Welcome to IIT

Institute for Research in Technology
Instituto de Investigación Tecnológica
Where we come from?

1890

*Universidad Pontificia Comillas*

- Jesuit university
- Economics, Law, Theology, Engineering, ...
- 12,000 students

The only Spanish university ranked among the top 100 in the world by Times Higher Education (Alma Mater Index)

1908

*ICAI School of Engineering*

- 29 labs for teaching and research
- 1,800 students and 250 faculty members
- More than 90% of the students spend at least a semester abroad

1984

*Institute for Research in Technology (IIT)*

- IIT is dedicated to applied research, doctoral and postgraduate education
- and the transfer of technology and knowledge to society
5 key points about IIT

...was founded more than 32 years ago and is a university-based research center which belongs to the ICAI School of Engineering of Universidad Pontificia Comillas.

...places academic excellence at the core of its activities, participating fully in the international research community.

...is self-financing and most of its work is carried out in collaboration with industry.

...has more than 100 researchers and academic staff.

...is dedicated to applied research, doctoral and postgraduate education and the transfer of technology and knowledge to society.
IIT in numbers 2017/2018

110

- Staff
- 31 PhD students,
- 71 senior researchers
- 7 admin

5.4

- M€ Turnover

130

- Project funded by industry and institutions

59

- Papers published in JCR journal
- 18 in other publications

6

- Thesis submitted,
- 46 ongoing

15

- Courses training and specialized offered to external entities

Graph showing turnover and projects from 2000/2001 to 2017/2018.
Research groups & Activity sectors

- Energy Economics & Regulation
- Electrical Power Systems
- Smart and Sustainable Grids
- Energy System Models
- Bioengineering
- Railway Systems
- Smart Industry & Cities
- Fire Safety, Thermal and Fluids Engineering
- ICT
- Industry
Products and Services

**COMPUTATIONAL MECHANICS AND ADVANCED MATERIALS**
- CANDY: Catenary Non-linear Dynamics

**INTELLIGENT SYSTEMS**
- SPLODE: Smart Planning Operation DER

**ELECTRICAL SYSTEMS**
- ISLA: Island System Load-shedding

**POWER ELECTRONICS AND TELECOM**
- SIMPRIME

**ENERGY SYSTEMS MODELING**
- OWL Offshore Windfarm
- TEPES Long-Term TN Expansion

**SMART AND SUSTAINABLE GRIDS**
- ROM RES Reliability Operation
- STARNET Bulk Gen Cost
- FLOP GenSys Reliability
- RNM Reference Network Model
- REM The Reference Electrification Model

**SMART AND SUSTAINABLE GRIDS**

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Collaborating companies

Our main customer list includes Spanish and international companies and institutions in sectors like Energy, Transportation or Communications.
Sharing knowledge and professional experience

IIT’s research teams make an important contribution to ICAI School of Engineering’s ambitious and internationally oriented postgraduate and doctoral programs.

**PhD Programs:**
- Official Doctorate Program in Power Systems
- Official Doctorate Program in Engineering Systems Modeling

**Master’s degree:**
- Official Master’s Degree in Industrial Engineering
- Official Master’s Degree in Telecommunications Engineering
- Official Master’s Degree in Railway Systems
- Official Master’s Degree in the Electric Power Industry
- Official Master's Degree in Research in Engineering Systems Modeling
- Master's Degree in Smart Industry
- Master in Big Data Technologies and Advanced Analytics
## Initiatives and Social Commitment

**Initiatives**

- Connected Industry Chair (CIC)
- BP Chair on Energy and Sustainability
- Chair in Science, Technology and Religion
- Electric Vehicle and Sustainable Transport Observatory
- Electric Energy Systems - University Enterprise Training Partnership (EES-UETP)

**Social Commitment**

- Juan Carlos Lavalle Association
- Energy Without Borders
- ICAI Engineers for Development Foundation
- Social Consultancy
- Higher Education for Social Transformation (HEST)
- MIT & IIT Comillas Universal Access Lab
- Spanish Roundtable on Universal Energy Access
- Más que Ingeniería MAG+S
Open to the world

International activity is at the core of IIT life. We are a committed member of the international research community.

