Annual Academic Report
Academic year 2010 - 2011

Institute for Research in Technology

Instituto de Investigación Tecnológica
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Dear Friend,

Another year, it is with much pleasure and satisfaction that I present the annual report of the work carried out in the Institute for Research in Technology (IIT) of the ICAI School of Engineering at the Comillas Pontifical University.

This document - a record of a year of effort and dedication on the part of our research staff - is proof indeed of the position we have been able to consolidate, both nationally and internationally, in our chosen areas of research. It describes a situation which attests both to the strength of the institute’s research teams, who also make an important contribution to our ambitious and internationally-oriented doctoral programmes, and to the continuing success of our collaboration with the industrial sector, a mutually beneficial relationship which now stretches back over twenty-five years.

All of the activity described in this report would not have been possible without the work and commitment of all the professionals in the institute: teachers, researchers, administrative staff, post-graduate students and representatives of the industrial sector. If the work of the IIT has become an international benchmark in its areas of research, it is without doubt entirely their achievement.

Our goal now is to build on our success and advance further in our areas of expertise. This we hope to achieve though our continuing commitment and our professionalism, a professionalism which will enable us to continue to enjoy the confidence of those national and international companies and organisations with whom we collaborate, in particular the ICAI School of Engineering itself, the Comillas Pontifical University, and ICAI Engineers Association, for whose valuable support we would like to express our gratitude. We wish to continue to earn this confidence by dint of our efforts to produce qualified professionals who are highly sought after by companies in the industrial sector, to encourage applied research which adds to the engineering knowledge base, and to pass on this knowledge so that it may be of use to society. We are conscious that this is a difficult challenge in the current global economic situation, we face it with enthusiasm and commitment.

I cordially invite you to get to know us better by reading this report.

Efraim Centeno Hernáez
1. Introduction

The Institute for Research in Technology (IIT) is a University Research Institute that belongs to the ICAI School of Engineering of Comillas Pontifical University. Its primary objective is to promote research and postgraduate training in various technological fields through participation in specific projects of interest to the industry and the administration. It is a nonprofit institute that seeks to be flexible and pragmatic in the way they work. Its funding comes mainly from projects contracted with companies and, therefore, meet the social demand proven.

The results of this research are specified in the following products:

• Innovative engineering equipment design and advanced computer applications (usually developed to customer specifications) used in many different companies.

• Analysis, consulting and technical, statistical, regulatory and econometric studies developed for companies and institutions in various countries.

• Doctoral theses defended at the University and publications in conferences and international journals.

The core of IIT is composed of a group of Professors and Researchers. This group is supplemented by postgraduate researchers as Research Assistants, usually with scholarships from the IIT and dedicated to the Institute. Work teams are formed between both groups for the development of research projects, some of which are made dissertations.
2. Organization

2.1 Management

The management of the Institute for Research in Technology has been formed by the following teachers:

- Centeno Hernáez, Efraim. Director
- Villar Collado, José. Deputy Director

2.2 Council

Members of the Council of the Institute for Research in Technology were:

- Centeno Hernáez, Efraim. Director
- Villar Collado, José. Deputy director
- Rodríguez-Morcillo García, Carlos. Secretary
- Alvar Miró, Manuel. (until December 2010)
- Díaz Durán, Cristian Andrés.
- Domínguez Gago, María. (since December 2010)
- Gómez San Román, Tomás. (since November 2010 until May 2011)
- Linares LLamas, Pedro. (until November 2010)
- Muñoz San Roque, Antonio. (since November 2010)
- Ramos Galán, Andrés.
- Reneses Guillén, Javier.
- Rivier Abbad, Michel.
- Sánchez Úbeda, Eugenio Francisco. (since May 2011)
2.3 Academic staff

The permanent staff of IIT consisted of the following Professors and Researchers:

• **Alexandres Fernández, Sadot.** Tenured Associate Professor
  Ph.D. in Telecommunications Engineering (UPM)
  Telecommunications Engineer (UPM)

• **Andrés Martínez, Ángel de.** Tenured Assistant Professor
  Ph.D. in Industrial Engineering (Comillas)
  Mechanical Engineer (Comillas)

• **Arenas Alonso, Antonio.** Tenured Associate Professor
  Ph.D. in Industrial Engineering (Comillas)
  Mechanical Engineer (Comillas)

• **Barquín Gil, Julián.** Tenured Associate Professor
  Ph.D. in Industrial Engineering (Comillas)
  Electrical Engineer (Comillas), Physics Science degree (UNED)
  Areas of interest: Energy planning, operation and economics, with an emphasis on electricity and natural gas.

• **Batlle López, Carlos.** Tenured Assistant Researcher
  Ph.D. in Industrial Engineering (Comillas)
  Electrical Engineer (Comillas)

• **Campos Fernández, Francisco Alberto.** Assistant Research Professor
  Ph.D. in Industrial Engineering (Comillas)
  Mathematics Science degree (UCM)

• **Centeno Hernández, Efraim.** Tenured Associate Professor
  Ph.D. in Industrial Engineering (Comillas)
  Electronics Engineer (Comillas)
• **Cerisola López de Haro, Santiago.** Adjunct Professor  
Ph.D. in Industrial Engineering (Comillas)  
Mathematics Science degree (UCM)  

• **Contreras Bárcena, David.** Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Computing Engineer (Comillas), Postgraduate in Management Information Systems (Comillas)  

• **Cuadra García, Fernando de.** Tenured Full Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electrical Engineer (Comillas)  

• **Cucala García, Asunción Paloma.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  
Areas of interest: Modelling, simulation, design, management and control of railway systems, and their safety and quality analysis.

• **Echavarren Cerezo, Francisco Miguel.** Assistant Research Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electrical Engineer (Comillas)  
Areas of interest: Modeling, analysis and simulation of power systems.

• **Egido Cortés, Ignacio.** Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  
Areas of interest: System modeling and control. Power system stability.

• **Fernández Cardador, Antonio.** Tenured Associate Professor  
Ph.D. in Industrial Engineering (Comillas)  
Physics Science degree (UCM)  
• **Fernández García, Mercedes.** Tenured Assistant Professor  
  Ph.D. in Economics Science (Comillas)  
  Law and Legal Advisor Companies degree (Comillas)  
  Areas of interest: Economics, Finance, Business administration, Multivariate data analysis.

• **Fernández Martínez, Cesáreo.** Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Electrical Engineer (UPM)  
  Areas of interest: Software for Real-time control. Parallel architectures in control. HV line protection. Control in electric power substations.

• **Frias Marín, Pablo.** Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Electrical Engineer (Comillas)  
  Areas of interest: Operation and planning of electric power systems. Power economics. Optimisation techniques. Integration of distributed generation in power systems. Advanced electric machines.

• **García Cerrada, Aurelio.** Tenured Full Professor  
  Ph.D. in Electrical and Electronics Engineering (University of Birmingham, U.K.)  
  Electrical Engineer (UPM)  
  Areas of interest: Power electronics. Control of electrical drives. FACTS. System identification and control.

• **García González, Javier.** Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Electrical Engineer (UPC)  
  Areas of interest: Economy and optimization of electric power systems.

• **García González, Pablo.** Tenured Associate Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Electrical Engineer (Comillas)  
  Areas of interest: Control. Power electronics. Power electronics applied to the electric power systems (FACTS devices, active filters, HVDC, etc.). Electric power systems stability and control.

• **Giannetti, Romano.** Tenured Associate Professor  
  Ph.D. in Electronics and Computing Engineering (University of Padua, Italy)  
  Electronics Engineer (University of Pisa, Italy)  
• **González Arechavala, Yolanda.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Computing Engineer (UPV-EHU)  
Areas of interest: Software engineering: software development process, programming paradigms, software quality assurance and control, CASE tools.  
RAMS: standards and analysis. Safety critical and real time systems. Railway systems.

• **Latorre Canteli, Jesús María.** Assistant Research Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  

• **Linares Llamas, Pedro.** Tenured Associate Professor  
Ph.D. in Environmental Economics (UPM)  
Environmental Economics degree (UPM)  

• **Lobato Miguélez, Enrique.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electrical Engineer (Comillas)  
Areas of interest: Analysis, planning, operation and economics in electric power systems.

• **Mateo Domingo, Carlos.** Assistant Research Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas), Computer Systems Engineer (UNED)  

• **Muñoz San Roque, Antonio.** Tenured Full Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electrical Engineer (Comillas)  

• **Nieto Fuentes, Francisco.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Mechanical Engineer (Comillas)  
Areas of interest: Robotics. Reliability and safety. Mechanical design.
• Olmos Camacho, Luis. Assistant Research Professor
  Ph.D. in Industrial Engineering (Comillas)
  Electrical Engineer (Comillas)
  Areas of interest: Regulation of the energy sector. Transmission of electricity.
  Power economics. System identification.

• Pagola y de las Heras, Francisco Luis. Tenured Full Professor
  Ph.D. in Industrial Engineering (UPM)
  Electrical Engineer (Comillas)
  Areas of interest: Theory and applications of automatic control. Digital and
  adaptive control. Electric power systems: stability, control, modeling,
  measuring and relaying techniques. Power electronics and electrical drives.

• Palacios Hielscher, Rafael. Tenured Assistant Professor
  Ph.D. in Industrial Engineering (Comillas)
  Mechanical Engineer (Comillas)
  Areas of interest: Advanced data analysis (including vibration analysis, optical
  handwritten character recognition, image processing, artificial intelligence and
  data mining). Parallel processing. Thermoelectric applications. Failure detection
  and maintenance. Aviation safety.

• Pérez Arriaga, José Ignacio. Tenured Full Professor
  Ph.D. and M.Sc. in Electrical Engineering (Massachusetts Institute of
  Technology - MIT, U.S.A.), Ph.D. in Industrial Engineering (UPM)
  Electrical Engineer (Comillas)
  Areas of interest: Regulation, economics, planning, operation and control of
  electric power systems. Sustainability of the energy model.

• Ramos Galán, Andrés. Tenured Full Professor
  Ph.D. in Industrial Engineering (UPM)
  Electrical Engineer (Comillas)
  Areas of interest: Development of new algorithms and computer
  implementation. Modeling of complex systems. Mathematical techniques of
  operations research and their application to large-scale problems. Large-scale
  Planning and operation of electric energy systems -models for generation and
  transmission network planning, generation operation models-. Economy of the
  electric sector. Computational techniques and analytical methods for planning,
  operations, and control. Economics, market organization, cost structures,
  pricing, and risk management. Reliability, uncertainty, and probability and
  stochastic system applications. Emerging methods for restructured systems.
  Generation system resource planning. Transmission system planning. Industry
  restructuring planning and policy issues.
• **Reneses Guillén, Javier.** Tenured Assistant Researcher  
Ph.D. in Industrial Engineering (Comillas)  
Electrical Engineer (Comillas), Mathematics Science degree (UNED)  
Areas of interest: Operation, regulation and planning of power and natural gas systems. Tariff design.

• **Rivier Abbad, Michel.** Tenured Full Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electrical Engineer (Comillas)  
Areas of interest: Electric power systems analysis, optimisation, regulation economic, operation and planning. Optimisation techniques.

• **Rodilla Rodríguez, Pablo.** Assistant Research Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electrical Engineer (Comillas)  

• **Rodríguez Mondéjar, José Antonio.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  
Areas of interest: Communication and control in electric power systems and railway systems.

• **Rodríguez Pecharromán, Ramón.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  
Areas of interest: Control systems. Railway electrification. Thermoelectricity.

• **Rodríguez-Morcillo García, Carlos.** Assistant Research Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  

• **Rouco Rodríguez, Luis.** Tenured Full Professor  
Ph.D. in Industrial Engineering (UPM)  
Electrical Engineer (UPM)  
Areas of interest: Electric power systems stability and control. System identification. Simulation of electromagnetic transients.
• **Sánchez Martín, Pedro.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Industrial Engineer (Comillas)  
Areas of interest: Transmission and generation electric system modeling.  
Industrial process planning and scheduling. Work system design.  
Manufacturing and logistics simulation

• **Sánchez Miralles, Álvaro.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  

• **Sánchez Úbeda, Eugenio Francisco.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  

• **Sanz Bobi, Miguel Ángel.** Tenured Full Professor  
Ph.D. in Industrial Engineering (UPM)  
Electrical Engineer (UPM)  

• **Sigrist, Lukas.** Assistant Research Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electrical and Electronics Engineer (École Plytechnique Fédérale de Lausanne - EPFL, Switzerland)  
Areas of interest: Modeling, analysis and control of electric power systems.

• **Ventosa Rodríguez, Mariano.** Tenured Associate Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  
Areas of interest: Operations, planning and economy of electric energy systems. Application of operations research in electric energy markets.

• **Villar Collado, José.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)

2.4 Associated academic staff

Collaborated with IIT, as Associate Researchers:

- **Cantizano González, Alexis.** Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Mechanical Engineer (Comillas), M.Sc. in Thermal Power and Fluids Engineering (University of Manchester Institute of Science and Technology - UMIST, U.K.), Psychology degree (UNED)  

- **Carnicero López, Alberto.** Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Mechanical Engineer (Comillas)  

- **Castro Ponce, Mario.** Tenured Assistant Professor  
  Ph.D. in Physics Science (UCM)  
  Physics Science degree (UCM)  

- **Fernández Bernal, Fidel.** Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Electrical Engineer (Comillas)  
  Areas of interest: Dynamics of electrical systems. Motor control and applications on electric vehicles. Power electronics.

- **Jiménez Octavio, Jesús.** Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Mechanical Engineer (Comillas)  
  Areas of interest: Railway systems. Design and optimization. Computational mechanics.
• Laloux Dallemagne, Damián. Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Electrical Engineer (Comillas)  
  Areas of interest: Modelling, analysis and control of electric power systems.  
  Sustainable development.

• Maté Jiménez, Carlos. Tenured Assistant Professor  
  Ph.D. in Mathematics Science (UCM)  
  Mathematics Science degree (UCM)  
  Areas of interest: Forecasting. Time series analysis. Symbolic data analysis.  
  Reliability. Life testing. Nonparametrics bayesian statistics. Multivariate  
  analysis. Marketing research. Customer satisfaction measurement. QoS.

• Meseguer Velasco, Claudia. Tenured Assistant Professor  
  Ph.D. in Industrial Engineering  
  Mechanical Engineer (UPM)  
  Areas of interest: Regulation, economics, operation and planning of electric  
  power systems.

• Mochón Castro, Luis Manuel. Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Mechanical Engineer (Comillas)  
  Areas of interest: Computacional fluid dynamic. Fluid control. Hydraulic  
  energy.

• Muñoz Frías, José Daniel. Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Electronics Engineer (Comillas)  
  Areas of interest: Digital systems design. Computer architecture. Motor drives  
  control. Design of embedded systems for automatic control applications.

• Ortiz Marcos, Susana. Tenured Assistant Professor  
  Ph.D. in Industrial Engineering (UPM)  
  Industrial Engineer (UPM)  
  Areas of interest: Business administration. Financial accountig. Production  
  management. Costing accounting. Regulation and organizational structure of  
  the electricity market and cost of capital estimation for companies of the  
  electricity sector. Renewable fuels.

• Porras Galán, José. Assistant Professor  
  Ph.D. in Industrial Engineering (Comillas)  
  Mechanical Engineer (Comillas)  
  Artificial inteligence. Acoustics.
• **Sáenz Nuño, María Ana.** Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Physics Science degree (UCM)  
Areas of interest: Dimensional Metrology.

