

Economic perspective of innovation: the energy sector

Jose García-Quevedo

Chair of Energy Sustainability and Barcelona Institute of Economics,
University of Barcelona (IEB, UB)

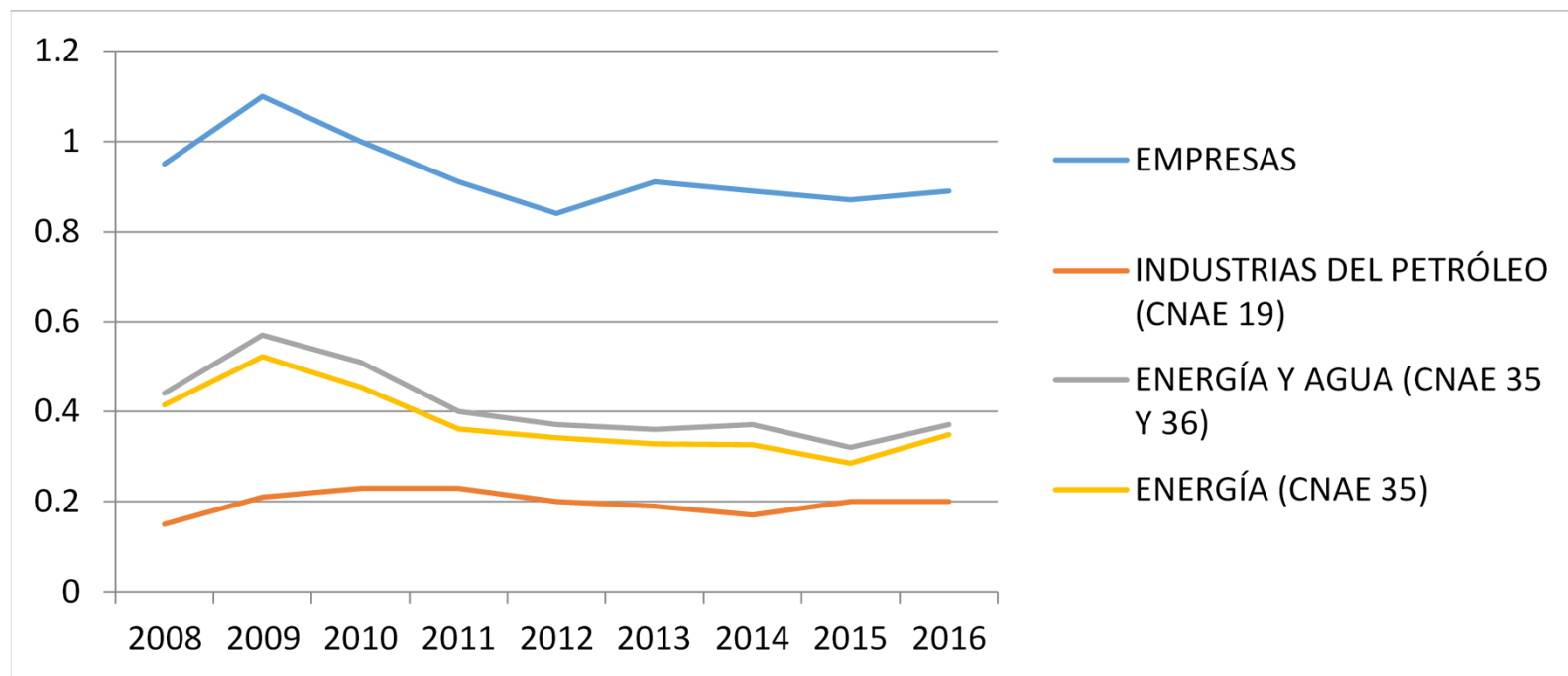
- “The US and the world need a revolution in energy technology....A dramatic increase in the pace of energy innovation is crucial...” (Anadon et al., 2011)
- “From a peripheral phenomenon, innovation now is central to fundamental shifts in the power sector” (Eurelectric, 2013)
- “Accelerating clean energy innovation... innovation is a key area...” (European Commission, 2016)

- R&D and innovation key issues to face the challenges of the energy sector (environment, efficiency, competitiveness)
- Knowledge about R&D and innovation of energy firms is still insufficient (incentives, innovation objectives, obstacles, effects public policies...)
- Lack of knowledge about R&D in energy in manufacturing firms (non-energy firms)

