THE ROLE OF CCS IN THE IBERIAN PENINSULA: CONTRIBUTION FOR A REGIONAL ROADMAP

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Overview

Technologies of carbon capture and storage (CCS) have been considered an important element of the greenhouse gas (GHG) mitigation portfolio from large-scale fossil fuel use as in fuel transformation, industry and power generation. Several authors argue that the deployment of CCS technology is conditioned by the existence of a carbon price and thus ultimately by climate policy. However, climate policy also promotes other options, like renewable base technologies (RES), energy efficiency (EE) and energy saving measures, with collateral advantages promoting security of supply.
The Iberian Peninsula (IP) has a significant RES potential, which has been exploited by the Spanish and Portuguese economies during the last decade, as well as EE potential, still to be implemented. In principle, such a context quite favorable to RES and EE might reduce the opportunity for the CCS in the region. Energy commodities prices also play a role to the promotion of CCS, with expectations on stabilization or decrease of gas prices promoting its use. The possible use of domestic coal resources may offer another opportunity to CCS development.
This paper assesses different conditions (renewables development, CCS deployment, and fossil fuel prices) under which CCS technologies may represent a cost-effective option to climate mitigation for the IP, both for power generation and industrial sector (cement and iron and steel) for the time horizon up to 2050. The results achieved are key data and knowledge to contribute for the development of a CCS regional roadmap.

Methods

The role for CCS technology in the energy and industry sectors in the IP was assessed through the TIMES_Iberia partial equilibrium optimization model (originally extracted from the Pan European Times model [1]), that generated nine scenarios representing different conditions: (i) Climate policy: EU targets stated constant for the period 2020 to 2050, including the effort sharing non-ETS sectors for Portugal and Spain vs. ambitious climate policy, following [2], (ii) Renewables Development: optimistic (investment costs 30% lower than expected) and pessimistic (investment costs 30% higher than expected) expectations for non-mature renewables technologies like solar, waves and wind offshore, (iii) CCS deployment: optimistic (investment costs 10%, 30%, 50% lower than expected) and pessimistic (investment costs - 30% higher) expectations for the deployment of CO_2 capture technologies, and (iv) Fuel prices: expectation on a falling trend up to 20% of gas price, due to recognized higher availability of gas reserves (mainly shale gas). All the scenarios mentioned in i); ii); iii) and iv); were built upon the ambitious climate policy of 50% reduction of CO_2 emissions regarding 1990 figures.
The demand for energy services supporting the future development of the IP energy and industry system considers an increasing population trend and optimistic economic growth rates, aiming to produce high level of activity, which maximize the generation of CO_2 emissions, and thus *a priori* might contribute to foster CCS.
The technical and economic characterization of CO_2 capture technologies were collected from ([3], [4]; [5] and EU-COMET project (2010-2012). For the CO_2 transportation, herein only onshore and offshore CO_2 transportation via pipeline is considered, with 1.5€/t CO_2 and 3.4€/t CO_2, respectively, considering an average pipeline length of 180km [6], which is a good approximate average distance for both countries when considering the CO_2 emissions sources and the spatial distribution of the storage sinks. Concerning CO_2 storage, saline aquifers are the only option considered for the IP, in regard of the characteristics of Iberian reservoirs (onshore and offshore). Under the EU-COMET project, a potential CO_2 storage sinks capacity was assessed up to 7.7 $GtCO_2$ for Portugal, and 23 $GtCO_2$ for Spain, with the onshore sink potential representing around 75% of the total potential [7]. CO_2 storage costs were derived from an average estimate from [8], notably 5€/t CO_2 for onshore and 14€/t CO_2 for offshore.

Results

Climate policy: An ambitious reduction of 50% of the energy related CO_2 emissions by 2050, over the 1990 emissions, is technological feasible for the IP, being the power, transport and industry sectors with very important changes. RES for electricity production appears highly competitive which limits the role for CCS. The decreasing production of nuclear energy until decommission of all power plants in 2030 is a main push for CCS technologies deployment in Spain. CCS starts to become competitive only when the mature renewables are fully exploited up to their technical potential, by year 2040. We estimate that CCS will capture about 17% of the power and industry emissions in Iberia (60% in power and 40% in industry; 5% in Portugal and 95% in Spain) from 2025-2050. The power sector is the most attractive for CO_2 capture technologies, and the imposition of a CO_2 cap is a major driver to anticipate around 10 years its implementation. Compared with current climate policies, a more stringent cap will promote CCS technologies to capture more 30% of CO_2 emissions in the simulated period.

RES development: an optimistic perspective on RES, when compared with the expected cost curve, will (i) benefit solar PV plants (double the capacity to 11.5GW in 2020), and concentrated solar power, ocean energy (both wave and tidal technologies) and wind offshore in medium to long term, (ii) decrease by 16% by 2040 the gas power plants with CCS, (iii) represent a CCS opportunity for cement industry. A pessimistic perspective on RES will (a) decrease, by 2050, 7% of the RES electricity production while promote in the same proportion the production from gas power plants with CO_2 capture technologies, and (b) increase 14% of CO_2 captured in cement industry.

CCS deployment: The uncertainty in CCS deployment is dealt through the consideration of a range of costs (-50% to +30%). This changes impact mostly the power sector and occur earlier with costs reductions higher than 30%. The CO_2 captured by 2030 almost double when costs reduce 30%, and increases by 150% when costs halved. In opposition, no CCS appears competitive by 2030 when costs increase 30%.

Fossil fuel prices: a decrease of about 20% in the gas price will increase the role for CCS in IP, mainly in the power sector, with the production of electricity from gas power plants with CO_2 capture raising more than 20% both in 2030 and 2040 and 5% in 2050, when compared to the ambition climate reduction scenario. In the industry sectors, CO_2 capture technologies decreases near 12% in cement industry and 2% in iron and steel sector by 2030. Lower costs of gas promote an increase of its use in other end use sectors like residential and commercial.

Conclusions

The role of CCS during the period 2025 to 2050 in the IP energy and industry sectors can be summarized as follows: i) increasing opportunity in an ambitious mitigation target (37% of total energy related CO_2 captured in 2050); ii) variations on the costs of RES technologies have restrained impacts; iii) no impact for a 10% cost reduction of CO_2 capture technologies, while important effects on CCS adoption for higher costs reductions (we estimated a range of minus 493 Mt CO_2 to additional 550 Mt CO_2 captured, for the 30% increase and decrease costs, respectively; iv) a slightly positive impact on early years from a decrease of gas price essentially in the power sector. Compared with an ambitious mitigation policy, a pessimistic perspective on the evolution of RES costs represents the higher opportunity for CCS adoption followed by an optimistic evolution of CCS costs. This means that, for the case of the IP, competition of the CCS technologies depends greatly on its own technological deployment and on RES constrained evolution.

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