IIT participates in a variety of European commission Research Projects in the fields of smart grids, renewable energy integration, electric vehicles and others.
International Collaboration

Visiting professors from prestigious Universities from all over the world (Australia, USA, Canada, Brazil, India, Sweden...) regularly participate in research stays at IIT. (foto Luiz Barroso, Ben Hobbs, Piotr Lukas, Ross Baldick, Steven Gabriel, Shmuel Oren, Joao Peças...).

IIT researchers spend short stays or sabbatical years at prestigious universities (such as MIT, Harvard and Cambridge).

IIT researchers regularly disseminate the results of their research both at international conferences and in scientific journals. Its participation in the global research community has earned IIT global prestige (e.g. ISGAN, ...)
European Projects
To end up

“We believe that sustainable energy is essential for a better and fairer world.”

“We are currently in a preeminent position, both nationally and internationally, in our chosen areas of research, mainly energy and railway systems.”

“The continuing success of our collaboration with the industrial sector is the consequence of a mutually beneficial relationship which stretches back over thirty years. Combining the real concerns of industry with state-of-the-art approaches has been a key factor in IIT's success.”
Detailed description of the Research groups

- Energy Economics & Regulation
- Electrical Power Systems
- Smart and Sustainable Grids
- Energy System Models
- Bioengineering
- Smart Industry & Cities
- Railway Systems
- Thermal, Fluids and Fire Safety Engineering
- ICT
ENERGY ECONOMICS & REGULATION (1/8)

- Regulatory design of energy markets
- Economic instruments for environmental and climate change policy
- Transmission and distribution networks regulation
SMART AND SUSTAINABLE GRIDS (2/8)

- Smart Grids
- Planning and operation of DERs
- Green energy integration
- Universal energy access & rural electrification
- ICT and data exchange protocols
- Smart grid data modeling (CIM, 61850,...)
Flagship Product: Reference Network Model

- **GIS-based** large-scale distribution planning (>1 million customers)
- Several voltage levels (HV, MV, LV) and areas (urban, rural) jointly planned
- Two options: Greenfield (from scratch) and Brownfield planning
- Constraints: geographical factors, technical constraints, reliability
- Inputs: contracted power, location of users, standardized grid components
- Outputs: efficient distribution costs, energy losses, reliability indices
Flagship Product: Reference Network Model

Applications:

• **Distribution regulation and tariff design**: Spain (CNE-CNMC), Chile (SYNEX and Systep)
• **Assessing the costs of improving reliability**: design of reliability incentives for DSOs (CNE), CBA of smart grid solutions (Ormazábal)
• **Quantifying the impact of DER (DG, EVs, DR)**: European projects (IMPROGRES, MERGE, ADVANCED), National projects (GAD, PSE-REDES, ENERGOS), other (MIT Future of Solar, ENI impact of µ–CHP)
• **Develop representative networks**: DSO Observatory (JRC, European Commission), Smart-DS (ARPA-E, US DOE)
Exporting Know-How Overseas

- **Utility of the Future**: MIT-IIT partnership to envision a low-carbon and decentralized power system
  - Technology performances & business models
  - Centralized vs. decentralized resources
  - Regulatory proposals

- **Future of Solar**: IIT contribution to an MIT study
  - Quantify the impact of PV on distribution

- **Smart-DS**: joint ARPA-E Project with NREL, MIT and Alstom Grid for the US DOE
  - Develop representative T&D network models to test algorithms and assess DER integration
Concerned about the Global Challenges: Reference Electrification Model (REM)

- **Reference Electrification Model (REM):** large-scale rural electrification tool to help policymakers establish an electrification plan
- REM uses heuristic algorithms in order to **minimize total cost** (financial and social)
- REM can be applied at vast areas, e.g. **Vaishali District** in Bihar (India)
- **Results** provided by REM can be used as inputs of other software tools

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**Vaishali District**
- Population: 3.5 million
- 626,000 households.
- Area: 2,036 km²

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Bihar State
ENERGY SYSTEM MODELS (3/8)

- Short-term operation and market bids
- Medium-term planning studies
- Long-term strategic analysis

Tools for strategic planning and operation in markets (Endesa, Iberdrola, EON-Viesgo...)

