Assessing the 2014 retroactive regulatory framework applied to the concentrating solar power systems in Spain

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HIGHLIGHTS

- Analysis of the RD 413/2014 new economic and regulatory framework for CSP in Spain.
- Description and formulation of the new remuneration scheme.
- A simplified model is proposed to identify the most influential regulatory parameters.
- The economic impact of the most influential regulatory parameters is identified.
- Remarks concerning the last arbitral Award related to Spanish CSP are discussed.

ARTICLE INFO

ABSTRACT

The RD 413/2014 new economic and regulatory framework applied to the concentrating solar power plants (CSPP) in Spain has been here analysed and its new remuneration scheme has been formulated, becoming evident its high complexity and the great number of regulatory parameters involved. Next, a new model focused on determining its impact on the economic results of the existing CSPP has been proposed. Due to the complexity of the system, a methodology comprising a set of different stages of analysis has been developed. The new model has proven to be a useful tool to analyse the economic impact of the new regulatory scheme on the facilities and to identify its most influential regulatory parameters. One of the most representative facilities has been chosen as a case study to undertake the analysis. The results of the analysis, which have shown a substantial profitability reduction, have been consistent with the appreciations and data provided by the claimants of the last arbitral Award concerning the Kingdom of Spain and investors of CSPP in this country.

1. Introduction

The research on Concentrating Solar Power (CSP) has gained great momentum in the last years. The short survey in Table 1 illustrates how prolific this research has become. There, a representative sample of relevant studies constituting the state of the art of CSP has been classified into the main topics that have shaped the recent research. As a result, four different thematic areas (placed as the main rows of Table 1) have been identified, namely, "Regulatory Analysis", "Economic Analysis", "Sector Studies" and "Technical Analysis". In addition, some of the thematic areas have been split into different subsections in order to provide a greater level of detail. Also, the references have been organized into different columns according to the focus country or region. The research not specially addressed to any particular location was placed under the heading "General".

Clearly, it has been the category "Technical Analysis" [1–72] which has captured the greatest attention of the researchers and its subsection "Storage" should be praised as the most prolific one [1–38,61].

Nomenclature

Acronyms

CPI   Consumer Price Index
CSP   Concentrating Solar Power
CSPP   Concentrating Solar Power Plants
ECT   Energy Charter Treaty
GCPVS   Grid Connected Photovoltaic Systems
ICSID   International Centre for Settlement of Investment Disputes
IRR   Internal Rate of Return
ISDS   Investor-State dispute settlement
MO   Ministerial Order
NPV   Net present value
PER 2005–2010   2005–2010 Spanish Renewable Energy Plan
RD   Royal Decree
RDL   Royal Decree-Law
RES   renewable energy systems
SCSPS   Spanish Concentrating Solar Power Sector
SES   Spanish Electric System
SR   Specific retribution

Variables and parameters

a year in which a CSPP obtained the operating permit
a_t year in which a CSPP of type t obtained the operating permit
$C_{j,a}$ coefficient representing the investment cost of a CSPP obtaining the operating permit in the year a that cannot be recovered with the market revenue within j
$Cexp_i$ standard operating cost per unit of installed power for a year i under the RD 661/2007 [€/MW]
$Cexpf_i$ standard operating cost per unit of installed power within the year i under the RD 413/2014 [€/MW]
$Cost_i$ cost in the year i of the SCSPS [€]
$Cost_{i,t}$ cost in the year i of a CSPP of type t [€]
$Cost_t$ cost of a CSPP of type t over its lifetime [€]
CPI Consumer Price Index
CPI_i Consumer Price Index for the year i
CPI_i' CPI_i at constant tax excluding unprocessed food and energy products
$Cumulative\ Cost$ cost of the SCSPS over their lifetime [€]
C_Eexpf_i standard operating cost per unit of generated energy in the year i under the RD 413/2014 [€/MW h]
C_Eexp_ei standard operating cost per unit of generated energy in the year i under the RD 661/2007 [€/MW h]
C_Eexp_reali actual operating cost per unit of generated energy in the year i under any regulatory framework [€/MW h]
C_Eexp_stdi standard operating cost per unit of generated energy in the year i under any regulatory framework [€/MW h]
d_i weighting factor reducing $SR\_Revenue_i$ according to Nh_inst_i
$Discount\_Rate$ rate of discount for the profitability analysis
E_i total energy generated within the year i [MW h]
$E_{i,t}$ total energy generated within the year i by the CSPP of type t [MW h]
E_max_i maximum value of E_i eligible for perceiving the Ro_i [MW h]
$Equity$ value of the equity
$FIT_{i,t}$ feed-in tariff in the year i for a type facility t under the RD 661/2007 [€/MW h]
F_OMC_{a+1} fixed operating cost within the year $a + 1$
Ing_i standard income per unit of installed power for a year i under the RD 661/2007 [€/MW]
$Ingf_i$ standard operating income per unit of installed power within the year i under the RD 413/2014 [€/MW]