- Research (economic analysis) oriented to: effects of liberalisation on R&D, debate about the low effort in R&D of the energy sector.
- Chair of Energy Sustainability. Research on:
 - Analysis of the determinants (R&D) and innovation strategies of energy firms in the current competitive situation.
 - Analysis of R&D in energy in non-energy sectors

- Overcoming lack of data availability (GEA, 2012):
 - Exploit available databases (Technological Innovation Panel, PITEC, Spanish version of CIS)
 - Create new sets of data (merging different sources): R&D, environment, taxes, emissions
 - Specific treatment of data (Spanish Institute of Statistics)

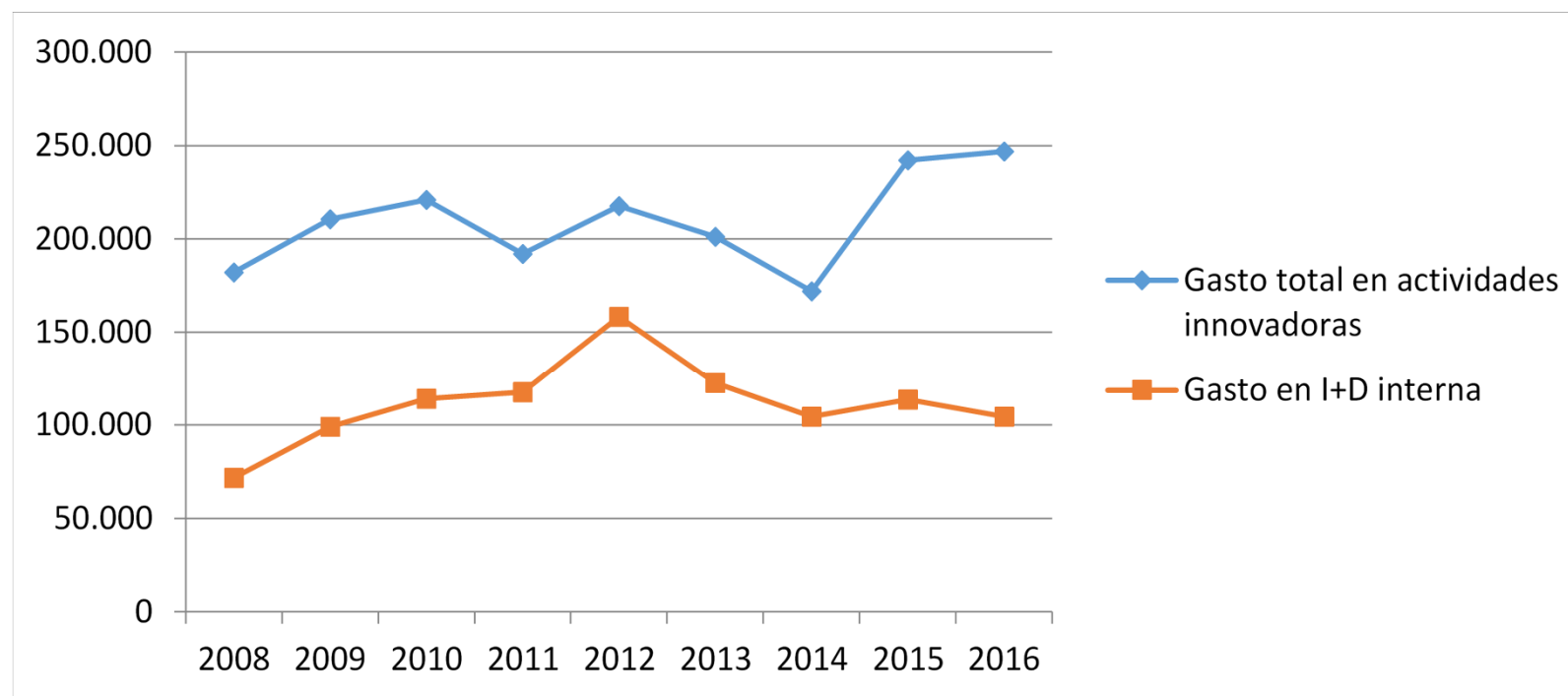
Figure 1. Innovation intensity (Innovation expenditure divided by the firm's sales. In %).