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Generation Planning Functions

**Functions**

**New market functions**
- Risk management
- Long term contracts:
  - Fuel acquisition
  - Electricity selling
- Objectives:
  - Market share
  - Price
  - Budget planning
  - Future market bids
- Market bids:
  - Energy
  - Power reserve
  - Other ancillary services

**Traditional operation functions**
- Investments
  - Installation
  - Repowering
- Maintenance
- Energy management
  - Nuclear cycle
  - Hyperannual reservoirs
- Fuel management
  - Annual reservoir and seasonal pumped storage management
  - Water value assessment
- Start-up and shut-down of thermal units
- Pumped storage operation
- Economic dispatch

**Scope**
- Long term
- Medium term
- Short term

- Objectives:
  - Market share
  - Price
- Budget planning
- Future market bids
- Market bids:
  - Energy
  - Power reserve
  - Other ancillary services
## General Perspective of Electricity Market Models

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<th>Endesa</th>
<th>Gas Natural Fenosa</th>
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ELECTRIC POWER SYSTEMS: MODELING, ANALYSIS AND CONTROL (4/8)

- Steady-state
- Dynamic analysis & stability
- Automatic Generation Control
- Power electronics
- HVDC
- Power Quality / Electromagnetic transients

Expert reports to analyze complex outages and electric incidents
SMART INDUSTRY & CITIES (5/8)

- Smart buildings
- Forecasting and data mining
- Smart cities
- Reliability, maintenance and diagnosis
- Mobile robotics and artificial vision
- Helping accessibility using ICT

Big data analytics in energy systems
Forecasting in Energy
Data Mining and Big Data in Energy

• Data Mining Energy Markets
  • Analysis and design of bidding strategies
  • Monitoring energy markets

• Energy Management for Demand Response and Efficiency
  • Characterization of consumption habits
  • Energy efficiency for homes
Optimize the thermal and electric energy in a household or building (renewables, storage, air conditioning, DHW, lighting, appliances, so on).

- Support price signals.
- Compatible with user preferences.
- Planning and real time.
- Use a thermal model of the building. It is learnt in real time.

**Building**

Is it profitable to install a heat pump?

You have left some windows opened!!

Is it profitable to install a PV panel in my home?

Today, you are consuming so much!

How much storage is optimum for my home?

In what rooms of my home is it profitable to change the type of lighting?
What is Stemy?

- Connects customers to the intelligence in the cloud (SPLODER).

- It consists of several IoT devices for:
  - Temperature control (Heating and cooling).
  - Consumption and power control (grid analyser).
  - Illumination control.
  - Humidity control.
  - Presence monitoring.
  - Storage and renewables control (DER).
RAILWAY SYSTEMS (6/8)

- Railway traffic planning and control
- Energy efficient timetabling and train driving (Ecodriving)
- Optimal design of signaling and railways capacity
- Railway power supply systems
- Safety analysis, specification and demonstration of RAMS, quality control and assurance
- Communication and control in railway power systems
- Mechanical design of overhead contact lines
BIOENGINEERING (7/8)

- Electronic Instrumentation
- Digital communications
- Embedded digital systems
- Biomaterials
- Biomechanics
- Biomedical metrology

Wireless Brain Computer Interface System
THERMAL, FLUIDS AND FIRE SAFETY ENGINEERING (8/8)

- Numerical modelling
- Structural analysis
- Experimental analysis
- Adhesives

Fractional Factorial Design for Atrium Fire Prediction