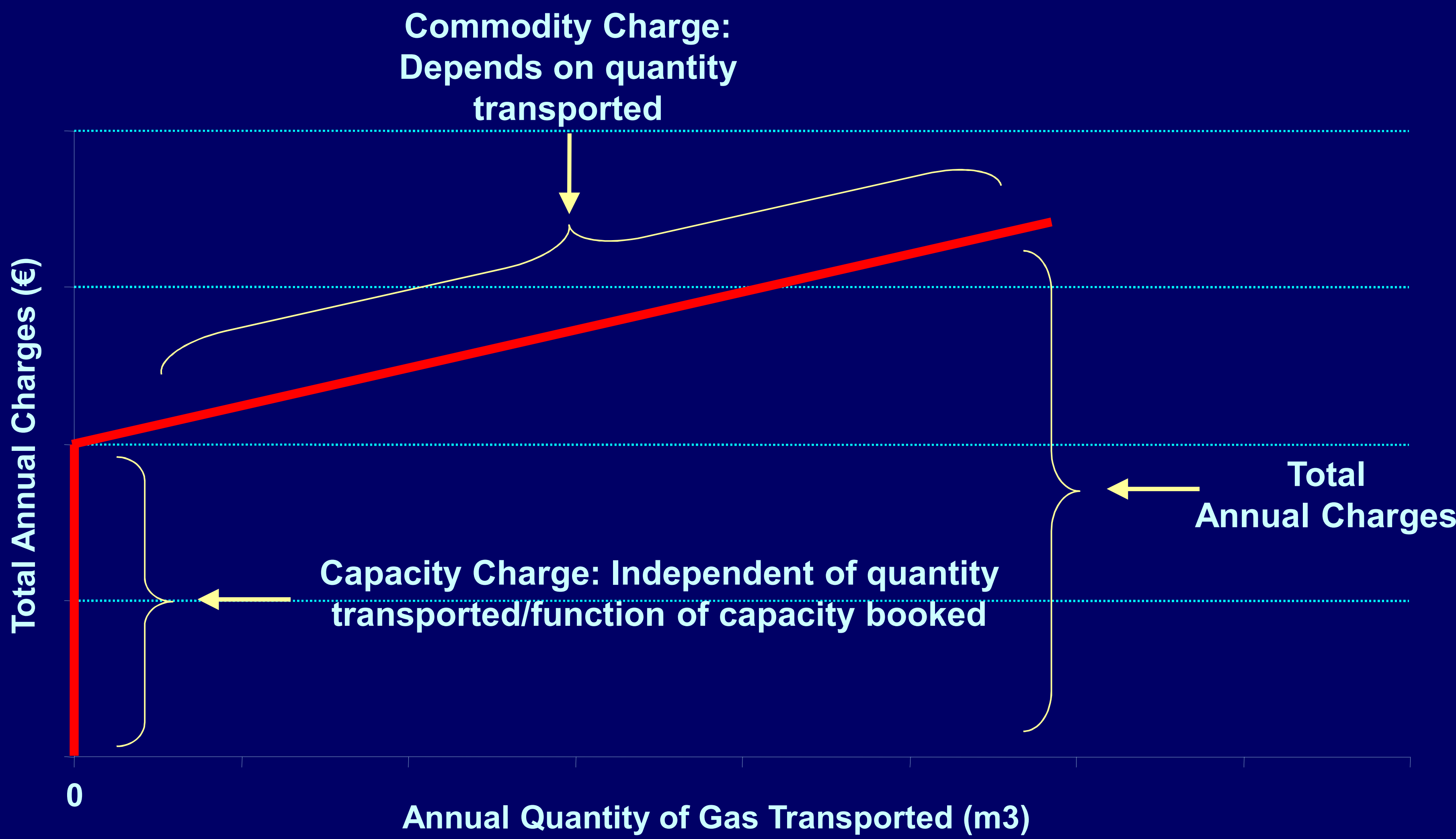
$$T = Cap \times a + Com \times b$$

Payments related to the capacity booked ($Cap \times a$)