Int_Rate value of the loan fixed interest rate
Inv_Cost investment cost [€]
Inv_R_i remuneration for the investment in the year i [€]
j three-year half-period
K_j capital recovery factor
K_R yearly degradation rate [%]
LR reasonable profitability
$LI1_{i,j}, LI2_{i,j}$ lower limits for the calculation of $Vajdm_{i,j}$
$LS1_{i,j}, LS2_{i,j}$ upper limits for the calculation of $Vajdm_{i,j}$
$Market\_Revenue_i$ market revenue perceived in the year i [€]
nd number of years for the depreciation of the asset [years]
$Nh_{i,j}$ standard equivalent operating hours within the year i of j under the RD 413/2014 [h]
$Nh_{i,t}$ standard equivalent operating hours within the year i of type facility t [h]
Nh_ei standard equivalent operating hours within the year i under the RD 661/2007 [h]
Nh_ei,t standard equivalent operating hours within the year i of type facility t under the RD 661/2007 [h]
Nh_eohi,t standard equivalent operating hours within the year i of type facility t under any regulatory framework [h]
Nh_inst_i actual equivalent operating hours within the year i under any regulatory framework [h]
Nh_inst_{a+1} initial value of Nh_inst_i
$Nh\_max_{(Ro)i}$ maximum value of Nh_inst_i eligible for perceiving the Ro_i [h]
Nh_min_i minimum value of Nh_inst_i that does not entail a reduction of $SR\_Revenue_i$ [h]
Nh_std_i standard value of Nh_inst_i [h]
$nyrd$ number of years to replace the debt or term of the loan [years]
Op_R_i remuneration for the operation in the year i [€]
$Operating\_Costi$ total operating cost for running the facility [€]
p first complete year of j
P_n rated power [MW]
P_t total capacity of the CSPP of type t [MW]
Pm_i average energy market price per unit of generated energy in the year i [€/MW h]
Pmf_i future estimated average market price per unit of generated energy for the year i [€/MW h]
Pm_ei revenue per unit of generated energy in the year i under the RD 661/2007 [€/MW h]
PT_IRR_i pre-tax internal rate of return up to the year i
r_i curtailment for CPI_i
$Revenue_i$ total revenue perceived in the year i [€]
$Rinv_{j,a}$ remuneration for the investment per unit of installed power in a year i within j of a CSPP obtaining the operating permit in the year a [€/MW]
Ro_i remuneration for the operation per unit of generated energy in the year i [€/MW h]
sm number of years of j
SB_j average yield during determined period of the 10-year Spanish bonds in the secondary market within j
$SR\_Revenue_i$ SR revenue perceived in the year i [€]
t type facility code
t_j per unit discount rate within j corresponding to the reasonable profitability
Tax_Rate rate of corporate tax
Tax_E tax on the produced energy [€/MW h]
Tax_R tax on the retribution of the produced energy [%]
Uf_i threshold of Nh_inst_i for perceiving $SR\_Revenue_i$ [h]
$Vajdm_{i,j}$ coefficient adjusting the deviations of Pm_i from Pmf_i
VI_a standard value of the initial CSPP investment per unit of installed power [€/MW]
$VNA_{j,a}$ net value per unit of installed power in a year i within j of