• **Santos Montes, Ana María.** Tenured Associate Professor  
Ph.D. in Chemistry Science (UCM)  
Chemistry Science degree (UAM)  
Areas of interest: Development, optimization and validation of chromatographic analytical methods for high-performance liquid chromatography (HPLC) to determine steroids, diuretics and contaminants in urine samples, feed and water. Analysis of the life cycle of crops for biofuels.

• **Zamora Macho, Juan Luis.** Tenured Assistant Professor  
Ph.D. in Industrial Engineering (Comillas)  
Electronics Engineer (Comillas)  
Areas of interest: Drive control. System identification. Signal processing.

### 2.5 Research assistants

The group of Research Assistants at the IIT consisted of the following graduates in this course:

- **Alvar Miró, Manuel.** Electronics Engineer (Comillas), Arts and Manufactures Engineer (École Centrale Paris, France)
- **Andrade Vieira, Rodrigo José.** Mechanical Engineer (Federal University of Pará - UFPA, Belém, Brazil), M.Sc. in Mechanical Engineering (Federal University of Pará - UFPA, Belém, Brazil)
- **Arranz Domingo, Álvaro.** Electronics Engineer (Comillas)
- **Ayala Santamaria, Pablo.** Mechanical Engineer (Comillas)
- **Báñez Chicharro, Fernando.** Electronics Engineer (Comillas)
- **Bello Morales, Antonio.** Mechanical Engineer (Comillas)
- **Boal Martín-Larrauri, Jaime.** Electronics Engineer (Comillas)
- **Brighenti, Chiara.** Automation Engineer (University of Padua, Italy)
- **Castel Conesa, Carlos.** Electrical degree (UPV), M.Sc. in Materials and Sensors Systems for Environmental Technologies (Polytechnic University of Valencia - UPV and Kungliga Tekniska Högskolan - KTH, Stockholm, Sweden)
- **Chaves Ávila, José Pablo.** Economics (University of Costa Rica), M.Sc. in Electric Power Industry (Comillas), M.Sc. in Network Industries and Digital Economics (University Paris-Sud 11, France)
- **Chazarra Jover, Manuel.** Electrical Engineer (Comillas)
- **Contreras Alfonsín, Alejandro.** Electrical Engineer (Comillas)
- **Cossent Arín, Rafael.** Electrical Engineer (Comillas)
• **Danesin, Alessandro.** Economics and Management of Complex Systems degree (Ca’ Foscari University of Venice, Italy), M.Sc. in Models and Methods of Quantitative Economics (Universidad Autónoma de Barcelona - UAB and Université Paris 1 Panthéon - Sorbonne, France)

• **Delgadillo Vega, Andrés Ramiro.** Electrical Engineer (Universidad Nacional de Colombia, Bogota, Colombia), M.Sc. in Economy (Universidad Nacional de Colombia, Bogota, Colombia)

• **Dias Blesby Rodrigues, Renato.** Economics Science degree (Federal University of Rio de Janeiro - UFRJ, Brazil), M.Sc. in Economics of Industry and Technology. Stricto Sensu (Federal University of Rio de Janeiro - UFRJ, Brazil)

• **Díaz Durán, Cristian Andrés.** Electrical Engineer (Industrial University of Santander - UIS, Bucaramanga, Colombia)

• **Dietrich, Kristin.** Industrial Engineering and Management degree (Dresden University of Technology - TU Dresden, Germany)

• **Díez Maroto, Luis.** Electrical Engineer (Comillas)

• **Domínguez Gago, María.** Electrical Engineer (Comillas)

• **Dueñas Martínez, Pablo.** Electrical Engineer (Comillas)

• **Fagiani, Riccardo.** Energy Engineer (Politecnico di Milano, Italy)

• **Fernández Fernández, Ismael Jaime.** Electronics Engineer (Comillas)

• **Fernández Sánchez, Miguel Ángel.** Electronics Engineer (Comillas)

• **Fitiwi, Desta Zahlay.** Electrical and Computer Engineer (Addis Ababa University, Ethiopia), M.Sc. in Electrical Engineering (PETRONAS University of Technology, Malaysia)

• **Formozo Fernandes, Camila.** Economics Science degree (Federal University of Rio de Janeiro - UFRJ, Brazil), M.Sc. in Electric Power Industry (Comillas), M.Sc. in Economics, Technology and Territory (University Paris-Sud 11, France)

• **García Matos, Jesús Ángel.** Mechanical Engineer (Comillas)

• **Gascón González, Alberto.** Electronics Engineer (Comillas)

• **Gebrekiros, Yonas Tesfay.** Electrical Engineer (Mekelle University, Ethiopia), M.Sc. in Electrical Engineering (Delft University of Technology - TU Delft, The Netherlands)

• **González García, Alezeia.** Electrical Engineer (Comillas)

• **González Sotres, Luis.** Electronics Engineer (Comillas)

• **Gutiérrez Alonso, Esther.** Electrical Engineer (Comillas)

• **Herranz Pindado, Rocío.** Electronics Engineer (Comillas)

• **Izadkhast, Seyedmahdi.** Electrical Engineer (University of Tehran, Iran), M.Sc. in Power Electronics and Electrical Machines (Sharif University of Technology, Tehran, Iran)

• **Juárez Montojo, Javier.** Electronics Engineer (Comillas)

• **Lago Vázquez, Óscar.** Electrical Engineer (Comillas)

• **López López, Álvaro Jesús.** Electronics degree (Comillas), M.Sc. in Automatics and Electronics (Comillas)
• López-Peña Fernández, Álvaro. Electrical Engineer (Comillas), Engineer (ICAM - Ecole d’ingénieurs généralistes, Toulouse, France)
• Lumbreras Sancho, Sara. Electrical Engineer (Comillas)
• Martín Sastre, Carlos. Agronomist Engineer (UPM)
• Momber, Ilan. Industrial Engineer (Karlsruhe Institute of Technology - KIT, Germany)
• Morales España, Germán Andrés. Electrical Engineer (Industrial University of Santander - UIS, Bucaramanga, Colombia), M.Sc. in Electricity Sector (Comillas), M.Sc. in Engineering and Policy Analysis (Delft University of Technology - TU Delft, The Netherlands)
• Moreno Barrado, Ana. Physics Science degree (University of Seville)
• Portela González, José. Electronics Engineer (Comillas)
• Rivero Puente, Enrique. Electronics and Communications Engineer (Instituto de Estudios Superiores de Monterrey - ITESM, Mexico), M.Sc. in Electric Power Industry (Comillas), M.Sc. in Economics, Technology and Territory (University Paris-Sud 11, France)
• Rodríguez Calvo, Andrea. Electronics Engineer (Comillas)
• Roldán Pérez, Javier. Electronics Engineer (Comillas), M.Sc. in Automatics and Electronics (Comillas)
• Saboya Bautista, Inmaculada. Electrical Engineer (Comillas)
• Sáiz Marín, Elena. Electrical Engineer (Comillas)
• Sánchez Rebollo, Cristina. Mechanical Engineer (Comillas)
• Santamaría Barroso, Alberto. Electronics Engineer (Comillas)
• Santodomingo Berry, Rafael. Electrical Engineer (Comillas)
• Sicre Vara del Rey, Carlos María. Electrical Engineer (Comillas)
• Vallés Rodríguez, Mercedes. Electrical Engineer (Comillas)
• Vázquez Martínez, Samuel. Mining degree in Energetic Resources, Fuels & Explosives (University of Leon), Mining Engineer (UPM)
• Veiga Santiago, Andrea. Electrical Engineer (Comillas)
• Wogrin, Sonja. Technical Mathematics degree (Graz University of Technology, Austria), M.Sc. in Computation for Design and Optimization (Massachusetts Institute of Technology - MIT, U.S.A.)

2.6 Services staff

2.6.1 Systems administrator staff

The staff responsible for managing networks and computer systems consists of:

• Martín Tena, Julián. Computer Expert
2.6.2 Administrative staff

The staff that manage the documentation, the technical secretariat and the Ph.D. consist of:

- **Ruiz González-Mateo, Cristina.** Law and Legal Advisor Companies degree (Comillas)
- **Sánchez Ortega, María Isabel.** Librarianship and Information Science diploma (University of Granada)
- **Tamudo González, Isabel.** Criminology diploma (UCM), Criminology degree (UEM)
3. Teaching

The IIT has, in teaching, the research orientation complement within the university setting in which it enrolls. This teaching activity takes the form of master courses in collaboration with departments of Comillas ICAI. Additionally, the IIT encourages participation of its researchers in activities of teaching.

Other academic activities include doctoral courses and teaching courses in other schools.

3.1 Master courses

In various master's programs organized by the Post-Graduate Institute in collaboration with Comillas ICAI are addressed technical and management problems.

You can find detailed information of the masters in the respective prospectuses of Comillas and through the University website.

The following are the courses taught by IIT staff in different masters in which the Institute participates.

3.1.1 Erasmus Mundus International Master in Economics and Management of Network Industries (EMIN)

Coordinator: Javier García González
More information at http://www.upcomillas.es/emin/

- Advanced analysis of electric power systems
  Luis Rouco Rodríguez

- Decision support models in the electric power industry
  Efraim Centeno Hernáez, Javier García González, Andrés Ramos Galán, Antonio Muñoz San Roque
- Environmental impact and renewable energy  
  Pedro Linares Llamas

- Fundamentals on electrical engineering and optimization techniques  
  Francisco Miguel Echavarren Cerezo, Pablo Frias Marín, Javier García González, Damián Laloux Dallemagne, Andrés Ramos Galán, Javier Reneses Guillén, Michel Rivier Abbad

- Introduction to electric power systems  
  Damián Laloux Dallemagne, Michel Rivier Abbad

- Regulation of the electric power industry  
  Carlos Batle López, José Ignacio Pérez Arriaga, Pablo Rodilla Rodríguez

- The electric power distribution business  
  Tomás Gómez San Román, Javier Reneses Guillén

- The electric power transmission business  
  Michel Rivier Abbad

- The natural gas industry and fuel markets  
  Javier García González

- Wholesale and retail electricity markets  
  Carlos Batle López, Michel Rivier Abbad, Pablo Rodilla Rodríguez

### 3.1.2 Master in Regulation of the Electricity Industry

Director: Carlos Batlle López

- Environmental regulation of the electric power industry  
  Pedro Linares Llamas

- Regulation of electric power: Retail electricity markets  
  Carlos Batlle López

- Regulation of electric power: distribution  
  Javier Reneses Guillén

- Regulation of electric power: tariff design  
  Javier Reneses Guillén

- Regulation of electric power: transmission  
  Michel Rivier Abbad
- Monopolistic activities
  Tomás Gómez San Román

- Decision support models in the electric power industry
  Jesús María Latorre Canteli

- Electric power systems
  Damián Laloux Dallemagne

3.1.3 Master in Electric Power Industry

Director: Javier García González

- Advanced analysis of electric power systems
  Luis Rouco Rodríguez

- The electric power distribution business
  Tomás Gómez San Román, Javier Reneses Guillén

- The electric power transmission business
  Michel Rivier Abbad

- The natural gas industry and fuel markets
  Javier García González

- Fundamentals on electrical engineering and optimization techniques
  Francisco Miguel Echavarren Cerezo, Pablo Frías Marín, Javier García González, Damián Laloux Dallemagne, Andrés Ramos Galán, Javier Reneses Guillén, Michel Rivier Abbad

- Environmental impact and renewable energy
  Pedro Linares Llamas

- Introduction to electric power systems
  Damián Laloux Dallemagne, Michel Rivier Abbad

- Wholesale and retail electricity markets
  Carlos Batlle López, Michel Rivier Abbad, Pablo Rodilla Rodríguez

- Decision support models in the electric power industry
  Efraim Centeno Hernáez, Javier García González, Andrés Ramos Galán, Antonio Muñoz San Roque
3.1.4 Master in Railway Systems

Director: Antonio Fernández Cardador

- Railway Systems Electrification
  Eduardo Pilo de la Fuente, Luis Rouco Rodríguez

- Catenary mechanics
  Alberto Carnicero López, Jesús Jiménez Octavio

- ERTMS and RAMS
  Yolanda González Arechavala

- Design and Traffic Control Advanced Systems
  Antonio Fernández Cardador, Asunción Paloma Cucala García, Piotr Lukaszewicz

- Control and supervision systems
  Sadot Alexandres Fernández, José Antonio Rodríguez Mondéjar

3.1.5 Master in Electrical Technology

Director: Luis Rouco Rodríguez

- Economy electricity sector
  Carlos Batlle López, Mariano Ventosa Rodríguez, Luis Rouco Rodríguez

- Reliability
  Javier Reneses Guillén, Andrés Ramos Galán

- Fundamentals thermal generation
  Luis Manuel Mochón Castro

- Renewable generation
  Luis Rouco Rodríguez

- Hydraulic generation
  Luis Manuel Mochón Castro
- Conventional thermal generation
  Alexis Cantizano González, Luis Manuel Mochón Castro

- Environmental impact of electricity industry
  Julián Barquín Gil, Luis Rouco Rodríguez

- High-voltage networks
  Tomás Gómez San Román, Luis Rouco Rodríguez, Francisco Miguel Echavarren Cerezo, Eduardo Pilo de la Fuente

- Medium- and low-voltage networks
  Tomás Gómez San Román, Francisco Miguel Echavarren Cerezo, Luis Rouco Rodríguez, Eduardo Pilo de la Fuente, Pablo García González

- Seminars
  Luis Rouco Rodríguez, Enrique Lobato Miguélez, Damián Laloux Dallemagne

- Central electrical systems
  Luis Rouco Rodríguez

3.1.6 Master on-line in Electricity Generation. Promotion, Technology and Operations
- Economic operation of electricity generation. Electricity markets.
  Tomás Gómez San Román

- Solar generation
  Luis Manuel Mochón Castro

- Hydroelectric Power Station Promotion, Investment analysis and economic viability
  Susana Ortiz Marcos

- Electrical Systems of Power Stations
  Luis Rouco Rodríguez

3.1.7 Master on-line in Project, Construction and Maintenance of High Voltage Electrical Transmission
- Maintenance management of high voltage power lines
  Miguel Ángel Sanz Bobi

- Maintenance management of high voltage power lines: models and strategies of maintenance: predictive, preventive, corrective, RCM and TPM.
  Miguel Ángel Sanz Bobi
Master courses

- Transmission Lines
  Luis Rouco Rodríguez

- Power lines parameters computation
  Francisco Miguel Echavarren Cerezo

- Projects of High Voltage Infrastructures: Design Parameters of High Voltage Installations
  Luis Rouco Rodríguez

- Electric high voltage infrastructure projects: electric infrastructure policy in Spain
  Michel Rivier Abbad

3.2 Master theses

3.2.1 Master in Electric Power Industry

- Análisis de los beneficios de la GAD para clientes industriales y comercializadoras
  Paloma Garbayo Tavera. Supervised by Pedro Linares Llamas.

- Generation costs estimation in the Spanish mainland power system from 2011 to 2020
  Jesús David Crisóstomo Ramírez. Supervised by Andrés Ramos Galán and Jesús María Latorre Canteli.

