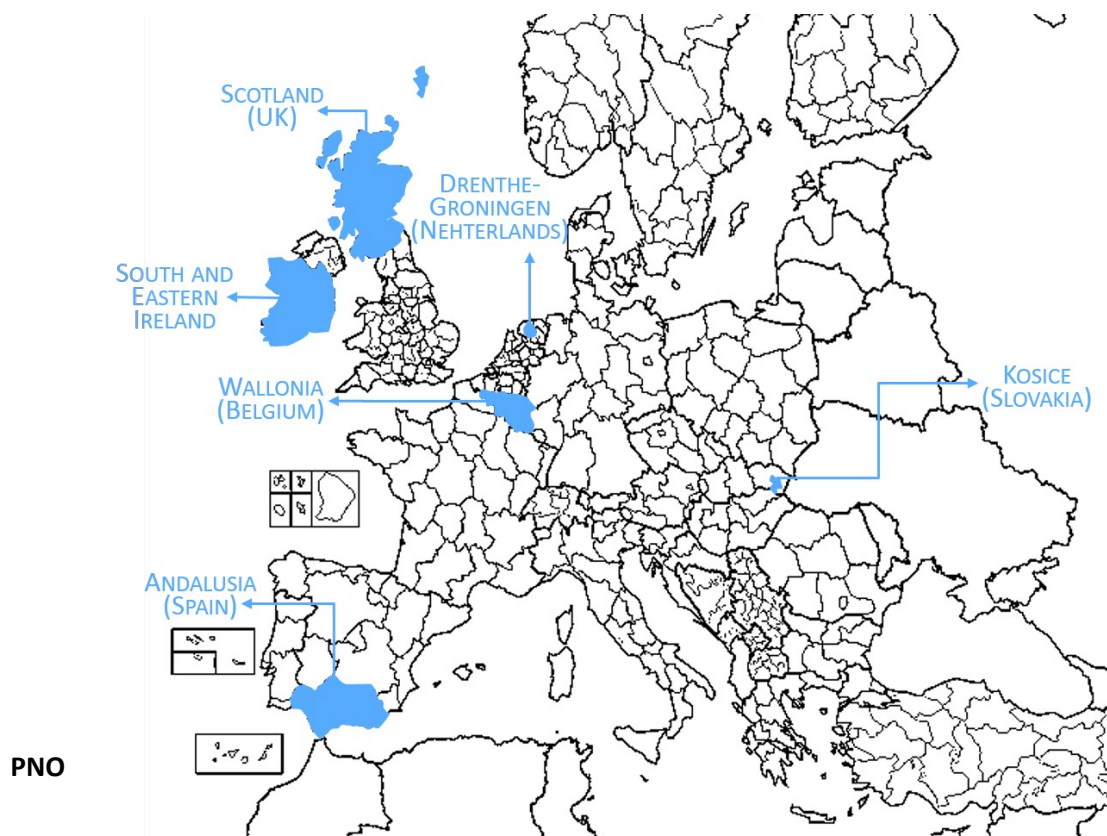


# Andalusia as a model demonstrator region

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Consultants – CIRCE

Task 2.1 Analysis of the investment readiness of the six “Model Demonstrator Regions”

September 2016

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## Introduction

This document is an assessment of the investment readiness of the region of Andalusia concerning investments in the area of Sustainable Chemicals. Sustainable Chemicals are defined as new chemical processes that use either biomass (agriculture and forestry), waste streams (organic waste streams and plastic waste) or CO<sub>2</sub> as feedstock. The assessment has been carried out using the Sustainable Chemicals framework for analysing a region's investment readiness.

Andalusia is the most populous region of Spain (8.4 million inhabitants) as well as one of the largest in Europe (87,268 km<sup>2</sup>). The region was struck severely by the recent economic crisis in 2008. Between 2008 and 2013 the industrial employment growth rate in 74% of the Andalusian municipalities has been negative<sup>1</sup>. Another result of the crisis is Andalusia's high unemployment rate, which amounted to 35.3% in 2014<sup>2</sup>. In spite of the current economic challenges, the recent attention for the Circular Economy (including Biobased Economy) on European level, could become the driver for new growth as Andalusia is uniquely positioned for a transition towards a more circular and biobased economy.