Payments related to the gas transported ($Com \times b$)

- Where:
  - T: Total amount to be paid for access to the transmission system (€)
  - Cap: Capacity Charge (€/unit of capacity booked)
  - a: units of capacity booked (for example: 300 m3/day)
  - Com: Commodity Charge (€/unit of gas flow)
  - b: units of gas quantity actually transported through the system (for example: 3000 m3)

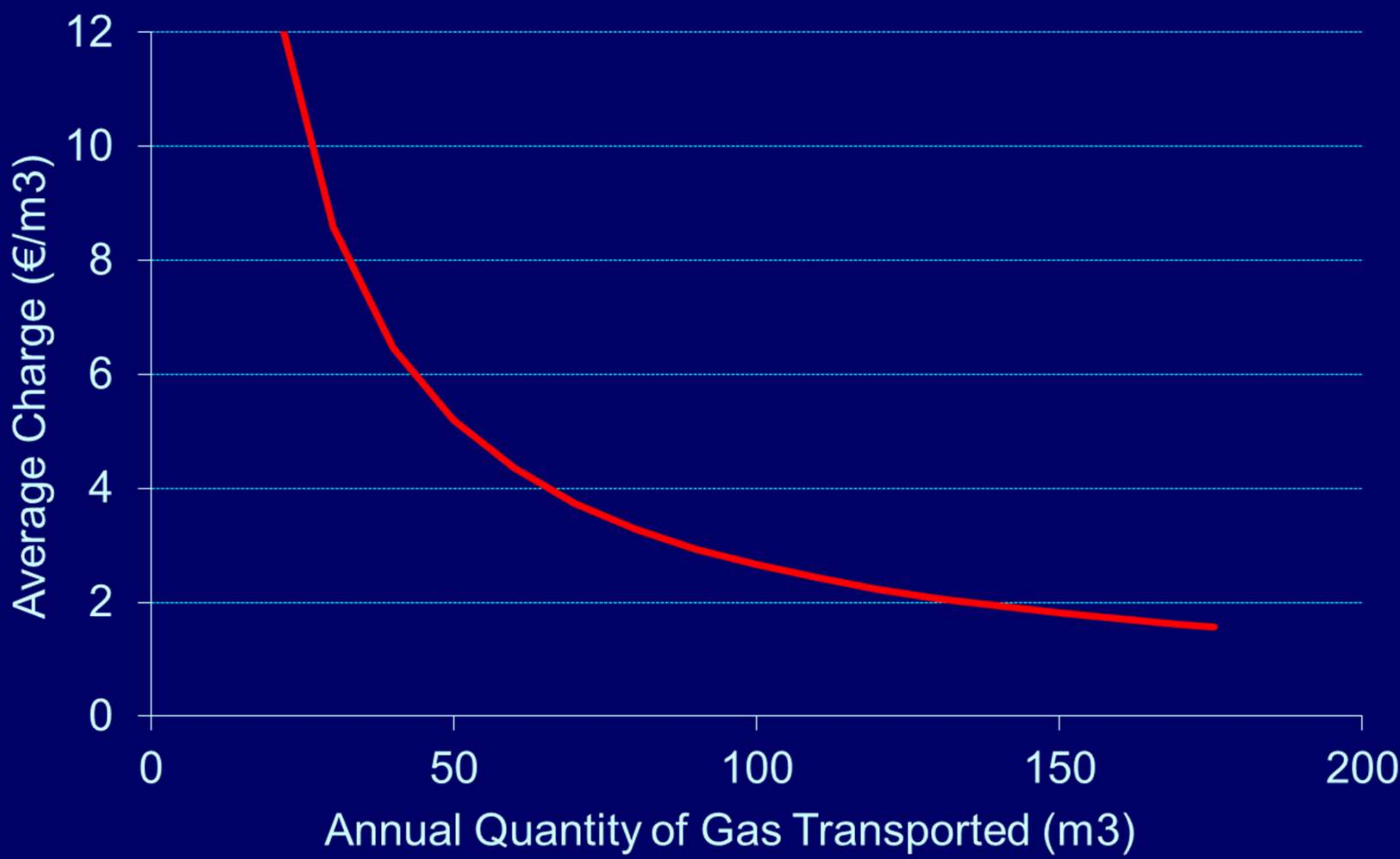
Total charge of a network user accessing the system