- Gestión del riesgo en un portfolio de centrales
  Carlos Ezquerra Pérez. Supervised by Pablo Rodilla Rodríguez.

- Metodología de previsión de producción de un representante de último recurso de régimen especial
  Juan Carlos Rucián Castellanos. Supervised by Eugenio Francisco Sánchez Úbeda.

- Modelo de optimización de la programación eólica a través de la minimización de los sobrecostes de los desvíos
  César Orellana Silva. Supervised by Enrique Lobato Miguélez.

- Optimización y gestión del riesgo del aprovisionamiento de carbón en centrales termoeléctricas
  Álvaro Urbasos Ramos. Supervised by Andrés Ramos Galán and Jesús María Latorre Canteli.
Valuation of transmission capacity rights. An option pricing approach with volatility estimation using GARCH models for the France-Spain case
Juan Pablo Tamayo. Supervised by Pablo Rodilla Rodríguez.

3.3 Other academic activities

3.3.1 Master courses


- José Ignacio Pérez Arriaga, "FSR Annual course on Regulation of Energy Utilities", European University Institute. Organized by Florence School of Regulation (FSR). Florencia (Italy).

- José Ignacio Pérez Arriaga, "Graduate course on Engineering, economics and regulation of the electric power sector", Engineering System Division, the Sloan School of Management and the Department of Electrical Engineering and Computer Science (MIT). Organized by Massachusetts Institute of Technology (MIT). Cambridge, MA (U.S.A.).

- Jesús Jiménez Octavio, Cristina Sánchez Rebollo, "Introduction to optimization", Organized by University of Edinburgh, School of Engineering. Edimburgo (United Kingdom).


3.3.2 Master theses

- "Impacts of large quantities of wind energy on the electric power system" por Yuan Yao. Engineering System Division. Massachusetts Institute of Technology (MIT), Cambridge, MA (U.S.A.).
  Supervisor: José Ignacio Pérez Arriaga

  Supervisor: José Ignacio Pérez Arriaga
4. Research

4.1 Research areas

The IIT is divided into two main areas of research:

1) **Power Systems (SE)**, that is mainly aimed at subjects related to the electricity and energy sector and in particular to the generation, transportation, and distribution of electrical energy. It is subdivided into four areas:

- **Modelling, Analysis and Control of the Electric Power Systems Area (MAC)**, dedicated to the development of computer tools for electrical studies related to such aspects as load flows, stability, transients, frequency-power control, power plant regulators, voltage control, design of systems of electric feeding, protection, harmonics, and the impact of the distributed generation.
  Coordinators: Luis Rouco Rodríguez (until May 2011) and Enrique Lobato Miguélez (since June 2011)
  Web page: http://www.iit.upcomillas.es/organizacion/mac.php.en

- **Smart and Green Networks Area (Redes)**, is focused on the analysis and development of models for the simulation and optimization of future electricity networks.
  Coordinators: Tomás Gómez San Román (until May 2011) and Pablo Frías Marín (since May 2011)
  Web page: http://www.iit.upcomillas.es/organizacion/redes.php.en

- **Regulation and Economics of the Electric Sector Area (RYE)**, centred on research into the organization, remuneration and regulation of the power systems (sector structure, market models, economic signals, tariffs and quality of service, etc.).
  Coordinator: Michel Rivier Abbad
  Web page: http://www.iit.upcomillas.es/organizacion/rye.php.en

- **Decision Support Systems in the Energy Sector Area (SADSE)**, which goal is to provide assistance in the taking of decisions and in the technical-economic analysis of the generation, transport and distribution systems in the energy sector.
  Coordinator: Andrés Ramos Galán
2) **Industrial Systems (SI)**, which is focused on activities in other technical sectors. This area is divided into four different technical areas:

- **Analysis and Design in Engineering Area (ADI)**, is dedicated to mechanical elements design and to running complex simulations using a computer, specially for general mechanical purposes as well as electromagnetism, wind grounds, etc. Coordinator: Francisco Nieto Fuentes

- **Railway Systems Area (ASF)**, aims to develop models and other custom-made software tools, safety analysis and quality control, related with different topics of railway systems. These topics include the infrastructure design and management, the power systems planification and operation, as well as the railway traffic planification and operation. Coordinator: Asunción Paloma Cucala García

- **Intelligent Systems Area (ASI)**, deals with the monitoring, diagnosis, reliability and maintenance of industrial processes, and modelling and prediction of industrial and economic systems. Coordinator: Álvaro Sánchez Miralles

- **Electronics and Control Group (GEA)**, works to develop electronic instrumentation and microprocessors, power electronics, control engineering applications, signal analysis, electronic design, automatization and digital communications. Coordinators: Sadot Alexandres Fernández

### 4.2 Research projects

Research projects in which they have worked during this academic year are collected here, grouped by area, type of funding and criteria CICyT, along with a brief description of them. It also indicates the collaborating institution, dates of beginning and end, and the researchers involved.
4.2.1 Power Systems Areas

4.2.1.1 Research and develop projects

4.2.1.1.1 Private funding

• Decision support models for optimal planning of hydropower resources in a market environment
  Acciona Energía S.A. October 2009 - May 2011. (Javier García González, Jesús María Latorre Canteli, Miguel Ángel Fernández Sánchez)
  The objective of this project is to develop a set decision support models to obtain the optimal scheduling of hydroelectric generators and reservoirs. The future integration with other renewable energy sources will be taken into account for a possible joint optimization of hydro and wind generation. The developed tools will cover both the short-term and the medium-long term.

• Additional developments in the stochastic hydrothermal coordination model MHE. Year 2010
  The objective of the project is to improve the stochastic hydrothermal coordination model integrated into the set of decision support models for market operation planning and to do small improvements in other stochastic simulation tool for the hydro system.
  The tasks developed are the following:
  a) Analysis of the water release tables of relevant reservoirs.
  b) Improvements in the SDDP decomposition algorithm.
  c) Use of the model for the short term.
  d) Flexibility in the time definition of the model scope.
  e) Improvement of the model interface and documentation.

• Planning of generation electricity markets
  This project is included in the framework of a continuous research for the Energy Planning Division of Endesa. It is aimed in the development of models for medium term planning for generation power systems. More specifically the research is focused on: wind generation modeling, and the impact of network constraints in the market equilibrium.

• Protection of power transformers installed in gas insulated substations against lightning overvoltages
  Iberdrola Distribución. January 2010 - December 2010. (Luis Rouco Rodríguez)
  The aim of this project is the development of practical recommendations for the protection of power transformers installed in gas insulated substations (220 and 132 kV) against lightning overvoltages in Iberdrola Distribución typical installations.
• **Studies for generation planning with non-dispatchable generation**

  This project is the continuation of a line of cooperation between IIT and Endesa about Strategic Analysis of Generation Capacity Expansion. The main work is about analysis and improvement of the algorithms and study methods used by Endesa in order to elaborate its yearly expansion plan and other studies associated to it. The result of this work is the tool EXPANDE. In this collaboration focus will be on the new regulation about national coal plants and analyzing the effect of wind generation plants in the system.

• **Operation and Planning in Electricity Markets**

  This project addresses the operation and planning in the context of the Iberian electricity market. The proposal is framed into the on-going cooperation line followed by Endesa and IIT since 1998, under which VALORE, AGM and HEPLASE projects have been made.

  Specifically, AGM-2010 is the follow-up of project AGM-09. It is focused on the development of advanced tools for statistical analysis and for optimization of a single company, as well as on the adaptation to the changes in the regulatory framework, among other tasks.

• **Protection of power transformers installed in gas insulated substations against switching overvoltages**
  Iberdrola Distribución. January 2010 - December 2010. (Luis Rouco Rodríguez)

  The aim of this project is the development of practical recommendations for the protection of power transformers installed in gas insulated substations (220 and 132 kV) against switching overvoltages due to opening of switches in Iberdrola Distribucion typical installations.

• **MORSE: strategic analysis of the Spanish electricity sector. Equilibrium with network and zonal constraints, new technologies and relationships with other industrial sectors**

  MORSE is a model of the Spanish electricity sector, developed by the Instituto de Investigación Tecnológica (IIT) in collaboration with Endesa. It is intended for strategic analysis of the evolution of this sector, especially when changes of the utilities structure, new regulations, or new generation technologies take place. Its core is EQUITEC, a Conjectural Supply Function Market Equilibrium, where the generation has been represented at the technology level, instead of considering generation units individually. EQUITEC includes an algorithm for agents conjectures computation based on local linearity and robustness against small demand changes. MORSE also has tools for histograms computations
based on Montecarlo, objectives optimization based on genetic algorithms, and optimal determination of the technologies definitions and of the demand load levels of the market model. This collaboration focuses on the extension of EQUITEC to include network and zonal constraints, the modeling of renewable and other emerging technologies, and the approach to other industrial sectors closely related with the electricity sector, to improve MORSE forecasting results.

• **Dynamic excitation module technology**
  Alstom. April 2010 - April 2014. (Luis Rouco Rodríguez, Luis Díez Maroto, Fidel Fernández Bernal)
  Alstom has developed a dynamic excitation module technology. This module is added to static excitation systems fed from generator terminals to improve the generator stability in case of network faults. This project will include the development of a reduced-scale test bank and will provide support to Alstom in the simulation of the machine behaviour. It will also study the large disturbance stability mechanisms of synchronous machines and the design of advanced control schemes of the dynamic excitation module.

• **Planning gas Spanish market**
  This project is focused on the planning and forecasting in the context of the Spanish gas market. In particular, it is expected to make a conceptual design of a planning tool, both in the physical and financial aspects. The second phase of the project is to identify the necessary data for the model. Finally, a prototype of the tool will be developed, designed to aid in planning decisions and forecasting in the gas market in Spain.

• **Analysis of the impact of wind power on future electricity prices in Spain**
  Acciona. June 2010 - October 2010. (Pablo Frias Marín, Pedro Linares Llamas, Jesús María Latorre Canteli, Camila Formozo Fernandes)
  This project analyzes the impact of wind generation in the future electricity market price in Spain. This analysis covers different scenarios for the year 2020, characterized by a specific generation mix, demand increase factor, and fuel and CO2 emissions costs. Research activities are focused in the operation of the different scenarios: power reserves, pumping units and probability of wind spillage. Secondly, this project explores the impact of wind generation on the power system costs, and also its impact on the electricity market prices.

• **Development of a dynamic thermal model of isolated cables**
  Unión Fenosa Distribución. July 2010 - February 2011. (Luis Rouco Rodríguez, Francisco Miguel Echavarren Cerezo)
  The aim of the project is the developments of a simulation tool of a dynamic thermal model of isolated cables.
• **Effects from carbon pricing and anti-leakage policies in selected industrial sectors in Spain - Cement, Power, Steel, Oil Refining**
  Climate Strategies. September 2010 - March 2011. (Pedro Linares Llamas, Alberto Santamaría Barroso)
  The objective of this project is to assess the effects from carbon pricing, and from anti-leakage policies, in some selected industrial sectors in Spain. The sectors to be covered are cement, power generation, steel and oil refining.

• **Extension of the optimization model to include secondary reserve, the simulation module and the particularities of the subsystems of Endesa**
  Endesa. September 2010 - December 2010. (Javier García González, Manuel Chazarra Jover)
  The objective of this project is to extend the current version of the model EXLA so it can be used in short-term studies.

• **Switzerland 100% supplied from renewable energy sources till 2050**
  AXPO. January 2011 - July 2011. (Julián Barquín Gil)
  The objective of the work is developing a long-term (40-year) generation and transmission expansion-planning model to study how the current electric energy system in Europe (UCTE) may evolve in an optimal way toward a fully renewable system. Needless to say, the emphasis will be within the Swiss electric energy system. The objective of this expansion-planning model is to minimize investment and operation costs and it is constrained by technical and financial requirements and bounds.

• **Planning of generation electricity markets**
  This project is included in the framework of a continuous research for the Energy Planning Division of Endesa. It is aimed in the development of models for medium term planning for generation power systems. More specifically the research is focused on: wind and solar generation modeling, and the impact of network constraints on the market equilibrium.

• **Additional developments in the stochastic hydrothermal coordination model MHE. Year 2011**
  The objective of the project is to improve the stochastic hydrothermal coordination model integrated into the set of decision support models for market operation planning and to do small improvements in other stochastic simulation tool for the hydro system.
  The tasks developed are the following:
  a) Introduction of the Scottish Power system.
  b) Integration with other planning tools.
  c) Improvements in the SDDP decomposition algorithm.
  d) Flexibility in the time definition of the model scope.
e) Improvement of the model interface and documentation.

• **Improvements on the short-term model considering detailed characteristics of hydroelectric units, and consolidation of the medium-term stochastic tool.**
  The model EXLA is a model for optimal operation and planing of hydropower units and reservoirs in the medium and short term. It has been developed by the IIT in collaboration with the heads of the hydraulic management of the Directorate of Analysis and Risk Management of Endesa. The project is divided into two parts. The first includes the computer tasks related with maintaining the operational license EXLA tool, to support users and upgrade components. The second deals with new development tasks aimed at introducing new features in the model to meet the needs identified as priorities.

• **Models for strategic analysis**
  This project is the continuation of a line of cooperation between IIT and Endesa about Strategic Analysis of Generation Capacity Expansion. The main work is about analysis and improvement of the algorithms and study methods used by Endesa in order to elaborate its yearly expansion plan and other studies associated to it. The result of this work is the tool EXPANDE. Aditionally a new tool (MERCO2) to estimate the price of CO2 emission allowances in under development.

• **Support for planning and assessing in the Iberian Electricity Market**
  This project addresses the operation and planning in the context of the Iberian electricity market. The proposal is framed into the on-going cooperation line followed by Endesa and IIT since 1998. Specifically, AGM 2011 is focused on the development of advanced tools for statistical analysis and the improvement in the wind generation modeling. The interaction with a natural gas operation model and the improvement in the consideration of secundary markets are also addressed in the project. Finally, the project deals with other tasks as the adaptation to the changes in the regulatory framework.

• **MORSE: energy and reserve equilibrium and network constrained equilibrium**
  MORSE is a model of the Spanish electricity sector, developed by the Instituto de Investigación Tecnológica (IIT) in collaboration with Endesa. It is intended for strategic analysis of the evolution of this sector, especially when changes of
Research projects

the utilities structure, new regulations, or new generation technologies take place. Its core are its Conjectural Supply Function Market Equilibriums, at a technology level, with different detail depending on the problem analyzed, that include an algorithm for the endogenous computation of the conjectured supply functions. This collaboration focuses on the following aspects: firstly the simultaneous energy and reserve market equilibrium, to adequately cope with the importance of reserves given the increasing penetration of new interruptible sources of energy, that will required more chronological detail and possibly decomposition techniques; secondly the equilibrium model with network constraints for the modeling of the European framework, with endogenous conjecture computation according to the agents structure and network lines status; finally the improvement of the uncertainty consideration, for example using Montecarlo techniques.

• Operation gas Spanish market

This project is focused on the operation and forecasting in the context of the Spanish natural gas market. In particular, it is expected to improve the prototype that has been developed during the year 2010 with the aim of representing properly the operation in the natural gas market. The first phase of the proyect is focused on the validation of the prototype. Afterwards, some improvements will be incorporated, such as the consideration of supply contracts, the management of LNG vessels, the extension of the physical system, and the introduction of strategic behaviour on behalf of the companies. During the project, the interfaces will be also improved so as to facilitate its use on behalf of the users at Endesa. Finally, it is expected to develop a tool based on Montecarlo in order to take into account the uncertainty.

