



## FICHA TÉCNICA DE LA ASIGNATURA

Datos de la asignatura	
Nombre completo	Optativa Complementaria: Regulation and New Business Models
Código	DIE-MII-615
Título	<a href="#">Máster Universitario en Ingeniería Industrial por la Universidad Pontificia Comillas</a>
Impartido en	Máster Universitario en Ingeniería Industrial + Máster in Smart Grids [Segundo Curso] Máster Universitario en Ingeniería de Telecomunicación [Segundo Curso] Máster Universitario en Ingeniería de Telecomunicación + Máster in Smart Grids [Segundo Curso] Master in Smart Grids [Primer Curso]
Nivel	Master
Cuatrimestre	Semestral
Créditos	7,5 ECTS
Carácter	Obligatoria
Departamento / Área	Departamento de Ingeniería Eléctrica
Responsable	Carlos Batlle
Horario	Mondays 16:10-17:50; Thursdays 15:10 16:50
Horario de tutorías	Contact with Professor

Datos del profesorado	
<b>Profesor</b>	
Nombre	Carlos Batlle López
Departamento / Área	Departamento de Ingeniería Eléctrica
Correo electrónico	Carlos.Batlle@comillas.edu
<b>Profesor</b>	
Nombre	Pablo Rodilla Rodríguez
Departamento / Área	Instituto de Investigación Tecnológica (IIT)
Despacho	Santa Cruz de Marcenado 26
Correo electrónico	Pablo.Rodilla@comillas.edu
Teléfono	2745

## DATOS ESPECÍFICOS DE LA ASIGNATURA

Contextualización de la asignatura
<b>Aportación al perfil profesional de la titulación</b>
<p>The course presents an in-depth interdisciplinary perspective of the electric power sector, with regulation providing the link among the engineering, economic, legal and environmental viewpoints.</p> <p>Electricity markets, incentive regulation of networks, reliability of service, renewable energy sources, contemporary network issues, retail</p>



competition, tariff design, distributed generation, multinational electricity markets, environmental impacts, future of utilities and strategic sustainability issues will be addressed under both traditional and competitive regulatory frameworks.

The course will make available the economic and legal basis to critically evaluate the regulatory instruments that are used worldwide for electricity supply activities that are performed as regulated monopolies or under competitive conditions. Most of these regulatory approaches are also of application in other industrial sectors.

The knowledge acquired in the course will provide the comprehensive understanding of electric power systems that will be needed for research in this field, as well as for future professional activities in the energy sector, whether in industry, government or consulting.

The key objective is to provide the student with a solid grasp of the fundamentals of energy regulation. The main learning outcomes are:

- Fundamentals of energy system economics, introduction to different regulatory models and the restructuring process of the power sector
- Approaches to the regulation of transmission and distribution networks as natural monopolies and principles for the allocation of regulated costs
- Market design of competitive electricity wholesale markets and its complements, being ancillary services and possibly capacity mechanisms
- Regulatory and technological challenges for the widespread inception of retail markets

## Competencias - Objetivos

### Competencias

#### GENERALES

<b>BA02</b>	Saber aplicar e integrar sus conocimientos, la comprensión de estos, su fundamentación científica y sus capacidades de resolución de problemas en entornos nuevos y definidos de forma imprecisa, incluyendo contextos de carácter multidisciplinar tanto investigadores como profesionales altamente especializados.
<b>CG01</b>	Tener conocimientos adecuados de los aspectos científicos y tecnológicos de: métodos matemáticos, analíticos y numéricos en la ingeniería, ingeniería eléctrica, ingeniería energética, ingeniería química, ingeniería mecánica, mecánica de medios continuos, electrónica industrial, automática, fabricación, materiales, métodos cuantitativos de gestión, informática industrial, urbanismo, infraestructuras, etc.

### Resultados de Aprendizaje

<b>RA01</b>	Aplicar e integrar conocimientos en un contexto multidisciplinar
<b>RA02</b>	Analizar y resolver problemas nuevos y definidos de forma imprecisa en un contexto multidisciplinar

## BLOQUES TEMÁTICOS Y CONTENIDOS

### Contenidos – Bloques Temáticos

#### BLOCK 0: INTRO

I.1. What Is Regulation About?

I.2. The Regulatory function



## BLOCK I: THEORY AND PRINCIPLES OF REGULATION

I.1. Regulatory Models for Energy Systems

I.2. Fundamentals of Energy Systems Economics

I.3. Cost Allocation Methodologies

## BLOCK II: REGULATION OF ENERGY SUPPLY ACTIVITIES

II.1. Wholesale Electricity Generation

II.1.1. Pricing electricity generation

II.1.2. Complements to energy markets: ancillary services and capacity mechanisms

II.2. Electricity Networks

II.2.1. Interplay between transmission and generation

II.2.2. Regulated revenues and cost allocation

II.3. End-User Energy Pricing

II.3.1. End-user tariffs

II.3.2. Retail markets

## Block III: Contemporary electric power systems' issues

III.1. Future Challenges and Trends of Electric Power Systems

III.2 Regulation of New Energy Resources and Solutions

## METODOLOGÍA DOCENTE

### Aspectos metodológicos generales de la asignatura

#### Metodología Presencial: Actividades

**Lectures:** Description of the course contents and open discussion of concepts. The students have also to try to respond to the numerous questions posed by the instructors throughout the lecture.