Source: INE and own elaboration

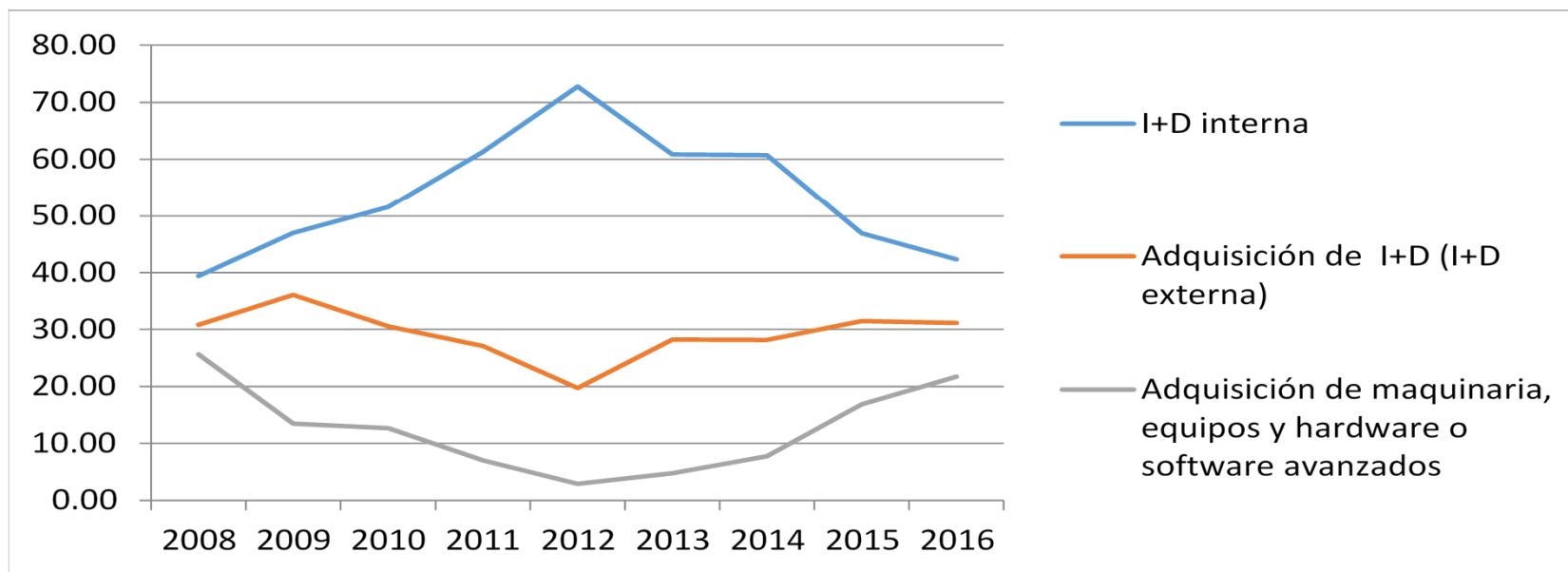
Note: R&D expenditure in oil, energy and water \approx 3% total R&D business expenditure

Figure 2. Innovation and R&D expenditure. Electricity, gas, steam and air conditioning supply (NACE Rev. 2. 35). Thousands of euro