Average charge of a network user accessing the system

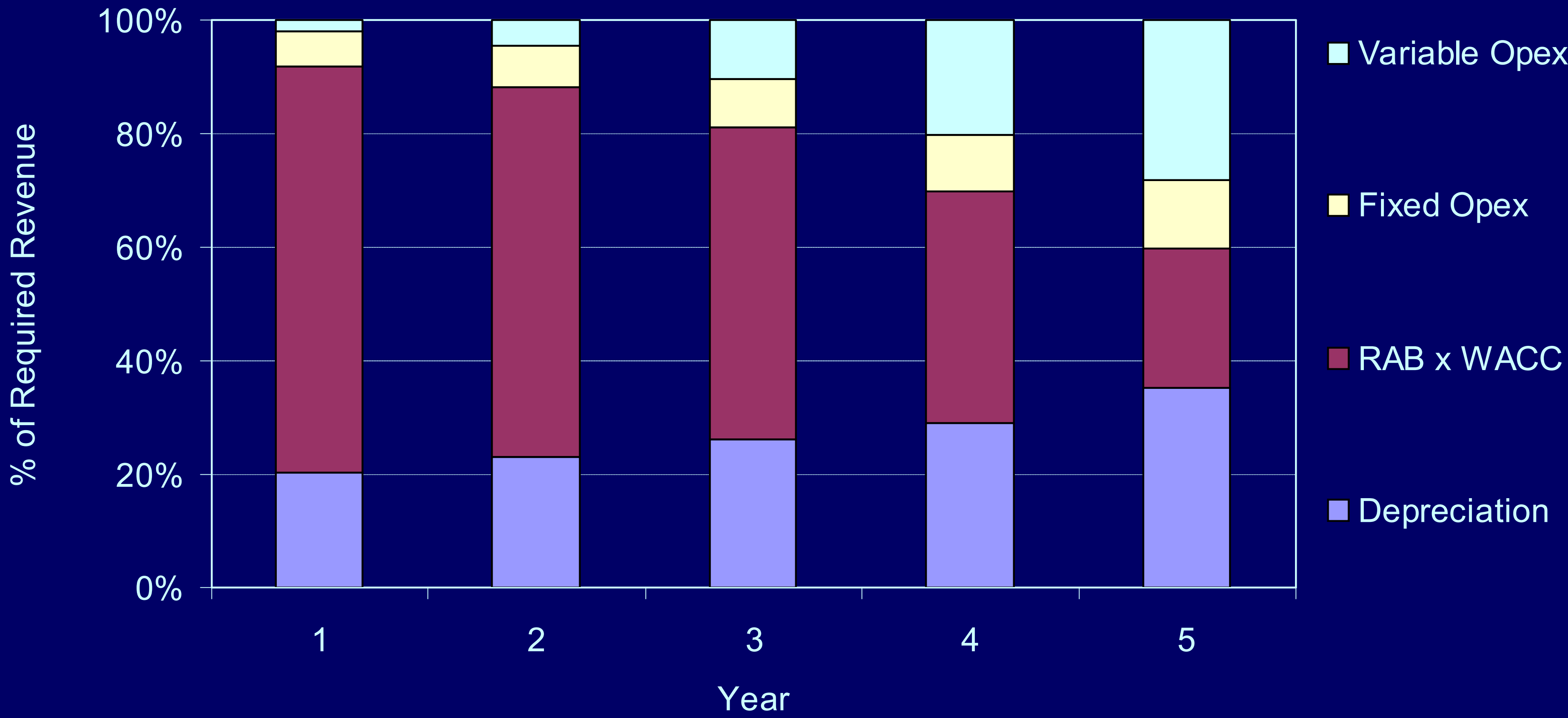
- The more the system is used, the more the average charge is lowered
- Incentive for the most efficient use of the system