• Optimal bidding strategies for the secondary reserve market

The primary aim of this project is the development of a set of tools for optimizing the bidding strategy of Endesa in the Spanish secondary reserve market.

• Development of an optimization model for hydropower planning and operation
Acciona Energía S.A. June 2011 - December 2011. (Javier García González, Jesús María Latorre Canteli, Miguel Ángel Fernández Sánchez)

The objective of this project is to expand the functionality of the hydropower planning and operation model developed for Acciona. This tool allows to obtain the optimal planning and operation of hydropower resources in a market environment, both in the short term and in the medium-long term.
• **Additional developments to the model determining the impact of the intermittent generation in the system operation**  
Red Eléctrica de España S.A. September 2011 - December 2011. (Andrés Ramos Galán, Jesús María Latorre Canteli, Luis Olmos Camacho, Kristín Dietrich)

Additional developments for studying the impact of the intermittent generation in the operation of the mainland Spanish system. These developments have been:
* Generation of synthetic series of wind forecasting errors for 14 and 24 hours
* Detailed modeling of exponential startup costs for the thermal units
* Preparation and analysis of the study case of mainland Spanish system for year 2008

• **Quantitative analysis of the impact of a European electricity market on the Iberian market**  
Endesa. September 2011 - December 2011. (Javier Reneses Guillén, Julián Barquín Gil, Mercedes Vallés Rodríguez, Andrés Ramiro Delgadillo Vega)

The main objective of this project is to assess the impact of the future implementation of a European electricity market on the Iberian electricity market (MIBEL). The impact on electricity prices, as well as on generated energy will be quantified. The study will allow to identify the risk and opportunities that will appear for the incumbents agents of the MIBEL.

**4.2.1.1.2 Public funding**

• **Economic and regulatory analysis for an active demand management**  
Consorcio GAD. January 2007 - December 2010. (Pedro Linares Llamas, Juan Rivier Abbad, Carlos Batlle López, Adela Conchado Rodríguez, Pablo Rodilla Rodríguez, Miguel Vázquez Martínez, Renato Dias Bleasby Rodrigues)

The objective of this research project is to perform the economic and regulatory analyses included in the CENIT project for Active Demand Management. This includes an analysis of the economic costs and savings associated to those active demand management actions which may contribute to optimize the net social benefit, i.e., both from the customer and from the system point of view; and an analysis and design of the different regulatory alternatives required to achieve the maximum efficiency levels. To that end, an exhaustive analysis of the international experience in this area is carried out, and an integral model to allow and incentive an active demand management is designed, as well as its implementation strategy.
• **Active distribution networks with full integration of demand and distributed energy resources**

ADDRESS will research, develop and deploy technologies and processes to increase usage of distributed Generation and Renewable Energy Resources thereby engaging in a new relationship between customers, generators and network operators. ADDRESS aims to develop new innovative architectures for Active Distribution Networks (ADN) able to balance in real time power generation and demand allowing network operators, consumers, retailers and stakeholders to benefit from the increased flexibility of the entire system. Innovative use of communications, automation and household technologies will be combined with new trading mechanisms and algorithms providing ADN with low cost and reliable solutions. Customers will be encouraged into active participation enabling them to change their consumption habits, adopting a smarter use of energy and saving money. A cost/benefit analysis of different solutions will be developed: the most promising will be tested in three sites with different geographic, demographic and generation characteristics.

• **SUSPLAN: Development of regional and Pan-European guidelines for more efficient integration of renewable energy into future infrastructure**

The SUSPLAN project is a collaborative Project of the seventh framework programme, included in theme 5: Energy. SUSPLAN will develop, during a period of 3 years, a comprehensive set of robust guidelines for more efficient integration of renewable energy into future infrastructures. These guidelines will address political, infrastructure and network decision makers and power distributors regionally and across Europe.

The guidelines, established on the basis of extensive regional and trans-national scenario studies, consist of strategies, recommendations, criteria and benchmarks for more efficient integration of renewable energy sources (RES) into future infrastructures. The time perspective of the study is 2030-2050, with special emphasis on Pan-European harmonisation.


• **Energy demand, public policies and adaptation**

This research consists of a microeconometric analysis of energy demand, jointly with the demand of capital goods in Spain. Although the analysis will be carried out only for Spain due to data availability, its results can easily be
extrapolated to other countries in Europe, and will provide a sound methodology also applicable in other countries.

- **Optimal integration of distributed energy resources**  
  Ministerio de Ciencia e Innovación. October 2009 - December 2010. (Pablo Frías Marín, Pedro Linares Llamas, Rafael Cossent Arín, Carlos Mateo Domingo, Álvaro Sánchez Miralles, Camila Formozo Fernandes)  
  This project is part of the Singular Strategic Project “Development and implementation of technological alternatives for the Spanish electricity network for 2025”. The following research activities will be carried out within this project: detailed characterization of the distributed energy resources, distributed generation voltage control procurement in distribution networks, integration of active demand side management in the operation systems of network operators, and the development of software tools for the optimal integration of distributed resources in the electrical networks.  
  This project is partially funded by the Ministerio de Ciencia e Innovación and co-funded by FEDER as a Singular and Strategic Project. [More information.](#)

- **Charging strategies for using and integration of renewable sources**  
  The objective of this project is implemented in two levels:  
  On one hand, we are going to model the behavior of the electric system in the long term. To this end the role of the EV in the operation of the electric system is represented in detail. The goal is to evaluate the impact of different levels of penetration of EV in different scenarios and observe the results in the operation of all the generators given a secure and stable system operation.  
  On the other hand, we will study the optimal strategies of the electric system and in particular of the EV to maximize the generation and use of renewable sources.  
  For further details see [http://cenitverde.es/](http://cenitverde.es/)

- **CENIT-VERDE: Characterization, operation modes and grid impact of electric vehicles**  
  REE (Red Eléctrica de España). December 2009 - December 2012. (Luis Rouco Rodríguez, Francisco Miguel Echavarren Cerezo, Alezeia González García)  
  The aim of REE-IIT collaboration is the development of tasks 6.1 and 6.2 of Activity 6 of the CENIT-VERDE project untitled "Integration of electric vehicle loading in the power system: infrastructures, network and services". Precisely, task 6.1 will address the characterization and operating modes of PHEVs and EVs, and task 6.2 will address the impact on the grid of the massive development of PHEVs and EVs.

- **ENERGOS: Models and systems for generation management in microgrids**  
  Indra. December 2009 - December 2012. (Luis Rouco Rodríguez, Francisco Miguel Echavarren Cerezo, Alezeia González García, Lukas Sigrist)
Research projects

This project is a part of the CENIT Energos project leaded by Gas Natural Fenosa on smart grids. Within the framework of the task "Models and systems for generation management in microgrids", IIT team will undertake two sub-tasks: voltage control and reactive power management and load-frequency control in microgrids.

**STORE: Demonstration project on energy storage technologies**
STORE is a demonstration project supported by Fondo Tecnologico of CDTI and led by Endesa. The project will comprise the installation of energy storage systems based on BrZn and NaS batteries and ultracapacitors in power systems of the Canary islands. IIT will contribute in a number of tasks of the technical and economic feasibility studies and experimental analysis.

**Climate Change and Post-2012 Regulatory Regime**
Ministerio de Ciencia e Innovación. January 2010 - December 2012. (Pedro Linares Llamas)
A new regulatory regime of greenhouse gas emissions, to replace the Kyoto Protocol, will be born in 2012. This project is interested, in a context of regulatory prospective and from an economic approximation, in several key issues for the definition, analysis and evaluation of Spanish climate change policies. In particular, the project will deal with the interactions and preferences of climate change instruments, the influence of climate change impacts in the conformation of policies, and the economic and distributional assessment of climate change policies in Spain. First of all, this project will offer a review of the economic literature on international environmental agreements. Although the major objective will be to yield a group of plausible post-2012 policy scenarios, during this phase some research gaps will be identified. In this sense, the project intends to yield advances in the field of game theory applied to climate negotiations between states and blocks. Nevertheless, the main output of this part will be the foundation and specification of simulations (in families of hypothetical scenarios) to be used in subsequent phases. The simulations will consider the main climate architectures under discussion and the existing (EU) regulatory scenarios. A second objective is related to the selection, application and preferences for different instruments that are part of climate change policies. As the problem has a considerable magnitude and extent, being caused by almost every agent, the instruments should be powerful and diverse (including environmental, energy or fiscal tools). However, an accumulation of instruments can be counterproductive in terms of effectiveness and economic efficiency. Therefore, the subproject will deal with the interactions amongst different instruments, both from positive and normative point of views. A third objective is to contemplate the role of inter-temporal preferences and discount rates, of preference assessment with respect to prevention and mitigation policies, as well as of other environmental impacts not previously studied, in the conformation of climate change policies and their modeling strategies. Finally, this project has as an objective the scenario-based study of the environmental, economic and distributional effects from the
application of different policies of climate change in Spain. With that in mind, the project integrates different methodologies and data. As a central core, a dynamic applied general equilibrium model for Spain will provide the main macroeconomic effects, although other models will be used to solve the problems related to the scarce data given to some key sectors or agents. An integrated use of a microsimulation model to contemplate the reactions and distribution of regulatory burden across households, and a detailed model of the Spanish electricity system (origin of most of the emissions) will quantify the impacts in that sector. Thus the project intends to increase the knowledge of matters that have traditionally been overlooked in Spain (at least with respect to European standards). We believe that the project responds both to a clear academic interest (in a growing discipline in Economics) and to the need to provide rigorous answers to regulators and other social agents in a major socio-economic field.

- **MERGE - Mobile Energy Resources in Grids of Electricity**

  Electric power systems are facing a major new challenge (and hence opportunity): future massive integration in the electric grid of electric plug-in vehicles (EV). Distribution and transmission grids and power system architectures still follow planning rules and procedures defined for the traditional operational paradigm. MERGE project will identify and prepare solutions for the operational problems that will be caused on the electric grid, to the generation sub-system and to its commercial operation as a result of progressively increasing deployment of EV.

  The conceptual approach involves the development of a methodology consisting of two synergetic pathways: - development of a management and control concept that will facilitate the actual transition – the MERGE concept; - Development of an evaluation suite that consists of methods and programs of modelling, analysis, and optimization of electric networks into which electric vehicles and their charging infrastructure is integrated.


- **Transmission system operation with large penetration of Wind and other renewable Electricity sources in Networks by means of innovative Tools and Integrated Energy Solutions**

  The aim with this project is to develop demonstration projects that will make it possible to overcome several obstacles regarding a larger integration of wind power, and its contribution to the operation of the power system. A group of 6 Transmission System Operators (Belgium, Denmark, France, Germany, The Netherlands and Spain) with 2 generator companies, 5 manufacturers and
The IIT is involved in different work packages of the project in three areas of activity: technological, economic and regulatory. One task is to support Iberdrola Renovables, responsible for the demonstration which will be checked frequently-active and reactive voltage-aggregation of wind farms. In addition, the IIT will lead the work package which will evaluate what is the technical-economic impact of the June demonstrations on the various countries, there will be a cross-sectional analysis of all of them to maximize European added value of the project, identify barriers that prevent scaling the results of the demonstrations, and propose solutions to eliminate these barriers, such as new rules for the regulation of electricity markets.

• **ENERGOS: Technologies for the automatic and intelligent management of future distribution networks**
  The main objective of the ENERGOS Project is to develop knowledge and technologies to move towards the implementation of Smartgrids. The ENERGOS project is within the CENIT Program 2009. Gas Natural and Union Fenosa are the leaders of the Project, and many leading Spanish electricity companies integrate the Project consortium. The IIT will collaborate with Unión Fenosa in different tasks. Firstly, barriers for the implementation of Smartgrids and its economic assessment will be analyzed. Then, the economic involvement and barriers for the integration of micro-generation in active demand management will be studied. Finally, an economic and regulatory analysis on the metering of different end-user services using the electricity network will be performed.

• **A model of the GHG emission sectors in Spain**
  Ministerio de Medio Ambiente y Medio Rural y Marino. September 2010 - March 2011. (Pedro Linares Llamas, Alberto Santamaría Barroso)
  The goal of the project is to develop a decision-aid tool which allows to analyze potentials and costs of CO2 mitigation in different sectors and technologies in Spain, and which in turn may allow to design mitigation strategies at a national level, through an appropriate combination of sectoral and technological goals.

• **Future scenarios and global sustainability indicators for a sustainable and self-sufficient biocity (BIOCAS)**
  Iberdrola Ingeniería y Construcción. January 2011 - December 2013. (Pedro Linares Llamas, Yolanda González Arechavala, Ana María Santos Montes, Carlos Martín Sastre, José Carlos Romero Mora)
  The objectives of the project are twofold, although very much related. On the one hand, we define future scenarios to make them compatible with the structural scenarios assumed for biocities, and to assess the behavior of the
biocity for each of them. We also assess the contribution of algi to biocities and to the general environment of the scenarios proposed. On the other hand, we propose a set of global sustainability indicators for biocities, considering energy and environmental sustainability indicators, and also introducing economic, social or human capital indicators.

- **Design and impact of a harmonised policy for renewable electricity in Europe**

  The work will comprise a detailed elaboration of feasible policy approaches for a harmonisation of RES support in Europe, involving five different policy paths - i.e. uniform quota, quota with technology banding, fixed feed-in tariff, feed-in premium, no further dedicated RES support besides the ETS. A thorough impact assessment will be undertaken to assess and contrast different instruments as well as corresponding design elements. This involves a quantitative model-based analysis of future RES deployment and corresponding cost and expenditures based on the Green-X model and a detailed qualitative analysis, focussing on strategic impacts as well as political practicability and guidelines for juridical implementation. Aspects of policy design will be assessed in a broader context by deriving prerequisites for and trade-offs with the future European electricity market. The overall assessment will focus on the period beyond 2020, however also a closer look on the transition phase before 2020 will be taken.

  The final outcome will be a fine-tailored policy package, offering a concise representation of key outcomes, a detailed comparison of pros and cons of each policy pathway and roadmaps for practical implementation. The project will be embedded in an intense and interactive dissemination framework consisting of regional and topical workshops, stakeholder consultation and a final conference.

### 4.2.1.2 Consultancy and technological support

#### 4.2.1.2.1 Private funding

- **Consultancy on modal analysis, model reduction and damping inter-area oscillations**
  RTE (Gestionnaire du Réseau du Transport d’Electricité). December 2007 - November 2010. (Luis Rouco Rodríguez)

  This project consists of providing RTE consultancy services in the fields of modal analysis, model reduction and damping inter-area oscillations. RTE requires these services in the framework of a number of studies perform for the UCTE.

- **Maintenance and new capabilities for Viesgo Tools 2009 a 2010**
The aim of this project consists of incorporating new capabilities identified by Viesgo that might be required due to the market evolution (regulatory and operational changes). The computer tools developed for Viesgo by IIT are GRIMEL, GRIMEL CORTO PLAZO, PLAMER OFERTAS and PLAMER CASACION. GRIMEL OFERTAS creates the bids that Viesgo submits into the market. GRIMEL CORTO PLAZO plans the electricity production by Viesgo assess in a variable time scope (from one week to a month), and PLAMER OFERTAS and PLAMER CASACION simulates the electricity market with an annual time scope.