One of the reasons for Andalusia's unique position is that it features a large agricultural sector. Over 44.3%<sup>3</sup> of its surface area and 8.4%<sup>4</sup> of its work-force are dedicated to this sector; in addition Andalusia's agro-food industry is one of the main economic drivers of the region. It is extended all over the Andalusian area and is widely present in rural areas. The biomass resources are coming mainly from olive grove, as well as the fruit and vegetable sector. Andalusia is the world's largest olive producing region and home to a substantial horticultural sector producing fruits and vegetables. Many remains of the agri-food sector can be transformed into products intended for animal feed and fertilizers to strengthen the concept of circular economy related to the bio-based economy; this aspect is of great interest given the agro-industrial potential of Andalusia. The water employed by agricultural processes can be reused and is a source for nutrients. The aquaculture sector is experiencing an important development to contribute to the sustainability of the fisheries sector. Furthermore there are several initiatives related to algae in Andalusia. Algae can provide a means to convert sun light and CO<sub>2</sub> into valuable chemicals.

The Andalusian Government has recently approved (July 12, 2016) the formulation of the Andalusian Bioeconomy Strategy, which aims to develop in the coming months, with the participation of the most representative economic and social actors and society in general. This program will advance in aspects in which Andalusia has more opportunities, having defined a line of action in relation to the plant remains from the intensive horticulture; the program has a great relevance since the intensive horticulture has a high producer potential and is strategic in the whole agriculture sector (the value of the production of fruit and vegetables is 4,800 million euros representing 21% of total greenhouse horticulture employment generated in Andalusian agricultural holdings).

The chemical sector and other related sectors (e.g. pharma) are also well represented in the region. There are two chemical clusters, Campo de Gibraltar and Bahía de Huelva, which are each managed by two cluster associations (Association of Large Industries of the Campo de Gibraltar, AGI, and the

1 Estrategia Industrial De Andalucía 2020, Agencia de Desarrollo y Innovación de Andalucía

2 Encuesta de Población Activa (EPA), Tercer trimestre de 2014, Instituto Nacional de Estadística, 2014

3 <https://www.agenciaandaluzadelaenergia.es/ciudadania/energia-andalucia/cartografia-energetica/recursos-y-potencial/mapa-potencial-biomas>

4 The Agricultural and Fisheries sector in Andalusia, Consejería de Agricultura, Pesca y Desarrollo Rural, 2015

Chemical, Basics and Energetic Industries Association of Huelva, AIQB). The production plants belonging to the AIQB covers the electric generation (including biomass as a raw material), the manufacturing of basic organic products (phenol, cumene, acetone, biofuel), inorganics (fertilisers, raw material for detergents, chlorine and by-products, mineral gases...), the metallurgy of the copper and the production of the paper pulp.

In order to make the transition towards a circular and biobased economy, the challenge is to (inter)link the existing chemical sector and agricultural sector. This is a process that is already going on through multiple initiatives. Andalusia has a strong Bio-energy sector and is at the forefront of thermal biomass in Spain with 23,744 installations, and has 11 operative biofuel plants with a capacity of 1,281 ktoe/year. The region has 18 biomass facilities with a total installed capacity of 257 MW and with a biomass consumption of almost 724 ktoe/year. In addition to that, 17 biogas facilities with almost 30 MW capacity, sourcing their gas from landfills and wastewater treatment plants that are within the Andalusian territory. The region is also the national leader in bio-fuels production-

Having sufficient alternative feedstocks available, a critical mass of chemical industry and also reasonable investment in biobased production, Andalusia is well positioned to further engage in Sustainable Production using biomass and waste. Both the olive industry as other agri-food industries are including other industrial processes for the utilization of by-products for feed, fertilizers, energy and composting mainly, and are increasingly acting now as Bioindustries.. This report will systematically assess the investment readiness of Andalusia in Sustainable Chemicals using the investment readiness framework developed in the Sustainable Chemicals contract. This framework consists of 8 factors which are important boundary conditions for Sustainable Chemicals investments. The analysis has been performed using information provided by the Junta de Andalucía, consisting of policy documents, the self-assessment the region has made based on the preliminary SAT questionnaire and information obtained from public available sources (Eurostat, INE, etc.). The eight factors are:

1. Long term, stability and availability of the feedstock;
2. Infrastructure to handle feedstocks and production;
3. Access to finance;
4. Skilled workforce, technical expertise, training;
5. Existence of support institutions;
6. Strength and availability of regional markets;
7. Entrepreneurship;
8. Public support policies.