Average Charge (€/m3) = Total charge (T) / Total gas transported (b)



Calculating Cap and Com coefficients (I)

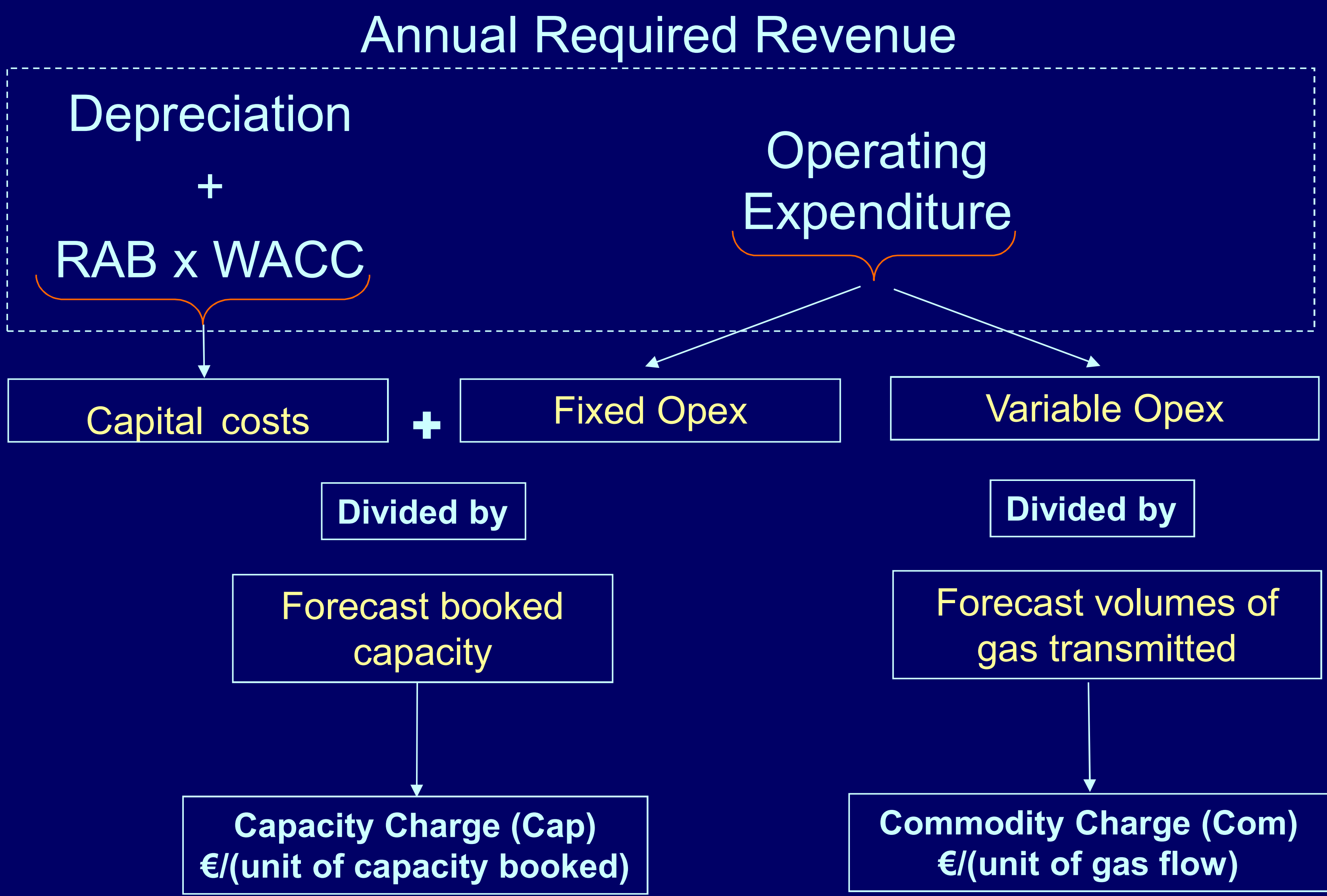
Cost structure of required revenue of the example