• **Improvements, maintenance and support on the use of the Distribution Network Reference Models of the Spanish National Electricity System**
  The aim of this project is to continue providing support and maintenance in the use of the network reference models of the national electricity system under two different versions: i) the basic model, and ii) the incremental model. These two models are used by the CNE as an input to determine the allowed revenues of the electricity distribution companies.

• **Technical assistance in the factory and site tests of AGC system for the energy management system of Cepsa**
  Núcleo. April 2010 - December 2010. (Luis Rouco Rodríguez, Fidel Fernández Bernal, Ignacio Egido Cortés, Inmaculada Saboya Bautista)
  This work will provide technical assistance during the factory and site tests of the AGC system developed by IIT for the energy management system of Cepsa supplied by Núcleo. Factory tests will be performed in the Eliop headquarters. Site tests will be performed in the Cepsa zone.

• **European Energy Markets Conference 2010**
  The international conference European Energy Markets 2010 has taken place in Madrid, Spain, from June 23, 2010 until June 25 2010. This premium event in the world of energy markets provides an ideal venue where academia and industry can meet. The attendance was over 150, primarily from Europe. The conference consisted of speeches by several important keynote speakers from both industry and academia and more than 100 conference papers in several parallel sessions.

• **Study of losses between measurement points and frontier points**
  REE (Red Eléctrica de España). May 2010 - November 2010. (Luis Rouco Rodríguez)
The purpose of this study is the review of the computing methods of the Operational Procedure (Grid Code) 10.5 of the Spanish System Operator concerning the estimation of the generation/load in the frontier points from the generation/load in the measurement points. It will also address the assignment of losses to each individual generator/load.

- **Design of the frequency load-shedding schemes of the Canary islands systems**
  REE (Red Eléctrica de España). July 2010 - January 2011. (Luis Rouco Rodríguez, Ignacio Egido Cortés, Lukas Sigrist)
  The aim of this project is the design of frequency load shedding schemes of the isolated power systems of the Spanish Canary Islands (Gran Canaria, Tenerife, Lanzarote-Fuerteventura, La Palma, La Gomera and El Hierro). The feasibility of centralized load shedding schemes will be explored as well.

- **Test specification of the turbogenerator stator bars of Puentes de García Rodríguez thermal station**
  Riesgos, Tasaciones y Servicios, S.A. July 2010 - July 2011. (Luis Rouco Rodríguez)
  This work provided technical assistance to the test specification of the spare stator bars of Puentes de García Rodríguez thermal station.

- **Feasibility study and specification of a fast start system of gas turbines for secondary regulation**
  Endesa. September 2010 - August 2012. (Luis Rouco Rodríguez, Fidel Fernández Bernal, Ignacio Egido Cortés, Eugenio Francisco Sánchez Úbeda, Inmaculada Saboya Bautista)
  The aim of this project is to study the development of a fast start system of hydro units for secondary frequency regulation. The purpose of such system is the optimization of the provision of the secondary frequency regulation ancillary service.

- **Development of new functions of a tool for computing electrical losses in power networks of wind farms**
  Indra. November 2010 - May 2011. (Luis Rouco Rodríguez)
  The aim of the project is the collaboration with Indra development of new capabilities of a tool for computing electrical losses in power networks of wind farms for Iberdrola Renovables. Electrical losses will be determined in hourly and yearly scenarios.

- **Evaluation of proposals of change of secondary regulation ancillary service**
  Endesa. November 2010 - February 2011. (Luis Rouco Rodríguez, Fidel Fernández Bernal, Ignacio Egido Cortés)
  The aim of this project is to study the proposal of change of the secondary regulation service. Precisely, it will be investigated the impact on the secondary regulation energy and on the frequency of changing hourly step-wise programs to ramp-wise programs.
• **Study on the disturbance occurred in Argüelles substation of June 22, 2010**  
  Iberdrola Distribución Eléctrica. December 2010 - December 2010. (Luis Rouco Rodríguez)  
  This project has studied the disturbance occurred on Majadahonda substation of June 22, 2010.

• **Review of the state of the art of technical problems in weak networks**  
  The aim of this project is the review of the state of the art of technical problems in weak networks.

• **Development of the dynamic model of the solar photovoltaic inverter of W2PS**  
  Wind to Power System S.L. February 2011 - April 2011. (Luis Rouco Rodríguez, Lukas Sigrist)  
  The aim of this project has been the development of a simulation model of the solar photovoltaic inverter of W2PS.

• **The New Planning Operation Model for the Brazilian Hydrothermal System**  
  Technical support in the definition of the technical specification of a medium-term hydrothermal scheduling model for the Brazilian electric system.

• **Analysis of the storage problems in renewable resources**  
  Technical support in the definition of the technical specification of a short-medium-term operation model for the Italian electric system with emphasis in representing storage systems.

• **AGC system for the energy management system of ALPIQ**  
  IIT has developed an AGC zone regulator adapted for Spanish AGC system. This project comprises the supply of the AGC zone regulator and its incorporation to the SCADA system that Nucleo under subcontract of Atos develops for ALPIQ. This work will also provide technical assistance during the factory and site tests of the AGC system developed by IIT for the energy management system of ALPIQ supplied by Nucleo (Nucleo is a subcontractor of Atos). Factory tests will be performed in the Nucleo headquarters. Site tests will be performed in the ALPIQ zone.

• **Collaboration with Inesc in the transient stability-voltage control study of the Portuguese transmission system on 2014**  
  INESC. April 2011 - December 2011. (Luis Rouco Rodríguez, Lukas Sigrist)
In this project, IIT collaborates with INESC-Porto in a transient stability and voltage control study of the Portuguese national transmission network under year 2014 scenario for REN. IIT contribution is around tasks 1.2, 1.3 and 1.4 of phase 1 of the project proposed by INESC to REN. The objective of each of the above mentioned tasks is respectively: review of available FACTS technologies; selection of FACTS technologies; and elaboration of phase 1 report.

• **Southern Tenerife Railway: Study of the Tenerife Transmission network**
  This project is aimed at simulating the Tenerife transmission network with the loads due to the Southern Tenerife Railway. Transmission lines, substations and transformers needed to supply railway loads will be included in the model of Tenerife power system.

• **Transients due to the Connection of a Capacitor Bank at Mihai Viteazu Wind Farm**
  Iberdrola Ingeniería y Construcción. September 2011 - September 2011. (Luis Rouco Rodríguez)
  This study is aimed at determining the transients due to the connection of a capacitor bank at Mihai Viteazu wind farm. The study on the transients due to the connection of a shunt capacitor bank determines the maximum overvoltages at the high and medium voltage busbars due to the connection of shunt capacitor bank at the wind farm medium voltage busbar. The high and medium voltage line overcurrents will be also determined. The natural frequencies of the oscillations will be also provided.

• **Development of the dynamic model of a variable speed hydraulic generator-motor set**
  Endesa. September 2011 - October 2011. (Luis Rouco Rodríguez, Ignacio Egido Cortés, Lukas Sigrist)
  The aim of this project is the development of a response simulation model of a variable speed hydraulic generator-motor set connected to the grid through power electronic converters and that can represent both doubly fed induction and synchronous machines. Response models represent performance requirements demanded by grid operators to manufacturers.

• **Development of the dynamic model of the W2PS STATCOM**
  Wind to Power System S.L. September 2011 - October 2011. (Luis Rouco Rodríguez, Lukas Sigrist)
  The aim of this project has been the development of a simulation model of W2PS STATCOM.
4.2.1.2.2 Public funding

- **Advisory activities to the European Parliament on energy and climate policies**
  This project consists in providing external expertise on energy and climate change policy to the Committee on Energy, Research and Industry (ITRE) in the form of briefings, studies and workshops.

- **A Think Tank Hosting an Interdisciplinary Network to provide Knowledge support to EU Energy Policy Making**
  European Commission. June 2010 - June 2013. (José Ignacio Pérez Arriaga, Julián Barquín Gil)
  The three year coordinating action THINK will improve the knowledge support to policy making by the European Commission in the context of the Strategic Energy Technology Plan. THINK is organized around a multidisciplinary group of 24 experts covering five dimensions of energy policy: science and technology, market and network economics, regulation, law, and policy implementation. The Think Tank will respond to the European Commission’s evolving needs on a semester basis and produce 12 dossiers and a book.

- **Assessment on Electricity system Dispatch model tools for better integration of renewable energy into regionally interconnected national grids**
  World Bank, Mercados EMI. April 2011 - June 2011. (Pedro Sánchez Martín, Andrés Ramos Galán, Jesús María Latorre Canteli)
  Inside the World Bank project “Multi-Donor Trust Fund (MDTF) for Addressing Climate Change in the MENA Region - Electricity system planning tools for better integration of renewable energy into regionally interconnected national grids”, it is necessary an assessment on Electricity system Dispatch model tools for better integration of renewable energy. This project contains a Review of the State of the Art of commercial and researching Power System Dispatch Models. In addition, it contains a qualitative specification of additional characteristics of Dispatch Model to cope with a high integration of renewable energy (wind and solar). Finally, the project includes a comparison study of these Dispatch model characteristics with respect to the current ones in operation at Morocco, Argelia and Tunisia. This project has been done in collaboration with a broader equipment that has analyzed other aspects of the World Bank project coordinated by the company AF-MERCADOS EMI.

- **European Renewable Energy Network**
  This project carries out an analysis of existing network expansion plans related to the integration of RES energy, as well as of those academic and consultant analyses on this same topic. Benefits resulting from the construction of this infrastructure are discussed. Finally, we propose to implement some regulatory
changes aimed at overcoming existing barriers to the construction of the required infrastructure.

4.2.2 Engineering Design Area

4.2.2.1 Research and develop projects

4.2.2.1.1 Private funding

- **Fatigue analysis of the water supply nozzles**
  The goal of the project is to perform a fatigue analysis of the water supply nozzles for a specific nuclear power plant and compare the results with the current fatigue monitoring system.

4.2.2.1.2 Public funding

- **IDEA Study of the mechanical and environmental impact of using mixtures of bioethanol and fossil fuels (diesel) in a captive transport float in Seville**
  Tussam, Municipal public transport society of Seville has the intention of use different mixtures of bioethanol and diesel in a short number of transport public busses. The engine behaviour and the environmental impact of the new fuel are going to be studied taking as reference the existing experience.

- **Advanced thermal management in aeronautics**
  This project is a viability study for a possible use of Loop Heat Pipe (LHP) in aircraft. They are passive systems that transfer energy between certain subsystems of the aircrafts without the need of additional power consumption.

- **Economic and Environmental assessment studies of energy crops**
  Ministerio de Ciencia e Innovación. January 2009 - June 2012. (Yolanda González Arechavala, Francisco Nieto Fuentes, Ana María Santos Montes, Carlos Martín Sastre)
  On Cultivos is a Singular and Strategic Project for Development, Demonstration and Evaluation of the Viability of the Commercial Production of Energy from Dedicated Crops in Spain. On Cultivos has been recognized and supported as a national singular and strategic project by the Spanish Ministry of Education and Science.
On Cultivos is a coordinated effort of enterprises, universities and R&D organisms to achieve the commercial deployment of energy crops in Spain following the objectives of the present policy on renewable energies. The purpose of the subproject "Economic and Environmental Assessment of energy crops" is the analysis and assessment of environmental impacts using the methodology of Life Cycle Analysis (LCA) and economic evaluation of the different stages of the main energy crops. IIT is responsible for the completion of life cycle analysis (evaluating the energetic and environmental impact, as GHG emissions, water use, soil effects...) and economic analysis of liquid biofuels from cultivation to its use in the vehicle (WTW, Well to Wheel), both for bioethanol and biodiesel.

- **Simulation of the wind effect on the catenary-pantograph interaction of high-speed trains**

The project aims to increase the little current knowledge that exists on the wind effect on the contact wire of railway catenaries and its influence on the dynamic interaction catenary-pantograph. Despite the fact that wind effect on cables is quite well-known, however, there is no much information about the wind effect on the dynamic interaction between catenary and pantograph and how the galloping of the catenary can affect this process. This subproject tries to obtain numerical models that provided with experimental data allow to understand the real effect of this phenomenon on the contact force between the catenary and the pantograph. The contact force between these two systems determines the quality of the energy collection. On one hand this contact force should be high enough to guarantee that there are no contact losses in order to avoid the production of electric arcs and the consequent damage in the contact wire and the pantograph. On the other hand, the contact force should lower enough in order to decrease the wear of the elements of the collecting system. Hence, the interest of studying the phenomenon of the vertical oscillations produced by the lateral wind. The models obtained would help to understand the effect of this phenomenon and its relationship with the different geometrical and mechanical parameters of the railway overhead.

The aim of the project is to make an approach to the problem at two levels: the first one will consist of simplified models, computationally economics, that allow the understanding of the basic physics of the problem and the second one will develop more complex models and with a high computational cost that allow to learn about the cases which are considered of interest using a more realistic approach.

- **Future scenarios and global sustainability indicators for a sustainable and self-sufficient biocity (BIOCAS)**
  Iberdrola Ingeniería y Construcción. January 2011 - December 2013. (Pedro Linares Llamas, Yolanda González Arechavala, Ana María Santos Montes, Carlos Martín Sastre, José Carlos Romero Mora)
The objectives of the project are twofold, although very much related. On the one hand, we define future scenarios to make them compatible with the structural scenarios assumed for biocities, and to assess the behavior of the biocity for each of them. We also assess the contribution of algi to biocities and to the general environment of the scenarios proposed. On the other hand, we propose a set of global sustainability indicators for biocities, considering energy and environmental sustainability indicators, and also introducing economic, social or human capital indicators.

4.2.2.2 Consultancy and technological support

4.2.2.2.1 Private funding

- **Ausbildung in Koordinaten Messtechnik**
  AUKOM. July 2009 - July 2011. (María Ana Sáenz Nuño)
  Objective of the organisation - Manufacturer-neutral training in coordinate metrology:
  The objective of the "Ausbildung Koordinatenmesstechnik e. V. - AUKOM" is to ensure an up-to-date, comparable, controllable and certifiable training in coordinate metrology in accordance with its capabilities. The organisation promotes the basic, comprehensive and solid training in the area of industrial production metrology, in particular in the area of coordinate metrology. The organisation ensures the standard and comparability of the courses offered by the members of the organisation within the coordinate metrology training. It organizes events for promoting the exchange between manufacturers, users and science in the area of coordinate metrology training and publishes new findings and trends from this area. It develops, promotes and spreads the "good measurement practice" and furthers the Europeanisation of cooperation in coordinate metrology training.
  The IIT will control the training in Spanish.

- **Electricity consumption simulation of a heating & cooling system**
  Electricity consumption simulation, during a whole year, of a heating & cooling system for a commercial building.

- **Dimensional metrology spanish standardization comittee**
  AENOR. October 2010 - December 2011. (María Ana Sáenz Nuño)
  Management of the Technical Secretary of the Dimensional metrology spanish standardization comittee and the development of the technical expert delegation in the mirror ISO comittee.