BA02, CG01

**Term paper discussion:** The papers will be discussed with the instructors with no presentations (as the instructors have read already the papers, the session will consist of just discussion on the content of the term papers, which, admittedly, cover many topics so the discussion could be broad

BA02, CG01

**Tutorial activities.** Available according to the need of the student

BA02, CG01

#### Metodología No presencial: Actividades

Teaching resources require the active participation of the student. In addition, the classroom activity should be complemented by the individual student work performed out of class. Both aspects are taken into account in

BA02, CG01



the evaluation method

**Term task.** Regulatory analysis of a power system chosen among a list of suggestions developed by the instructor. The student has to face her own research, in order to develop the ability to first investigate the current state of the regulation of a real case, and also to apply the critical skills acquired to build regulatory recommendations (40 hours).

BA02, CG01

**Personal work of the student.** Study of the course contents.

BA02, CG01

## RESUMEN HORAS DE TRABAJO DEL ALUMNO

HORAS PRESENCIALES	
Clase magistral y presentaciones generales	
75.00	
HORAS NO PRESENCIALES	
Trabajos de carácter práctico individual	Estudio y resolución de problemas prácticos fuera del horario de clase por parte del alumno
40.00	80.00
CRÉDITOS ECTS: 7,5 (195,00 horas)	

## EVALUACIÓN Y CRITERIOS DE CALIFICACIÓN

Actividades de evaluación	Criterios de evaluación	Peso
<ul style="list-style-type: none"><li>Mid-term exam: 25%</li><li>Final exam: 35%</li></ul>	In order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points.	60 %
<ul style="list-style-type: none"><li><b>Participation in class</b> will account for 5%</li><li><b>Term paper</b> will account for the remaining 35%</li></ul>	In order to pass the course, the mark of the term paper must be greater or equal to 4 out of 10 points	40

## Calificaciones

### Regular assessment

- Theory** will account for 60%, of which:
  - Mid-term exam: 25%
  - Final exam: 35%
- Participation in class** will account for 5%
- Term paper** will account for the remaining 35%

In order to pass the course, the mark of the final exam must be greater or equal to 4 out of 10 points and the laboratory mark must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.



## Retake

The student has two periods of final evaluation during one academic year. The first one will be carried out at the end of course (end of the semester). In case that this was not passed obtaining 5 or more points, the student has another opportunity of final evaluation at the end of the academic year. The dates of evaluation periods will be announced in the web page.

The new grade will be obtained as follows:

- 65% New exam covering the whole course.
- 5% Participation in class
- 30% Term task (the student can resubmit to improve the first grade received).

The mark of the retake final exam must be greater or equal to 4.5 out of 10 points and the mark of the final project must be at least 5 out of 10 points. Otherwise, the final grade will be the lower of the two marks.