On average, variable costs account for only 10-15% of annual required revenue

Calculating Cap and Com coefficients (II)

Theoretical allocation of required revenue in capacity and commodity charges



Calculating Cap and Com coefficients (III)
Theoretical allocation of required revenue in capacity and commodity charges

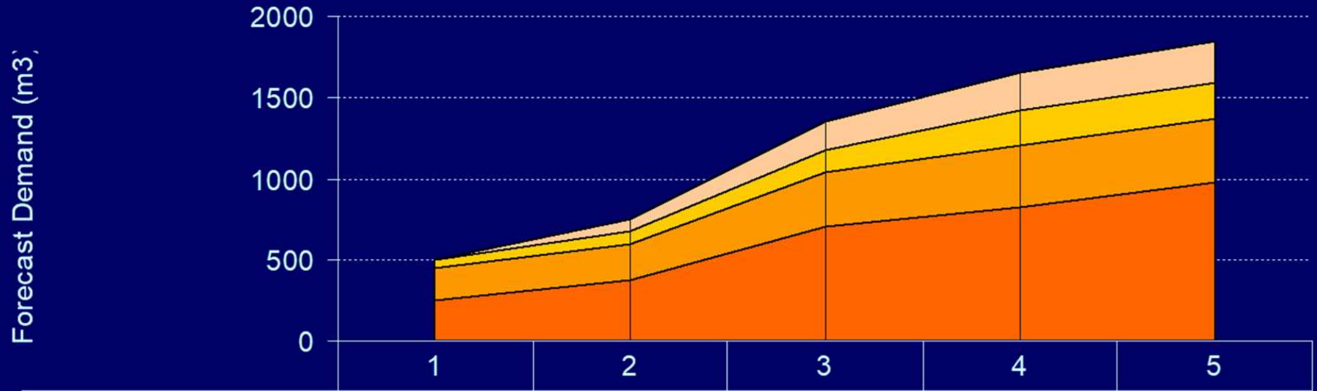
- $Cap = Y \times \frac{Required\ Revenue}{Forecast\ Booked\ Capacity}$

- $Com = (100\% - Y) \times \frac{Required\ Revenue}{Forecast\ Gas\ Transported}$

- Coefficient Y is known as the “capacity/commodity split”
  - Y takes values between 0% and 100%
  - Y is defined by the regulator

- Example Y values:
  - Greece: 80%
  - Netherlands: 100%
  - United Kingdom: 65%
  - Transit tariffs in Russia: 0% (only commodity)

Calculating Cap and Com coefficients (IV)
Forecast gas transmitted and booked capacity



	1	2	3	4	5
Domestic	0	75	175,5	231	259
Commercial	50	75	135	214,5	222
Industry	200	225	337,5	379,5	388,5
Electricity Generation	250	375	702	825	980,5

Year (i)

Forecast booked capacity (in m3/day)

Year (i)	1	2	3	4	5
Electricity Generation	1,14	1,58	2,56	3,01	3,58
Industry	0,64	0,73	1,09	1,22	1,25
Commercial	0,27	0,41	0,74	1,18	1,22
Domestic	0,00	0,34	0,96	1,41	1,77
Total	***2,06***	***3,06***	***5,35***	***6,82***	***7,82***

Calculating Cap and Com coefficients (V)
Assuming capacity/commodity split = 90%

Year (i)	**1**	**2**	**3**	**4**	**5**
Capacity/Commodity split					
Required Revenue (i)	1393	1352	1331	1331	1291
Forecast Volume (i)	500	750	1350	1650	1850
Forecast Peak (i)	2.06	3.06	5.35	6.82	7.82
% of RR to be recovered through capacity charge:	**90%**				
Capacity charge: (€/(m3/day))	**608.32**	**397.71**	**223.82**	**175.67**	**148.45**
% of RR to be recovered through commodity charge:	**10%**				
Commodity charge: (€/m3)	**0.279**	**0.180**	**0.099**	**0.081**	**0.070**