- **Kinematic simulation of the vertebral column**
  Javier Pereiro. February 2011 - September 2011. (Álvaro Sánchez Miralles, Ángel de Andrés Martínez)
The aim of the project consists in making a kinematic simulation of the vertebral column, just after the application of a patented mechanism.

4.2.3 Railway Systems Area

4.2.3.1 Research and develop projects

4.2.3.1.1 Private funding

• Traffic regulation system for FGV - Metro de Valencia
  The objective of this project is the functional specification and design of the new traffic regulation system for suburban of Valencia-FGV, as well as the validation of the functionality once the system is in service. The system will be validated analysing the historical data generated by the new regulation system.

• Regulation system for automatic driving of high speed trains
  The goal of this project is the design and development of a regulation system for automatic driving of high speed trains, in order to fulfill the programmed schedule in an efficient way.

• Increasing the capacity of the railway line Barcelona - Vallès de FGC
  In previous projects studies have been carried out about railway capacity, train timetable planning and train headways. These studies had finished in 2009 with a new timetable of 32 trains per hour in Plaza de Catalunya, after improving the signaling systems in some points of the railway net.
  In this project new studies will be carried out with the aim of increasing the railway capacity to 40 trains per hour in Plaza de Cataluña in the year 2015. For that, new improvements in the signaling system will be considered, as well as the modification of the tracks and new operation patterns needed to reach that goal.

• WSP: Wheel Slide Protection
  Train Automatic Solutions In Out, S.L. January 2011 - July 2011. (Ramón Rodríguez Pecharramón, Francisco Nieto Fuentes, Álvaro Jesús López López)
  The aim of this project is the development of a new Wheel Slide Protection (WSP) algorithm for trains. The WSP device has the role of optimizing the train braking, preventing wheels from locking and minimizing the stopping distance. Train braking capacity depends strongly on the wheel/rail adhesion, which in turn depends on the weather conditions, the train speed, etc. The WSP temporarily reduces the braking force, so preventing wheels from locking. This
project focuses on the development of the WSP algorithm and its performance assessment by using a simulator test rig.

- **Design of the planning and control traffic system of Metro de Málaga**  
  In this project centralised planning and control systems are designed for the Metro de Málaga Control Center. The systems are parametrised and the performance is evaluated.

4.2.3.1.2 Public funding

- **Efficient technologies for urban transport- ecodriving. Algorithms for the generation of ecodrivings in the control centre**  
  The objective of this project is the development and implementation of new ecodriving models to design efficient manual driving to be included in the control centre. The models calculate the ecodriving for a specific track section, a train, and the commercial timetable, minimising the energy consumption. As a result, the list of efficient commands to be executed is provided.

4.2.3.2 Consultancy and technological support

4.2.3.2.1 Private funding

- **Control center requirements of high-speed railway power system**  
  ADIF. December 2007 - December 2010. (José Antonio Rodriguez Mondéjar, Yolanda González Arechavala, Eduardo Pilo de la Fuente, Rafael Santodomingo Berry)  
  The operational and commercial needs of the Spanish railway operator (ADIF) require power control center to not only perform traditional functions (supervisory & control) but also support many of the new functions, specifically to meet the needs of competition with deregulation. The aim of this project is to establish the requirements of new high speed railway power control centers. The proposal architecture must take into account the requirements of real-time data, security, availability, scalability, information exchange, etc.
4.2.4 Intelligent Systems Area

4.2.4.1 Research and develop projects

4.2.4.1.1 Private funding

- Monitoring and diagnostic analysis of the Spanish electricity market
  Endesa. January 2010 - December 2010. (Eugenio Francisco Sánchez Úbeda)
  The primary aim of this project is the consolidation of a methodology for the analysis of the Spanish electricity market operation and the characterization of participants bidding strategies. In particular, a new information system implementing this methodology will be developed.
  Taking as input the information published by the Market and System Operators, the proposed methodology establish the most appropriate mechanisms of advanced analysis for its treatment, with the purpose of analyzing the bidding behaviour of firms and their pricing of the different generation technologies.

- MORSE: strategic analysis of the Spanish electricity sector. Equilibrium with network and zonal constraints, new technologies and relationships with other industrial sectors
  MORSE is a model of the Spanish electricity sector, developed by the Instituto de Investigación Tecnológica (IIT) in collaboration with Endesa. It is intended for strategic analysis of the evolution of this sector, especially when changes of the utilities structure, new regulations, or new generation technologies take place. Its core is EQUITEC, a Conjectural Supply Function Market Equilibrium, where the generation has been represented at the technology level, instead of considering generation units individually. EQUITEC includes an algorithm for agents conjectures computation based on local linearity and robustness against small demand changes. MORSE also has tools for histograms computations based on Montecarlo, objectives optimization based on genetic algorithms, and optimal determination of the technologies definitions and of the demand load levels of the market model. This collaboration focuses on the extension of EQUITEC to include network and zonal constraints, the modeling of renewable and other emerging technologies, and the approach to other industrial sectors closely related with the electricity sector, to improve MORSE forecasting results.

- DELFOS-E: Short-term forecasting of the Spanish natural gas consumption of the combined cycle power plants
  Enagas, the technical operator of the Spanish natural gas system, is in charge of planning the short-term operation of this system to ensure the continuity and quality of natural gas supply at any point in Spain. In order to carry out this coordination and optimisation work for the joint operation of the whole system, Enagas needs short-term forecasts of the natural gas consumptions at different
points of the pipeline network. Conventional demand for natural gas (which includes household, commercial, industrial and cogeneration consumption) is properly forecasted by Enagas using specific tools developed for that purpose. However, during the last decade the demand for electricity generation has gained importance due to the increase of the number of combined cycle power plants. This demand responds to different consumption patterns, requiring a different type of forecasting models.

DELFOS-E is a tool designed for short-term forecasting of the Spanish natural gas consumption of the combined cycle power plants. The developed forecasting models use as input variables, among others, those provided by the Spanish electricity system and market operators.

- **Quantitative analysis of the deviations of the Spanish Electric Power System**
  EGL Energía Iberia, S.L. September 2010 - December 2010. (Antonio Muñoz San Roque, José Villar Collado, Rocío Herranz Pindado)

  The main objective of this project is to conduct a quantitative analysis of the deviations of the Spanish Electric Power System, in order to develop a predictive model able to estimate the sign of the hourly deviations as a function of past deviations and a set of explanatory variables.

- **Power generation asset management based on continuous life monitoring in the new context of high renewable energy penetration**
  Iberdrola. October 2010 - September 2012. (Miguel Ángel Sanz Bobi, Antonio Muñoz San Roque, Jesús Ángel García Matos)

  In this PhD project a model for anomaly detection and diagnosis in industrial processes and components of the energetic sector will be developed. Its major advantage will be to anticipate anomaly’s evolution, what involves a major shift in asset management. The proposed model will also anticipate the impact of these anomalies, both failures and efficiency losses. This will ensure the reliability and quality of the service while avoiding the economic, social and environmental costs resulting from power cuts, accidents or loss of energy efficiency that can cause failures in a power generation plant.

- **Analysis and identification of improvements in the forecasting and bidding process for the Spanish secondary reserve electricity market**
  Endesa. October 2010 - December 2010. (Eugenio Francisco Sánchez Úbeda)

  The aim of this project is the review of the algorithms and procedures used by the Secondary Reserve Forecasting System (SIPREBAN), in order to identify possible improvements. This system was developed by IIT for the Spanish utility Endesa in 2005.

- **Aggregation control center II**
Research projects

The project consists of developing an application for controlling and monitoring several electrical vehicles. This application communicates with an embedded system onboard the car. The main objective of the application is to control the state of charge of each vehicle while the constraints of an energetic dispatch are accomplished.

- **SCIA system with a prediction model**

  The project consists of developing an application embedded in a PC104 board with Linux as operative system. It is installed in an electric vehicle. This application allows both managing the vehicle energy, and monitoring the state of the car and batteries. A mobile telephone is the user interface of the whole system. Besides, it communicates with an aggregator control centre.

- **Application of data mining techniques for the monitoring and analysis of the Spanish electricity market**
  Endesa. January 2011 - December 2011. (Eugenio Francisco Sánchez Úbeda)

  The primary aim of this project is the improvement of the information system and the methodology implemented for the analysis of the Spanish electricity market operation and the characterization of participants bidding strategies. Taking as input the information published by the Market and System Operators, the proposed methodology establish the most appropriate mechanisms of data mining for its treatment, with the purpose of analyzing the bidding behaviour of firms and their pricing of the different generation technologies.

- **MORSE: energy and reserve equilibrium and network constrained equilibrium**

  MORSE is a model of the Spanish electricity sector, developed by the Instituto de Investigación Tecnológica (IIT) in collaboration with Endesa. It is intended for strategic analysis of the evolution of this sector, especially when changes of the utilities structure, new regulations, or new generation technologies take place. Its core are its Conjectural Supply Function Market Equilibriums, at a technology level, with different detail depending on the problem analyzed, that include an algorithm for the endogenous computation of the conjectured supply functions. This collaboration focuses on the following aspects: firstly the simultaneous energy and reserve market equilibrium, to adequately cope with the importance of reserves given the increasing penetration of new interruptible sources of energy, that will required more chronological detail and possibly decomposition techniques; secondly the equilibrium model with network constraints for the modeling of the European framework, with endogenous conjecture computation according to the agents structure and network lines status; finally the improvement of the uncertainty consideration, for example using Montecarlo techniques.
• **Optimal bidding strategies for the secondary reserve market**

  The primary aim of this project is the development of a set of tools for optimizing the bidding strategy of Endesa in the Spanish secondary reserve market.

• **Short term electricity and secondary reserve price forecasting**
  ALPIQ. March 2011 - April 2011. (Antonio Muñoz San Roque, Rocío Herranz Pindado)

  The main objective of this project is the development of a short term (24 to 168 hours) forecasting model for the Spanish day ahead electricity and secondary reserve market prices.

• **Integration of forecasting tools at Enagas. Application to the medium-term forecasting tool for conventional demand**
  Indra. June 2011 - September 2012. (Eugenio Francisco Sánchez Úbeda, Alberto Gascón González)

  Enagas, the technical operator of the Spanish natural gas system, is in charge of ensuring the continuity and quality of natural gas supply at any point in Spain. Enagas uses specific forecasting tools developed for that purpose.

  The aim of this project is to develop an integrated forecasting system able to provide a coordinated view of the different forecasting time scales (short, medium and long term horizons). This process will start with the integration of PATRONES, the medium-term forecasting tool of Enagas for the conventional demand.

4.2.4.1.2 Public funding

• **System based in a small helicopter and mobile robots for efficient generation of resources maps. Application to the precise spreading and minimization of pesticides**
  Ministerio de Educación y Ciencia. October 2007 - July 2011. (Álvaro Sánchez Miralles, Juan Luis Zamora Macho, Rafael Palacios Hielscher, Cesáreo Fernández Martínez, Manuel Alvar Miró, Álvaro Arranz Domingo, José Porras Galán, Fidel Fernández Bernal)

  This project will develop a system to generate georeferenced fumigation maps of crops that will help farmers in getting better product, reducing expenses in pesticides and minimizing environmental impact.

  The system comprises a small helicopter, autonomous ground vehicles and a central station. The helicopter is equipped with remote control, motion/position sensors, auto-pilot electronics, wireless communication and digital cameras. The ground vehicles are unmanned autonomous robots used as georeferenced landmarks. They are equipped with navigation devices (GPS or Galileo) and linked wirelessly to communicate their position. The central station is a laptop computer in charge of the system coordination during image acquisition and
Communicates with the helicopter and ground vehicles. After data acquisition, it performs image processing to generate fumigation maps.

In order to make the system efficient and feasible (low cost) for extensive utilization, the project includes the development of control algorithms to help helicopter maneuvers, such as hover, and also the development of mobile ground landmarks that allows for immediate field analysis without requiring manual installation of fixed georeferenced marks. Previous work of the research team has demonstrated the feasibility of obtaining fumigation coordinates from georeferenced aerial images.

- **Standard advanced toll (2nd phase): Development and integration of the modular system**
  Ministerio de Industria Turismo y Comercio. January 2009 - December 2010. (Eugenio Francisco Sánchez Ubeda, Rafael Palacios Hielscher, Miguel Ángel Sanz Bobi, José Villar Collado, Antonio Muñoz San Roque, Cristian Andrés Díaz Durán)

  The project is oriented to develop a system capable of improving the reliability and maintenance management of toll facilities. It covers the case of channeled tolls and the case of free flow tolls, which require different approaches. The tool is based on multiagent technology for the detection of anomalies, diagnosis of components and maintenance management. From the results of the diagnostic system a list of maintenance actions is generated, and then it is sorted intelligently in order to reduce displacements and costs.

  Reference TSI-020100-2009-844

- **Retailer's management system for electric vehicles**

  The project consists of the development of a retailer's management system for the electric vehicles. Two main tasks should be done: the first one is to develop an intelligent system for optimizing offers in energy markets and in the ancillary services market, and the second one consists of identifying the different agents involve in the management of the electric vehicles.

- **SMARTCITY: Alignment with the DENISE project**
  Endesa. October 2009 - March 2013. (Álvaro Sánchez Miralles, Álvaro Arranz Domingo, Miguel Ángel Sanz Bobi)

  The aim of the project is to determine what aspects of the DENISE project could be used in the SMARTCITY project, exploiting synergies between both projects. Besides, activity monitoring of the SMARTCITY will be done, in order to assure an efficient alignment with the DENISE project.
4.2.4.2 Consultancy and technological support

4.2.4.2.1 Private funding

- **Agregation control center**
  The project consists of developing an application for controlling and monitoring several electrical vehicles. This application communicates with an embedded system onboard the car. The main objective of the application is to control the state of charge of each vehicle while the constraints of an energetic dispatch are accomplished.

- **Embedded system for the energy management of electrical vehicles**
  The project consists of developing an application embedded in a PC104 board with Linux as operative system. It is installed in an electric vehicle. This application allows both managing the vehicle energy, and monitoring the state of the car and batteries. A mobile telephone is the user interface of the hole system. Besides, it communicates with an aggregator control centre.

4.2.5 Electronics and Automatic Group

4.2.5.1 Research and develop projects

4.2.5.1.1 Private funding

- **WSP: Wheel Slide Protection**
  Train Automatic Solutions In Out, S.L. January 2011 - July 2011. (Ramón Rodríguez Pecharromán, Francisco Nieto Fuentes, Álvaro Jesús López López)
  The aim of this project is the development of a new Wheel Slide Protection (WSP) algorithm for trains. The WSP device has the role of optimizing the train braking, preventing wheels from locking and minimizing the stopping distance. Train braking capacity depends strongly on the wheel/rail adhesion, which in turn depends on the weather conditions, the train speed, etc. The WSP temporarily reduces the braking force, so preventing wheels from locking. This project focuses on the development of the WSP algorithm and its performance assessment by using a simulator test rig.

- **Evaluation of hybrid active power filters by simulationion**
  RTR Energía S.L. May 2011 - September 2011. (Aurelio García Cerrada, Juan Luis Zamora Macho, José Daniel Muñoz Frías, Pablo García González, Javier Roldán Pérez)
  This project will evaluate the main characteristics of a hybrid active power filter and will prepare a detailed estimate for a pre-industrial prototype. This estimate will include the participation of COMILLAS-IIT in that prototype.
The present project will consist of the following tasks:
(1) Literature survey of hybrid active power filter topologies.
(2) Preparation of a detailed simulator for a hybrid active power filter based on
MATLAB-SIMULINK. This simulator will include ideal switches, passive
components, control algorithms and a simplified power-system model.
(3) Simulation of realistic scenarios.
(4) Preparation of a detailed estimate for a pre-industrial prototype of a hybrid
active power filter.