## PLAN DE TRABAJO Y CRONOGRAMA

Actividades		Fecha de realización	Fecha de entrega																						
<table border="1"> <thead> <tr> <th colspan="2">Session</th> <th>In-class activities</th> </tr> <tr> <th>#</th> <th>hours</th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>2</td> <td>WHAT'S REGULATION ABOUT?</td> </tr> <tr> <td>2</td> <td>2</td> <td>THE REGULATORY FUNCTION</td> </tr> <tr> <td>3</td> <td>2</td> <td rowspan="3">           REGULATORY MODELS           <ul style="list-style-type: none"> <li>• Energy services pricing: from regulated costs to price competition: Cost-of-service regulation. Incentive regulation. Competitive bidding. Market competition</li> <li>• Energy systems' governance: activities, structure, and stakeholders' roles: Unbundling. System and market operation</li> </ul> </td> </tr> <tr> <td>4</td> <td>2</td> </tr> <tr> <td>5</td> <td>2</td> </tr> <tr> <td>6</td> <td>2</td> <td>           FUNDAMENTALS OF ENERGY SYSTEMS ECONOMICS           <ul style="list-style-type: none"> <li>• Centralized versus market-based planning: Costs' characterization: investment, average and marginal costs. Cost minimization versus profit</li> </ul> </td> </tr> </tbody> </table>		Session		In-class activities	#	hours		1	2	WHAT'S REGULATION ABOUT?	2	2	THE REGULATORY FUNCTION	3	2	REGULATORY MODELS <ul style="list-style-type: none"> <li>• Energy services pricing: from regulated costs to price competition: Cost-of-service regulation. Incentive regulation. Competitive bidding. Market competition</li> <li>• Energy systems' governance: activities, structure, and stakeholders' roles: Unbundling. System and market operation</li> </ul>	4	2	5	2	6	2	FUNDAMENTALS OF ENERGY SYSTEMS ECONOMICS <ul style="list-style-type: none"> <li>• Centralized versus market-based planning: Costs' characterization: investment, average and marginal costs. Cost minimization versus profit</li> </ul>		
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7	2	<p>maximization</p> <ul style="list-style-type: none"> <li>Basics on energy contracts: Physical versus financial contracts</li> </ul>
8	2	<p>COST ALLOCATION METHODOLOGIES</p>
9	2	<ul style="list-style-type: none"> <li>Basic pricing principles. Locational marginal pricing. Monopoly pricing</li> </ul>
10	2	<p>PRICING ELECTRICITY GENERATION</p>
12	2	<ul style="list-style-type: none"> <li>Investment and operation planning: From central planning and operation to wholesale markets</li> </ul>
13	2	<ul style="list-style-type: none"> <li>Energy markets design elements: Market-based economic scheduling: Market models, bidding formats and clearing algorithms</li> </ul>
14	2	<p>COMPLEMENTS TO ENERGY MARKETS</p>
15	2	<ul style="list-style-type: none"> <li>Flexibility markets: Intraday, reserves and regulation markets.</li> </ul>
16	2	<ul style="list-style-type: none"> <li>Capacity and RES-support mechanisms: Design elements of capacity and RES promotion mechanisms</li> </ul>
17	2	
18	2	<p><b>EXAM 1</b></p>
19	2	<p>INTERPLAY BETWEEN TRANSMISSION AND GENERATION</p>
20	2	<ul style="list-style-type: none"> <li>Exercise: single vs. nodal pricing. Congestion rents. Financial Transmission Rights</li> </ul>
21	2	<ul style="list-style-type: none"> <li>Characterization of transmission. Regulatory treatment of transmission investment planning (golden rules), business models</li> </ul>
22	2	<p>REGULATED REVENUES AND COST ALLOCATION</p>
23	2	<ul style="list-style-type: none"> <li>Remuneration mechanisms for distribution: Cost-of-service, RPI-X, TOTEX...</li> </ul>
24	2	<ul style="list-style-type: none"> <li>Network costs allocation: Transmission and distribution tariffs</li> </ul>
25	2	



26	2	END-USER TARIFFS	
27	2	<ul style="list-style-type: none"><li>Principles and basic tariff structures: Efficiency &amp; equity. Additivity, components.</li><li>Time and locational granularity: Dynamic, TOU, fixed, ...</li></ul>	
28	2		
29	2	RETAIL MARKETS	
30	2	<ul style="list-style-type: none"><li>Business models: Retail activities, stakeholders' roles.</li><li>Consumer protection: Data management, switching, vulnerable customers</li></ul>	
31	2		
32	2	CONTEMPORARY ELECTRIC POWER SYSTEMS' ISSUES	
33	2	<ul style="list-style-type: none"><li>Future Challenges and Trends of Electric Power Systems</li><li>Regulation of New Energy Resources and Solutions</li></ul>	
34	2		
35	2		
36	2	<b>EXAM 2</b>	
37	2	<b>TERM PAPERS' DISCUSSION</b>	
38	2		

## BIBLIOGRAFÍA Y RECURSOS

### Bibliografía Básica

"Regulation of the electric power sector". Pérez-Arriaga Ed., Springer Verlag, 2013

- Body of Knowledge on Infrastructure Regulation
- <http://regulationbodyofknowledge.org/>
- Schweppe, F.C., Caramanis, M.C., Tabors, R.D., Bohn, R.E., 1988. Spot pricing of electricity. Kluwer Academic Publishers.
- Kahn, A.E., 1988. The economics of regulation: Principles and institutions. The MIT Press.
- Stoft, S., 2002. Power System Economics, Wiley-IEEE Press.
- Joskow, P. L., 2003. "The difficult transition to competitive electricity markets in the U.S." May 2003. Available at <http://dspace.mit.edu/handle/1721.1/45001>.
- Al-Sunaidy, A., R. Green, 2006. "Electricity deregulation in OECD (Organization for Economic Cooperation and Development) countries. Energy, vol. 31, pp. 769–787.

### Bibliografía Complementaria



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[www.iit.upcomillas.es/batlle/Publications.html](http://www.iit.upcomillas.es/batlle/Publications.html)

- Batlle, C., Barroso, L. A. and Pérez-Arriaga, I. J., 2010. "The changing role of the State in the expansion of electricity supply in Latin America". Energy Policy, vol. 38, iss. 11, pp. 7152-7160, November 2010.
- Rodilla, P. & Batlle, C. 2010. "Security of electricity supply at the generation level: problem analysis". Working Paper IIT-10-027A, Energy Policy, vol. 40, pp. 167.185.
- Batlle, C., Pérez-Arriaga, I. J., Zambrano-Barragán, P., 2011. "Regulatory design for RES-E support mechanisms: Learning curves, market structure, and burden-sharing". MIT CEEPR 2011-011 Working Paper, May 2011. Energy Policy, vol. 41, pp. 212-220.

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