Calculating Cap and Com coefficients (VI)

Example calculation of charges for consumers in Year 3

Year 3					
		Electricity Generation	**Industry**	**Commercial**	**Domestic**
Consumption (m3)	(1)	702	338	135	176
Commodity charge (€/m3)	(2)	0.099	0.099	0.099	0.099
Commodity charges (€)	(3) = (1) x (2)	69.2	33.3	13.3	17.3
Capacity booked (m3/day)	(4)	2.56	1.09	0.74	0.96
Capacity charge (€/(m3/day))	(5)	223.82	223.82	223.82	223.82
Capacity charges (€)	(6) = (4) x (5)	574.0	243.5	165.6	215.2
Total charges (€)	**(7) = (3) + (6)**	**643.2**	**276.8**	**178.9**	**232.5**
Average charge (€/m3)	**(8) = (7) / (1)**	**0.92**	**0.82**	**1.33**	**1.33**

Advantages/disadvantages of two-part tariffs

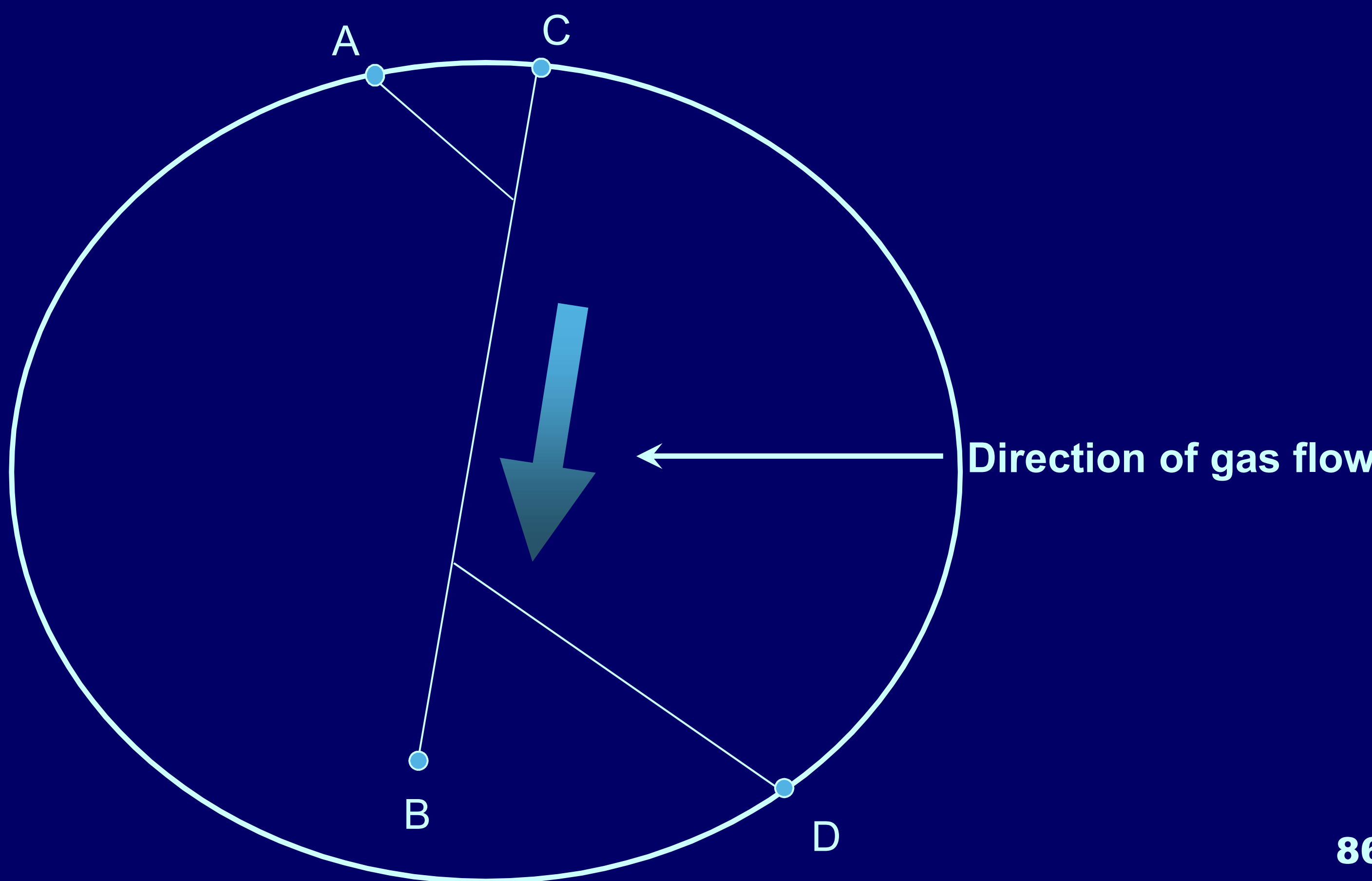
- More certainty for the recovery of revenues by the TSO
  - The largest part of the TSO's costs are fixed i.e. independent of the quantity of gas transported
  - If properly designed, through capacity charges the TSO should able to recover at least its fixed costs even if forecasts of gas consumption volumes do not realise…