4.2.5.1.2 Public funding

• IEC 61850 within the Framework DENISE (Intelligent, Secure and Efficient
distribution of electricity)
TELVENT. October 2007 - December 2010. (José Antonio Rodríguez Mondéjar,
Sadot Alexandra Fernández, Carlos Rodríguez-Morcillo García, Rafael
Santodomingo Berry, Íñigo Ramiro González, Javier Juárez Montojo)
The project CENIT-DENISE is a project financed by CDTI developed by a
consortium of firms and research centers whose objective is the research of the
future electricity networks that will enable an intelligent, secure and efficient
production and distribution of electricity. The consortium is headed by Endesa
Servicios.
The activities around IEC 61850 within DENISE corresponds with subtasks 3.1
and 3.3 integrated in task 3 "Intelligent networks" coordinated by Eliop. Among
the participants of the consortium several research Centers (AICIA and IIT of
Comillas University) are participating in the task.
The project will study the application of IEC 61850 to power distribution
networks, the development of 61850 controllers and configuration software.

• Advanced solutions for the Spanish Electrical Grid towards 2025: Sub-project
1: Power Electronics Applications
Ministerio de Ciencia e Innovación. January 2010 - December 2010. (Aurelio
García Cerrada, Juan Luis Zamora Macho, Pablo García González, Javier
Roldán Pérez)
The main objective of this sub-project is to accelerate the development of
Power Electronics within the Spanish industry gathering together a research
team consisting of private companies and research institutions (from the public
and private sectors). This team will carry out coordinated research and viability
studies together with promotion activities in order back the advance of the
Spanish Electricity Sector towards the knowledge forter of Power Electronics
applied to electrical grid control. The participation of Universidad Pontificia
Comillas in this sub-project will focus on the study of High Voltage DC
transmission systems (HVDC) based on Voltage Source Converters
(HVDC-VSC). The work to be carried out will consist, mainly, on (a) a
state-of-the-art review of this technology, (b) the analysis and development of
models to be included in steady-state and dynamic analysis of the Spanish Grid
and (c) the detailed analysis of possible applications of this technology in future
developments of the Spanish Grid.
This project is partially funded by the Ministerio de Ciencia e Innovación and co-funded by FEDER as a Singular and Strategic Project. More information.

- **Project ENERGOS: Technologies for automated and intelligent management of energy distribution networks of the future**
  Sistemas Avanzados de Control. January 2010 - December 2012. (Sadot Alexandres Fernández, Carlos Rodríguez-Morcillo García, José Daniel Muñoz Frías, José Antonio Rodríguez Mondéjar, Ainhoa Cabetas Azcoitia, David Contreras Bárceca)
  The goal of Project ENERGOS "Technologies for automated and intelligent management of energy distribution networks of the future" is the development of knowledge and technologies that advance the deployment of Intelligent Networks.
  The main technological challenges of Intelligent Networks, are tackled in different lines of work of the Project. In the area of Business Management, includes the development of technologies for the creation of new environments Operation of the Network (including tools for simulation and estimation of states), the active demand management and the Planning and Optimizing.
  In the Area of Platform Integration and Communication, will work on the processes of acquiring and processing information in real time (with the difficulties of the large volume of information being generated and the criticality of its availability), the infrastructure necessary for the management and recharging of electric vehicles and the requirements of supervision and control of micro.
  Smart Network Devices, new techniques include signal acquisition, the development of intelligent devices and energy recording equipment Automation Network
  The consortium, led by natural gas - Unión Fenosa Distribución, has the presence of a leader in technologies such as Indra and prestigious companies in the electricity sector as ZIV, AIA, Ormazabal, SAC, Diagnostiqa and the technology sector information as Visual Tools, Brainstorm, Prodevelop, and Indra Answare Software Labs.

4.2.5.2 Consultancy and technological support

4.2.5.2.1 Private funding

- **Control center requirements of high-speed railway power system**
  ADIF. December 2007 - December 2010. (José Antonio Rodríguez Mondéjar, Yolanda González Arechavala, Eduardo Pilo de la Fuente, Rafael Santodomingo Berry)
  The operational and commercial needs of the Spanish railway operator (ADIF) require power control center to not only perform traditional functions (supervisory & control) but also support many of the new functions, specifically to meet the needs of competition with deregulation. The aim of this project is to establish the requirements of new high speed railway power control centers.
Research projects

The proposal architecture must take into account the requirements of real-time data, security, availability, scalability, information exchange, etc.

- **Review of the state of the art of technical problems in weak networks**
  The aim of this project is the review of the state of the art of technical problems in weak networks.

4.3 Publications

4.3.1 Books


4.3.2 Chapters in books


4.3.3 Publications in journals


4.3.4 Presentations in congress


- K. Dietrich, "Using demand response mechanisms to achieve a flexible load shape and to reduce uncertainties in system operation", Communication in 10th Young Energy Economists & Engineers Seminar - YEEES. Dresde (Germany). 6-7 April 2011.


4.3.5 IIT technical documents

Here are collected, the reports submitted to both companies at their request, within the framework of research projects listed above (usually confidential), as possible articles or research papers not yet published.


- P. Rodilla, S. Cerisola, C. Batlle, "Electricity wholesale spot prices in different market designs with a strong presence of renewable intermittent generation". April 2011. Ref: IIT-11-065A.


- J. Juárez Montojo, C. Rodríguez-Morcillo, J.A. Rodríguez-Mondéjar, "Advanced simulation platform for Smart Grid communications". April 2011. Ref: IIT-11-078A.


- A. Santamaría, P. Linares, "Effects from carbon pricing and anti-leakage policies in selected industrial sectors in Spain - cement, steel and oil refining". May 2011. Ref: IIT-11-090A.


Publications

- P. Sánchez, G. Sánchez González, G. Morales-España, "Direct load control decision model for electric vehicle microgrid aggregation units". September 2011. Ref: IIT-11-150A.


4.3.6 Other publications


4.4 Software products

• Electric Generation System Reliability Model (FLOP Model) (http://www.iit.upcomillas.es/aramos/flop.htm)
  The model calculates the Expected Energy Non Served (EENS) and the Loss Of Load Probability (LOLP) for a prespecified set of periods in which the year is
divided. It uses discrete convolution method. The input data for the model are: Demand in each period, modelled as a chronological or load-duration curve, and Generating units in each period: effective output in peak hours and availability rate. Generators are dispatched to supply demand in increasing merit order given a price ladder (although this order is irrelevant for reliability purposes). Price has only informative effects while a reserve bid system isn’t available.

The results given by the model: For each period value of EENS, LOLP and price (only for the clearing process of power reserve bids), Graphs of EENS and LOLP evolution along the time, and Graph of resulting price in each period.

**Bulk Production Cost Model (StarNet Model)**
(http://www.iit.upcomillas.es/aramos/starnet.htm)
A bulk production cost model determines the system operation variables that minimize variable costs for a defined time scope. The model determines the unit commitment binary variables and furthermore the unit output and power flow through the network. It is a short and medium term model. In the short term demand is modeled chronologically, while in the medium term it is considered as a load-duration curve.

It can also be considered as a medium term Bulk Production Cost Model (BCPM) to obtain economic and unit operation forecasts.

**Reliability and Operation Model for Renewable Energy Sources (ROM Model)**
(http://www.iit.upcomillas.es/aramos/ROM.htm)
The model objective is to determine technical and economic impact of intermittent generation (IG) and other types of emerging technologies (active demand response, electric vehicles, concentrated solar power, solar photovoltaic) into the medium-term system operation including reliability assessment. Results include generation output including IG surplus, pumped storage and storage hydro usage, and adequacy reliability measures. The benefits of improving IG predictions can also be determined by changing forecasting error distributions and re-running the model.

A daily stochastic optimization model followed by a sequential hourly simulation. Detailed operation constraints such as minimum load, ramp-rate, minimum up-time and downtime of thermal units and power reserve provision are included into the daily stochastic unit commitment model. The hourly simulation is run for the same day to account for IG production errors and unit failure and therefore revising the previous schedule. This system modeling in two phases reproduces the usual decision mechanism of the system operator.

A chronological approach to sequentially evaluate every day of a year. Decisions above this scope as the weekly scheduling of pumped storage hydro plants are done internally in the model by heuristic criteria. Yearly hydro scheduling of storage hydro plants is done by higher hierarchy models, as for example, a hydrothermal coordination model.

Monte Carlo simulation of many yearly scenarios that deal with IG stochasticity.

**AGC Software for the Spanish power system v2.0.1**
AGC software adapted to the Spanish Power System that outperforms other
Software products

current commercial alternatives. The software can be easily integrated in any complete SCADA system.

• **IDAT** is an intelligent information processing tool that includes technologies of processing and visualization of information, as well as advanced analysis and data mining by means of statistical models and Artificial Intelligence techniques. IDAT has been developed at the IIT and is being used as analytical tool for diverse projects.

• **iMetro: Subway best route calculator**
(http://www.iit.upcomillas.es/imetro/)
Finds the best routes between two stations in a subway (metro) network (several cities implemented)
There are three versions of this application: iMetro WebApp (web access, Javascript algorithm), iMetro PHP (web access, PHP interface), and iMetro Multi-city (iOS application).
- If possible, it finds three different solutions:
  o **Fastest Route**: based on minimum time estimation.
  o **Minimum Connections**: it is useful if you have luggage, or just prefer an easier route.
  o **Handicap accessible**: makes all connections at stations with handicap access.
5. Doctorate

5.1 ICAI Engineers' Association

The IIT maintains a close relationship with the ICAI Engineers' Association in several aspects. On the one hand, the Association funds a portion of a doctoral thesis developed at the IIT every year. During this academic year, the thesis funded was "Implicaciones de la continuidad de suministro en el diseño de la tarifa de red de distribución", developed by Alezeia González García, and supervised by Tomás Gómez San Román and Francisco Miguel Echavarren Cerezo.

Moreover, the IIT has agreed to publish some of their research at the Associations' official journal, "Anales de Mecánica y Electricidad".

5.2 Doctoral courses

The courses that comprise the Master in Research in Engineering Systems Modelling and the Master in Power Systems, of Comillas ICAI, relevant technical and managerial problems to which the industry currently faces are described rigorously, and are proposed approaches and methods for analysis and solution based on the latest research. These courses are conducted in collaboration with the Departments of Comillas ICAI.

5.2.1 Master in Research in Engineering Systems Modelling

Director: Pablo García González
More information at
http://www.upcomillas.es/eng/estudios/estu_mast_inve_mode.aspx?idIdioma=ENG
- Advanced Computing Tools for Applied Research
  Rafael Palacios Hielscher, Fernando de Cuadra García
Doctoral courses

- Elaboration of a PhD thesis
  Francisco Luis Pagola y de las Heras

- Modeling of Physic Systems in Engineering
  Alberto Carnicero López

- Artificial intelligence
  Francisco Alberto Campos Fernández, Miguel Ángel Sanz Bobi, José Villar Collado

- Decision methods
  Pedro Linares Llamas

- Stochastic Optimization
  Andrés Ramos Galán

- Seminars on research methods and tools
  Eugenio Francisco Sánchez Úbeda

- Writing technical papers in english
  Aurelio García Cerrada

5.2.2 Master in Power Systems

Director: Pablo García González
More information at
http://www.upcomillas.es/eng/estudios/estu_mast_sist_ener.aspx?idIdioma=ENG

- Advanced analysis of electric power systems
  Luis Rouco Rodríguez

- Elaboration of a PhD thesis
  Francisco Luis Pagola y de las Heras

- The electric power distribution business
  Tomás Gómez San Román

- The electric power transmission business
  Michel Rivier Abbad

- Environmental impact and renewable energy
  Pedro Linares Llamas

- Artificial intelligence
  Francisco Alberto Campos Fernández
- Analisys and Management Risk Models in Electricity Markets
  Julián Barquín Gil

- Decision support models in the electric power systems
  Javier García González

- Regulation of the electric power industry
  José Ignacio Pérez Arriaga

- Seminars on research methods and tools
  Eugenio Francisco Sánchez Úbeda

- Writing technical papers in english
  Aurelio García Cerrada

5.3 Doctoral seminars

The aim of the doctoral seminars is to provide students with basic information about various research techniques. With that, it is intended that students will be able to assess the potential usefulness of these techniques to determine a deepening in them or their possible application in projects and research.

- An introduction to decision theory
  Pedro Linares Llamas

- Applied forecasting
  Antonio Muñoz San Roque

- Bibliographic search and reference management
  Yolanda González Arechavala

- Data mining
  Eugenio Francisco Sánchez Úbeda

- Database systems
  Álvaro Sánchez Miralles

- Developing web-based applications
  Rafael Palacios Hielscher

- Fuzzy logic
  José Villar Collado
- Genetic algorithms
  Eugenio Francisco Sánchez Úbeda

- Graphic visualization with Matlab
  Eugenio Francisco Sánchez Úbeda

- Multivariate analysis techniques
  Carlos Maté Jiménez

- Object oriented programming
  José Villar Collado

- Optimization techniques
  Andrés Ramos Galán

- Oral presentation of scientific papers
  Aurelio García Cerrada

- Scientific computing with Matlab
  Rafael Palacios Hielscher

- Simulation techniques
  Pedro Sánchez Martín

- Visual Basic for applications
  Jesús María Latorre Canteli

- Writing scientific papers with LaTeX
  Romano Giannetti

5.4 Research sufficiency degree

The following doctoral students, whose tutor is a researcher at IIT, have obtained the Master Degree, through public defense of the Final Project:

5.4.1 Master in Research in Engineering Systems Modelling
- Auto-regressive processes explained by self-organized maps. Application to the detection of abnormal behaviour in industrial processes
  Chiara Brighenti. Supervised by Miguel Ángel Sanz Bobi.

- Frequency adaptive repetitive controller for a high accuracy dynamic voltage restorer
  Javier Roldán Pérez. Supervised by Aurelio García Cerrada.
- Diesel powered vehicle share and transport fuel demand, an aggregate approach applied to Spain
  Alessandro Danesin. Supervised by Pedro Linares Llamas.

- Energy and environmental assessment of electricity production from winter cereals biomass harvested in two locations of northern Spain
  Carlos Martín Sastre. Supervised by Yolanda González Arechavala.

- Performance evaluation of two narrowband PLC systems: PRIME and G3
  Javier Matanza Domingo. Supervised by Sadot Alexandre Fernández and Carlos Rodríguez-Morcillo García.

5.4.2 Master in Power Systems
- How much should we pay for a DR program? An estimation of network and generation systems benefits
  Adela Conchado Rodríguez. Supervised by Pedro Linares Llamas.

- Optimal demand-side bidding strategies in electricity spot markets
  Rocío Herranz Pindado. Supervised by Antonio Muñoz San Roque.

- Effect of network congestion on single-node electricity markets
  Andrés Ramiro Delgadillo Vega. Supervised by Javier Reneses Guillén and Julián Barquín Gil.