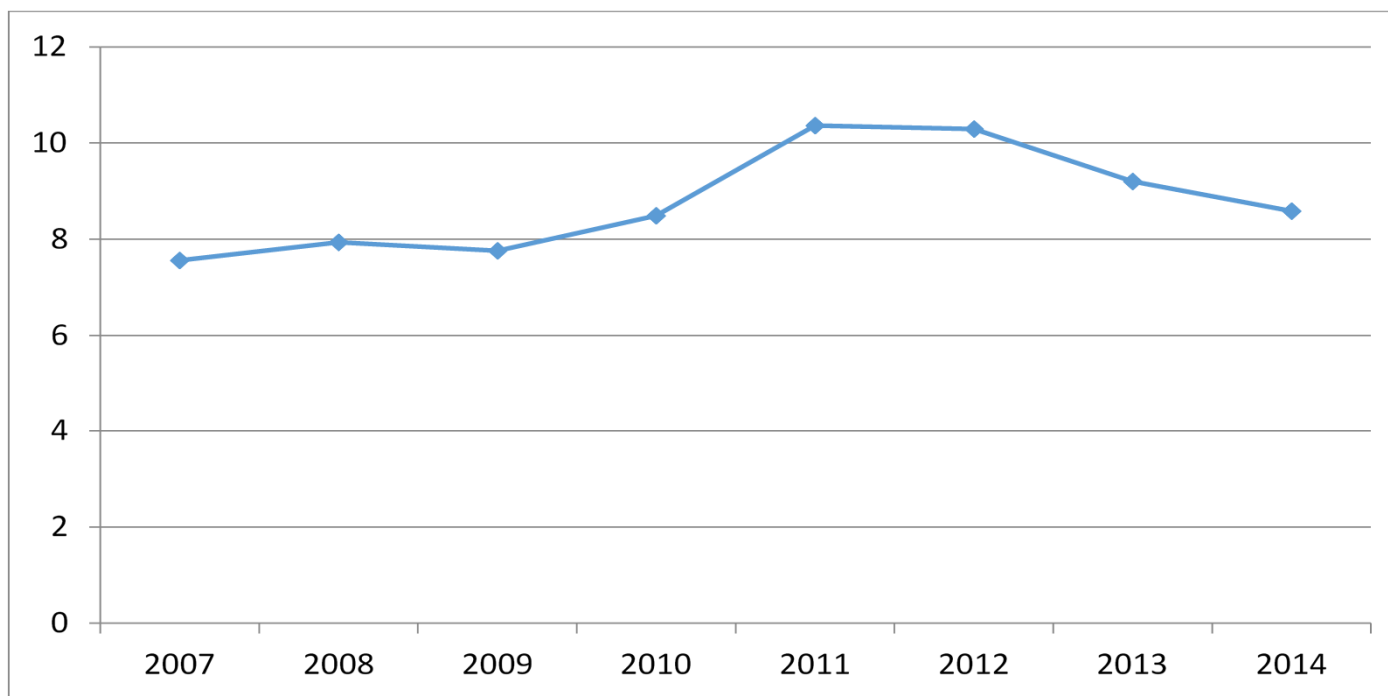
Source: INE and own elaboration

Figure 3. Internal R&D, external R&D, acquisition of advanced machinery, equipment and software (As percentage over total innovation expenditure).



Source: INE and own elaboration

Figure 4. R&D expenditure in energy (as percentage over business internal R&D)



Source: INE and own elaboration

R&D into production, distribution and rational use of energy (SEO 5, OECD).

Main sectors: Electrical equipment (23,5%), machinery and equipment (15,5%), chemicals (10,5%), paper and printing (9,3%)

Source: R&D and own elaboration

- Models and econometric techniques (causal effects)
- CDM model (three stages): R&D decision, investment (amount) and innovation (product and process separately)

$$D_{it} = \begin{cases} 1 & \text{if } \beta Z_{it} + \alpha_{1i} + d_t + \varepsilon_{1it} > 0 \\ 0 & \text{if } \beta Z_{it} + \alpha_{1i} + d_t + \varepsilon_{1it} < 0 \end{cases} \quad (1)$$

$$R\&D_{it} = \begin{cases} \beta X_{it} + \alpha_{2i} + d_t + \varepsilon_{2it} & \text{if } D_{it} = 1 \\ 0 & \text{if } D_{it} = 0 \end{cases} \quad (2)$$

$$INN_{it} = \gamma R\&D_{it} + \beta W_{it} + \mu_{it} \quad (3)$$

RESULTS

- R&D and innovation in energy: determinants and barriers
- R&D and innovation strategies of energy firms
- Public policies

RESULTS. Determinants and barriers

1. Recent recovery of R&D effort in energy in the world (not in Spain)
2. Firms key agents: \approx 9-10% R&D expenditure in energy / total R&D business expenditure (Public administration: 2-3%).
3. Effort in R&D of energy firms: size affects the decision to do R&D, age (young firms), public support.
4. Firms not restricted by financial barriers, overcome uncertainty obstacles. Perception that “incumbents” limit R&D investment (debate)

RESULTS. R&D and innovation strategies

1. Innovation objectives: R&D effort related with environmental challenges and regulation requirements
2. Energy efficiency and process innovation: innovation expenditure – no R&D- (acquisition of advanced machinery)
3. Positive relationship between technological and organizational innovation
4. Complementarity between internal and external R&D
5. Important role of suppliers: amount of R&D expenditure and cooperation with energy firms

RESULTS. Public policies

1. Business investment is key but public support is very important (spillovers). Public subsidies have a positive effect on business R&D. Sustained effort is needed
2. Public support to environmental R&D requires more than one instrument (double externality)
3. Public-private cooperation is necessary to face challenges. Importance of cooperation between energy firms and suppliers (networks)

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