- Incentive for the maximisation of the use of infrastructure by users
  - The average charge of the consumer is falling as the quantity of gas transported is increasing
  - The consumer will try to optimise the use of the system

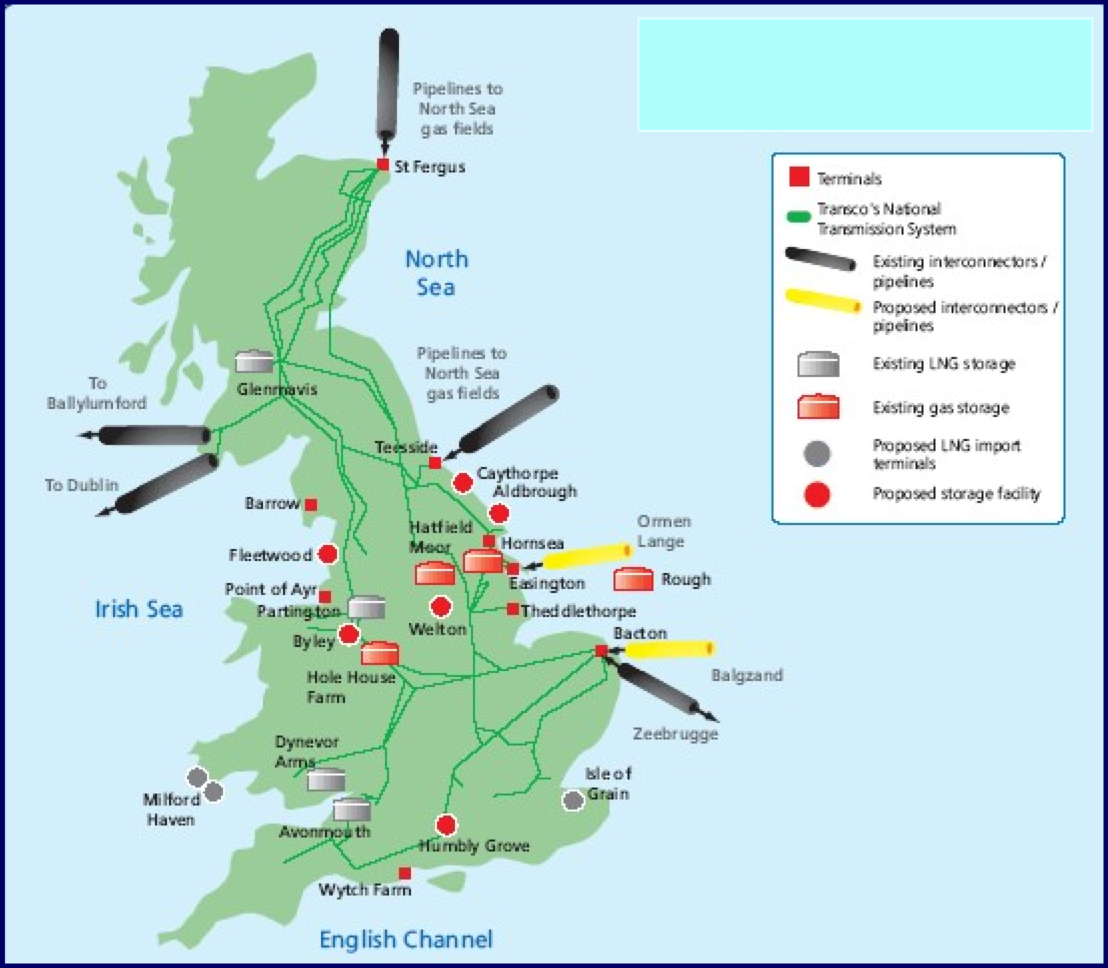
- Possible very high charges for consumers that cannot forecast accurately their need for capacity and/or annual consumption:
  1. New consumers
  2. Distribution networks