For each factor, a SWOT analysis has been performed. Based on the SWOT analysis, an overall analysis of synergies was performed, including recommendations, expected impacts and way forward.

## Current state-of-play

The current state-of-play in the creation of biobased and circular value chains in Andalusia is presented in the overview in Annex I. When discussing the individual factors for investment readiness in the next chapter, we build on this state-of-play analysis.

The olive sector in the Andalusian economy is one of the most important by its extension, economic value, generated biomass, employment and related direct and indirect industry. Andalusia is the main producing region of olive products worldwide, with an agro-industrial network composed of 800 mills, 16 olive oil refineries 211 seasoning plants and 40 plants for the extraction of pomace oil. The

average olive production is 5.48 tons of olive, which is mainly intended to obtain olive oil (92%) and the rest to table olive. The agro-industries in this sector generate a high quantity of by-products as a result of their activity.

The pomace that is generated in the production of olive oil is mainly intended to obtain olive oil, but can also be used to produce electricity. The pomace contains fat, that is extracted to obtain olive oil pomace, so it is necessary to dry and extract. The result is the olive pomace oil and a product, olive marc (orujillo) with good properties as fuel and properties that allow its use both in generation of energy thermal as electric. The average production of orujillo in Andalusia is around 985,500 tonnes per year.

Another by-product obtained is the olive stone or olive pit, which is a fuel of optimal characteristics for thermal applications in households. 277,000 tonnes of olives stone per year from the oil industries and 80,000 tons from the seasoning olives industries, are produced in Andalusia. Finally, we must mention that there are annually generated more than 2.5 million tonnes of remains of pruning, for which equipment for chipping and management is actually being developed.

The total energy potential of the olive by-products in agro-industries of the olive grove is estimated in 567.702 tep/year

These by-products are mainly used for energy purposes; in particular, 47,0% of the total amount generated is used for electricity generation or cogeneration and 32.9% for thermal applications (altogether, energy uses represent 79.9%). Their incorporation as soil organic matter accounts for 14.3%, and the rest of applications such as animal feed, residue management, etc. represent 5.9%<sup>5</sup>complex for refining olive oils and valorising by-products is very well developed.

Regarding forestry, biomass has a double application: either for timber products (sawlogs, boards, chipboard, etc), or for energy use (electrical or thermal energy production). In the first case, the residual fraction of the main forestal use can also be used for energy production.

The development of energy applications in recent years has been very important although innovation continues and the potential remains enormous given the situation of monoculture plantations of olive trees in vast regions of Andalusia.

At the other end of the spectrum, there are applications oriented to the development of new value added bioproducts (anti-oxidant food ingredients, lubricants, cosmetics and even bioplastics), which are the most innovative and promising ones. There are some companies but especially many research projects in preliminary phases and alliances and contracts between research centres and businesses working with productions in these fields.

For horticulture and forestry waste streams, there is a biobased industry potential in development like composting for fertilizers, animal feeding, anaerobic digestion for biogas or incineration for bio-energy. These applications to be more effective must have technological improvements, development of new processes, advances in logistics and new infrastructures that allow an adequate profitability and utilization of resources from chemical and biological processes. The Government of Andalusia has presented various lines of action on management of plant debris in horticulture from the perspective of circular economy; this action will form part of the Andalusian Strategy of Bioeconomy. The consumption of biomass transformed as livestock feed or fertilizer in soils has great possibilities in

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5 It is important to distinguish the concept of biorefinery in the bioeconomy "structure that integrates processes of conversion of biomass and equipment to produce fuels, power, and chemicals from biomass" traditional refining of the olive oil and pomace.

Andalusia given the importance of the agricultural sector and its climate of dry periods which does not allow the use of pastures year-round.

Currently, the energy use does not enable biomass fractionation to obtain recoverable products and this results in an economic sub optimal valorization of these streams. An advance in the fractionation of the biomass to improve its recovery is needed.