- Electric power demand forecasting using interval time series methods
  Carolina García de Ascanio. Supervised by Enrique Lobato Miguélez and Carlos Maté Jiménez.

- Detailed and flexible simulation platform for IEC 61850-based systems
  Javier Juárez Montojo. Supervised by José Antonio Rodríguez Mondéjar.

- Effects from carbon pricing and antileakage policies in selected industrial sectors in Spain: cement, steel and oil refining
  Alberto Santamaría Barroso. Supervised by Pedro Linares Llamas.

- Mechanisms for energy trading in eight European power systems: intra-day and ancillary services

- Impact of vehicle-to-grid on power system operation costs: the Spanish case study
  Camila Formozo Fernandes. Supervised by Pablo Frías Marín.

- Application of an entry–exit tariff model to the gas transport system in Spain
  Miguel Serrano Fernández. Supervised by Luis Olmos Camacho.
- Comparison between Dynamic Voltage Restorer (DVR) with and without transformer for compensation voltage sags
  Shazly Abdo Mohammed Ahmed. Supervised by Aurelio García Cerrada.

- Optimal design and profitability study of VRB Storage application in a PV Plant under curtailment policy
  Iker Lain Carrascosa Vacas. Supervised by Aurelio García Cerrada.

- Dual-zone electricity equilibrium computation with mixed integer programming
  Alfonso Román de Andrés. Supervised by Francisco Alberto Campos Fernández and José Villar Collado.

5.5 Doctoral theses

The following doctoral theses defended in this academic year or currently in development are or have been conducted and led by researchers at the IIT. Usually, these theses are developed in conjunction or in close relationship with some of the research projects mentioned above.

5.5.1 Submitted theses

- Title: Analysis of forward prices in electricity markets by means of their fundamental drivers
  Author: Miguel Vázquez Martínez
  Supervisor: Julián Barquín Gil
  Date: July 22, 2011

- Title: Batch sequencing for resource management in manufacturing environments
  Author: Santiago Jesús López de Haro
  Supervisors: Pedro Sánchez Martín and Andrés Ramos Galán
  Date: February 04, 2011

- Title: Design of underfrequency load-shedding schemes of small isolated power systems
  Author: Lukas Sigrist
  Supervisors: Luis Rouco Rodríguez and Ignacio Egido Cortés
  Date: December 17, 2010

5.5.2 Ongoing theses

- Title: Estudio de sistemas termoeléctricos mediante el método de los elementos de contorno y técnicas experimentales
  Author: Jorge Vázquez Arias
  Supervisor: Rafael Palacios Hielser
- Title: Diseño de tarifas eléctricas: tarifas de redes de distribución  
  Author: María Pía Rodríguez Ortega  
  Supervisors: Jesús Pascual Peco González and Juan Rivier Abbad

- Title: Desarrollo de un modelo de red de referencia para la regulación de la distribución  
  Author: Javier Cimadevila García  
  Supervisor: Juan Rivier Abbad

- Title: Metodología de ayuda a la decisión para la electrificación rural apropiada en países en vías de desarrollo  
  Author: Francisco Javier Santos Pérez  
  Supervisor: Pedro Linares Llamas

- Title: Diagnóstico bioquímico y tecnológico de un proceso de producción de bioetanol mediante aprendizaje automático  
  Author: Pablo Ruiz Castelló  
  Supervisors: Julio Montes Ponce de León and Miguel Ángel Sanz Bobi

- Title: Análisis de mercados eléctricos no ideales: interconexiones y funciones de costes no convexas  
  Author: Félix Fernández Menéndez  
  Supervisors: Julián Barquín Gil and Begoña Vitoriano Villanueva

- Title: Implicaciones de la continuidad de suministro en el diseño de la tarifa de red de distribución  
  Author: Alezeia González García  
  Supervisors: Tomás Gómez San Román and Francisco Miguel Echavarren Cerezo

- Title: Predicción a corto plazo del precio de la electricidad mediante modelos de series temporales con cambio de régimen  
  Author: Alberto Miguel Cruz García  
  Supervisor: Antonio Muñoz San Roque

- Title: Regulation of distribution system operators under large penetration levels of distributed generation  
  Author: Rafael Cossent Arín  
  Supervisor: Tomás Gómez San Román

- Title: Armonización de los modelos de información de las redes eléctricas aplicando conceptos de la web semántica  
  Author: Rafael Santodomingo Berry  
  Supervisors: José Antonio Rodríguez Mondéjar and Miguel Ángel Sanz Bobi
- Title: Contributions to interpretable nonparametric regression. An application to mid-term forecasting of energy demand  
  Author: Ana Berzosa Muñoz  
  Supervisor: Eugenio Francisco Sánchez Úbeda

- Title: Electricity market analysis with bilevel mathematical programming techniques  
  Author: Sonja Wogrin  
  Supervisors: Efraim Centeno Hernáez and Julián Barquín Gil

- Title: Analysis of oligopolistic electricity markets with network constraints  
  Author: Cristian Andrés Díaz Durán  
  Supervisors: Francisco Alberto Campos Fernández and José Villar Collado

- Title: Strategic analysis of the joint operation of natural gas and electricity markets in the medium term  
  Author: Pablo Dueñas Martínez  
  Supervisors: Javier Reneses Guillén and Julián Barquín Gil

- Title: Conducción eficiente de trenes metropolitanos con ATO  
  Author: María Domínguez Gago  
  Supervisors: Antonio Fernández Cardador and Asunción Paloma Cucala García

- Title: Diseño eficiente de servicios ferroviarios y control de la conducción en Alta Velocidad.  
  Author: Carlos María Sicre Vara del Rey  
  Supervisors: Asunción Paloma Cucala García and Antonio Fernández Cardador

- Title: Hybrid modeling for electricity policy assessments  
  Author: Renato Dias Bleasby Rodrigues  
  Supervisors: Pedro Linares Llamas and

- Title: Evaluation and design of sustainable energy policies: an application to the case of Spain  
  Author: Álvaro López-Peña Fernández  
  Supervisors: José Ignacio Pérez Arriaga and Pedro Linares Llamas
6. Other activities

6.1 EES-UETP

Web page: http://www.ees-uetp.com/

The Electric Energy Systems - University Enterprise Training Partnership (EES-UETP) is a consortium of 4 companies and 24 universities and research centers in 15 European countries. They started operations in July 1992 under the program COMETT (COMmunity program for Education and Training in Technology).

The main objective of the EES-UETP is to increase the competitiveness and profitability of the electricity sector through technology training. In this sense, the main activities of the EES-UETP are the organization of advanced courses in electric power systems and exchanges of students and researchers.

The main activities of the ESS-UETP are financed through contributions from its industrial partners.

6.1.1 EES-UETP partners

Currently, the partners of the ESS-UETP are as detailed below, classified by country:

- **Austria**
  - Graz University of Technology
- **Belgium**
  - Katholieke Universiteit Leuven
- **Croatia**
  - Energy Institute Hrvoje Požar
  - University of Osijek
- **Denmark**
  - Danmarks Tekniske Universitet
- **Finland**
  - Lappeenranta University of Technology
  - Tampere University of Technology
• **France**  
  - École Supérieure d’Electricité (SUPELEC)  
  - Electricité de France  
  - Gestionnaire du Réseau de Transport d’Electricité (RTE)  
• **Germany**  
  - Technische Universität Dortmund  
• **Greece**  
  - National Technical University of Athens  
• **Ireland**  
  - University College Dublin  
• **Italy**  
  - ENEL  
  - Università degli Studi di Bologna  
  - Università di Cagliari  
  - Università di Genova  
• **Portugal**  
  - INESC Porto  
• **Spain**  
  - Iberdrola, S.A.  
  - Universidad Carlos III de Madrid  
  - Universidad de Sevilla  
  - Universidad Politécnica Valencia  
  - Universidad Pontificia Comillas  
• **Sweden**  
  - KTH Royal Institute of Technology  
• **Switzerland**  
  - École Polytechnique Fédérale de Lausanne (EPFL)  
  - ETH Zürich  
• **United Kingdom**  
  - University of Manchester  
  - University of Strathclyde  

Besides being an active member of the network, the Comillas Pontifical University covers the following positions in the EES-U ETP:  
- Member of the Board: Mr. Tomás Gómez San Román  
- Coordinating Secretary: Mr. Luis Olmos Camacho

### 6.1.2 Taught courses

- Protection of future networks with distributed generation  
  Prof. Vladimir Terzija (University of Manchester, Manchester, England)  

- Smart electricity distribution grids: economics and regulation  
  Dr. Tomás Gómez San Román (Comillas Pontifical University, Madrid, Spain)  
  and Dr. Pablo Frías Marín (Comillas Pontifical University, Madrid, Spain)
6.2 International exchanges

It is an IIT policy to encourage and finance, to the extent possible, that its members expand their education and research experience abroad.

Some members of IIT have spent some time at foreign universities and agencies, as visiting scientists or engineers, working on specific projects and expand its expertise in research problems. During this academic year, the stays are:

- Luis Olmos Camacho, in Robert Schuman Centre for Advanced Studies - Florence School of Regulation, European University Institute, Florencia (Italy). February 2010-June 2011.


- Rafael Santodomingo Berry, in R&D Division Energy, Interoperability and Standards Group, OFFIS Institute, Oldenburg (Germany). November-December 2010.

- Rafael Santodomingo Berry, in R&D Division Energy, Interoperability and Standards Group, OFFIS Institute, Oldenburg (Germany). June-July 2011.

- Pablo Ayala Santamaría, in BRE Centre for Fire Safety Engineering, University of Edinburgh, Edimburgo (Scotland). June-August 2011.

- Rafael Cossent Arín, in School of Management & Languages; Chair in Energy Economics, Heriot-Watt University, Edimburgo (Scotland). June-September 2011.

6.3 Visiting professors
- Luiz Augusto Barroso, Power Systems Research (PSR), Río de Janeiro (Brazil). June 2011.
- Piotr Lukaszewicz, from Department of Aeronautical and Vehicle Engineering, KTH - Transtrail, Estocolmo (Sweden). May 2011.
- Chris Marnay, from Environmental Energy Technologies. Lawrence Berkeley National Laboratory, University of California, Berkeley CA (USA). April 2011.
- Steven Gabriel, from Department of Civil and Environmental Engineering, University of Maryland, Maryland (USA). December 2010.

6.4 Courses offered to external companies and institutions

The courses offered to companies and consultancy activities are frequently related to research projects. There have been as follows:


- Carlos Batlle López, "FSR Summer school on regulation of energy utilities 2011". Florence School of Regulation. April-July 2011.


6.5 Seminars

Members of the IIT offered dissemination seminars throughout the year, which can present results of research carried out or simply refer to current issues. The seminars that have taken place in this academic year are:

- Cristina Sánchez Rebollo, Jesús Jiménez Octavio, "Computational Mechanics on High Speed Trains". University of Edinburgh, School of Engineering.

- Rafael Cossent Arín, "Reference Network Models: A Tool to Regulate Electricity Networks and Other Applications". Heriot-Watt University. School of Management and Languages.

- Rodrigo José Andrade Vieira, "¿Cómo se configura el acceso remoto a un ordenador?". Universidad Pontificia Comillas.


- Sonja Wogrin, "Investment decisions in liberalized electricity markets considering capacity payments". 7th Workshop on Industrial Systems and Energy Technologies - JOSITE'2011. Universidad Pontificia Comillas.


- Germán Andrés Morales España, "Start-up & shut-down ramping of thermal units in unit commitment". 7th Workshop on Industrial Systems and Energy Technologies - JOSITE'2011. Universidad Pontificia Comillas.

- Kristin Dietrich, "Using demand response mechanisms to achieve a flexible load shape and to reduce uncertainties in system operation". 7th Workshop on Industrial Systems and Energy Technologies - JOSITE'2011. Universidad Pontificia Comillas.

- Steven Gabriel, "A Discretely-Constrained MPEC for electricity markets". Aula de investigación. Universidad Pontificia Comillas.

- Luiz Augusto Barroso, "Application of multi-stage stochastic optimization and cloud computing to the energy management of multi-country systems". Aula de investigación. Universidad Pontificia Comillas.
- Chris Marnay, "Applications of optimal building energy system selection and operation". Aula de investigación. Universidad Pontificia Comillas.

- Alberto Gascón González, "Descifrado de mensajes secretos de la Guerra Civil Española". Aula de investigación. Universidad Pontificia Comillas.

- Hugh Outhred, "Indonesia's electricity supply challenges & wind integration in the Australian national electricity market". Aula de investigación. Universidad Pontificia Comillas.

- Manuel Peña Alcaraz, Álvaro Richi Castellano, "Introducción al desarrollo de aplicaciones para iOS". Aula de investigación. Universidad Pontificia Comillas.

- María Ana Sáenz Nuño, "Metrología: la medida de las cosas en la vida". Aula de investigación. Universidad Pontificia Comillas.


- Rafael Palacios Hielscher, "Sensibilidad del tráfico aéreo en EEUU al fallo de las comunicaciones radio". Aula de investigación. Universidad Pontificia Comillas.

- Mario Blázquez de Paz, "The effect of transmission market design in the performance in the wholesale electricity market". Aula de investigación. Universidad Pontificia Comillas.

- Germán Andrés Morales España, "Zotero: manage your references and files in one place". Aula de investigación. Universidad Pontificia Comillas.


6.6 Congress, seminars and journals organization

6.7 Other activities


- José Ignacio Pérez Arriaga, Director of Energy Training in Florence School of Regulation (FSR). Florencia (Italy). October 2003- Today.


- Luis Rouco Rodríguez, Presidente del Capítulo Español de la Power Engineering Society in Institute of Electrical and Electronic Engineers (IEEE). (Spain). July 2009- Today.


- Eugenio Francisco Sánchez Úbeda, Miembro de la Red española de Series Temporales in Universidad de Granada y Universidad de Pablo de Olavide. Granada (Spain). September 2010-September 2011.


- Mariano Ventosa Rodríguez, Miembro del Comité de la Energía y la Ingeniería de Arbitraje y Mediación in Asociación Europea de Arbitraje (AEADE). Madrid (Spain). December 2010- Today.


- José Ignacio Pérez Arriaga, Editor de Fifth Assessment Report (AR5). Intergovernmental Panel on Climate Change (IPCC). Ginebra (Switzerland). October 2010-December 2014.


- Carlos Rodríguez-Morcillo García, Invited lecture "Optimización de sistemas embarcados basados en TCN y Ethernet para aumentar la capacidad del canal". Montané Comunicación. Madrid (Spain). October 2010.


- Pedro Linares Llamas, Invited lecture "Renewable energy development in Spain: the good, the bad and the ugly". European University Institute. Florencia (Spain). November 2010.


7. Data about IIT

The relevant numbers of the academic year 2010 - 2011 are shown below, as well as the historical evolution of the turnover of the Institute and of its staff, separated into academic staff and research assistants:

5.23 M€ Turnover
62 Professors and researchers
57 Research assistants
79 Research projects
36 Consultancy projects
2 Books
16 Chapters in books
33 Papers published in JCR journals
16 Papers published in other journals
67 Papers presented at conferences
15 Technical reports
3 Submitted theses
18 Ongoing theses
9 Courses offered to external entities
Data about IIT

**Turnover**

- Millions


**Staff**

- Research Assistants
- Academic Staff