Locational cost-allocation

- A transmission system can be simple:
  - A, C: Entry points
  - B, D: Exit points



- …or complex (UK network):



Tariffs independent of the gas transmission path

- **“Entry-exit”**
  - Separate (capacity and commodity) tariff for each entry and exit point of the transmission system
  - Every user of the system is charged based on which entry and/or exit points it has access to, independently of:
    - The actual gas flow path
    - The distance between these entry and exit points

- **“Postage stamp”**
  - The same (capacity and commodity) tariff for all entry and exit points of the transmission system
  - Every user of the system is charged independently of:
    - The entry and/or exit points it has access to
    - The actual gas flow path
    - The distance between these entry and exit points

Tariffs dependent on the gas transmission path

- **“Distance-related”**
  - Every user of the system is charged proportionally to the distance the distance the gas is transported (between entry and exit points)
  - It is a special case of a broad category of tariff systems called “point-to-point”, in which (capacity and commodity) charges are calculated on a case-by-case basis, based on the path of the gas flow
  - Example capacity charge: 58 € / (m3/day) / 100 km
  - Example commodity charge: 3 € / m3 / 100 km

- **“Zonal”**
  - The transmission system is split in geographical zones
  - Separate (capacity and commodity) tariff for each zone
  - Every user of the system is charged based on the zones he is using for flowing the gas

Critical review on allocation methodologies

Review

- Two-part tariffs (capacity/commodity split) generally fulfills to a great extent the regulatory objectives
- Locational cost-allocation is a typical example of conflicting regulatory objectives
- Path-dependent tariffs:
  - In general, reflect more accurately the cost each user causes to the system
  - Are much more complex
  - May hinder entry of new/small players in the market
- Path-independent tariffs:
  - Are less cost-reflective (inherently allowed cross-subsidies)
  - Are much simpler
  - Encourage entry of new/small players in the market, that usually have less options on the path of the gas they can choose (incumbent/big players have many more options to minimize tariffs even with path-dependent tariffs, because they have various gas import contracts at many entry points/gas supply contracts at many exit points and they can optimize the gas flow to have least possible tariff charges)

Choice of model

Gas Regulation 715/2009/EC

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Tariffs, or the methodologies used to calculate them, shall facilitate efficient gas trade and competition, while at the same time avoiding cross-subsidies between network users and providing incentives for investment and maintaining or creating interoperability for transmission networks.

- Regulation makes reference to path-independent systems
- European Network Code on harmonized transmission tariff structures for gas:
  - Generally, any system may be used that leads to separate entry/exit tariffs
  - Capacity/commodity split is very high

References

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Models of regulation of Required Revenue Paul L. Joskow: Regulation of Natural Monopolies	http://economics.mit.edu/files/1180