From the economic point of view, the establishment of a **lignocellulosic biobased** (and to **horticultural / agricultural biobased**<sup>[6]</sup> could really increase the added value from these feedstocks )

- The lignocellulosic biorefinery could produce ethanol or (in a more advanced process) sugars for advanced fermentation processes towards for example building blocks for bioplastics and coatings. Also a fibre fraction can be part of a lignocellulosic biorefinery, which could be used for the production of composites, paper, filler or rheology modifiers. The lignin could be used for the production of aromatic building blocks, which can be applied in a range of chemical applications. It could also be converted thermochemically towards oils, gas or biochar. The branches and leaves together with forestry wastes and olive and fruit tree pruning could serve as a feedstock for this biorefinery. However, in the current Andalusian setting, the local players which could take the lead in this are limited. Currently, the Agrifood Campus for International Excellence (ceiA3) is exploring various technologies in this field. However, for a large-scale plant, only a player like a big company may be able to take the lead in this type of initiative. Quite likely however this may need to be a company outside of the region.
- A horticultural/agricultural biorefinery would extract valuable compounds based on residual streams from crops (vegetables/fruits). Important components in these crops could for example be pectin, fibres or specialty sugars and proteins. These could be valorised for the production of building blocks for high value-added chemicals (cosmetics, gels), microcellulose fibres as filler or rheology modifier. At this stage, it is difficult to assess whether there is an Andalusian company that could take the lead in this.

Andalusia by the strength of its primary sector has high potential and capacity to produce different types of biomass, making possible the simultaneous existence of different models of Bioindustries, and without competition for feedstocks. In fact, with an adequate strategy the biomass can enter into a cycle of valorisation of their different fractions towards different industries (food, chemical, energy), existing supply capacity for all of them. Management of raw biomass and its necessary pre-preparation for their transport and/or subsequent transformation have been the main obstacles for a more ambitious development of the biobased industries. Energy use has helped develop a sector of logistics and distribution of biomass, close to the biomass thermal power plants that enable its use for other activities of the energy or complementary to these ones.

For this reason, it is important to consider a model of development of the bio-industries based in part on the joint of the SME's agri-food industries already existing, spread all over the region, close to the points of biomass production and that in Andalusia are nearly 5,700 industries taking advantage of the synergistic effects between them and the auxiliary or related sectors (transport, logistics, computer...) that cannot be overlooked

As for the introduction of algae bioindustries, the region is gaining an interesting position. Several promising projects are on-going using algae for waste water and CO<sub>2</sub> emissions treatment facilities, contributing to the development of the concept of an algae biorefinery, under which multiple high value-added products (food, nutraceutical, energy, materials, services) in a single installation can be obtained.

In addition, more advanced biobased projects for the production of bioplastics and the production of high added value chemicals are on-going in which partners from the region play an important role. The establishment of new links between algae cultivation and the extraction from valuable chemicals (which is now mostly taking place based on olive oil by-products) may yet give another boost to the establishment of algae biorefineries.

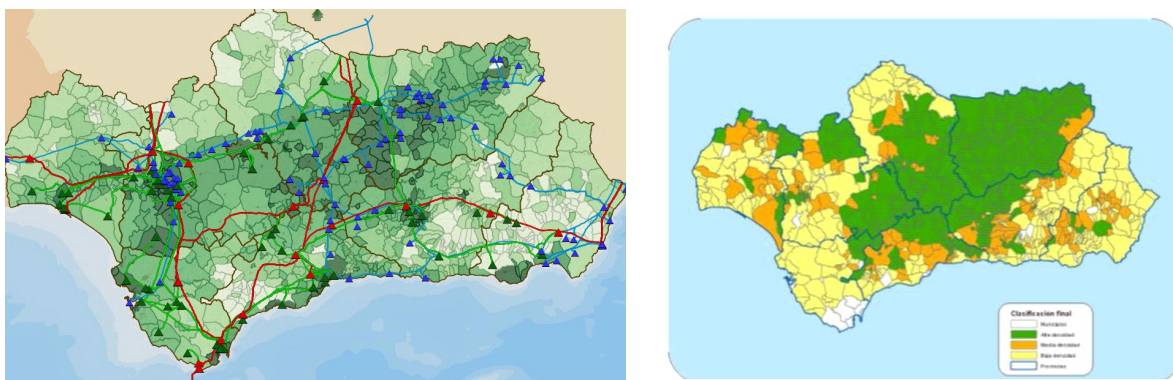
## SWOT Analysis of the eight key factors

The feedback to the key factors by the region of Andalusia was used as input for a SWOT analysis made by CIRCE. The SWOT analysis for the KF1-KF8 on biomass is given below. For each factor, an overview is provided of the region's strengths, weaknesses, threads and opportunities. Strengths and weaknesses are the region's current characteristics, whereas opportunities and threats are external characteristics and future situations which may be the result of the deployment of these strengths and weaknesses. Following this logic and based on the tables, then the SWOT analysis is made by:

- determining how strengths can be deployed in order to seize opportunities and counteract threats.
- determining how weaknesses can be mitigated in order to seize opportunities and counteract threats.

## SWOT KF1: Long term availability and stability of the feedstock

Andalusia has a strong agricultural base, which results in a high availability of potential biobased and waste feedstocks for Sustainable Chemicals production. The biomass potential identified in Andalusia amounts to 3,955 kt<sub>oe</sub><sup>6</sup> of which 1,322 kt<sub>oe</sub> are agricultural waste, 77 kt<sub>oe</sub> are livestock waste, 1,023 kt<sub>oe</sub> correspond to industrial waste, 322 kt<sub>oe</sub> are forest biomass, 620 kt<sub>oe</sub> are from energy crops and 591 kt<sub>oe</sub> are urban waste<sup>7</sup>. In addition, there are ample waste water treatment plants available since over 90% of the inhabitants are connected to waste water treatment and it has a separate collection system for recyclables in place<sup>8</sup>. Due to the intensive use of biomass for energy purposes, the region has an excellent statistical overview of the waste and biomass streams available and these are even registered in a digital system (see figure 1 below).



**Figure 1: Impression of the biomass database (left, green color indicates biomass availability) by the Andalusian Energy Agency (left) and the importance of the olive sector (green area) in the region**

6 Kilotons of oil equivalent

7 Data by the Andalusian energy Agency

8 Questionnaire feedback

Currently, much of the biomass and waste value chains are directed towards energy applications by means of cogeneration and generation in biomass power, biomass heating (ranging from small scale stoves for households to large scale boilers for industry, farms, commercial buildings) or conversion into solid biofuels like wood pellets or wood chips. This is due to the strong tradition Andalusia has in renewable energy, which has been driven by the objective to become self-sufficient in energy supply. The definition of dedicated policies<sup>9</sup> in this area already started in 1995 and is now implemented by the Andalusian Energy Strategy 2020. As such, the use of biomass has also very much developed towards liquid biofuels (11 plants in total) first position at national level, 18 Biomass Power Plants (first position at national level too), 17 Biogas plants for electric use, and 24 composting plants.

Its high solar irradiation makes Andalusia not only a very strong sector in solar energy technology and production, but also an attractive location for algae production for energy, fuel or chemicals production. Already several projects are on-going in this field.

In the same way the agri-food industry, in general, has capacity of having surplus of biomass as fruits that is not destined for the market, shells, pulps etc. In any case, the volume of biomass produced is very significant and varied and with ability to extend application beyond the energy sector by using Andalusian biotechnology. Also the horticultural sector generates a large amount of remains plant that only in Almeria already accounts for a million of tonnes per year. The transformation of these remains is conditioned by its high moisture content, seasonality in its production and the possibility of containing remains of plastics.

The table below presents strengths, weaknesses, opportunities and threats for this factor:

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>• Significant biomass potential in terms of agricultural biomass (extensive areas of olive groves, fruit and vegetables in the region).</li> <li>• Strong and rooted agri-food and farming sectors (waste).</li> <li>• Important agri-food industry with the ability to participate in biobased processes</li> <li>• Large amount of pruning, mill leaf, olive pomace, olive marc, and olive pit, vineyard residues, sunflower and forest crops produced in the region.</li> <li>• Important concentration of the feedstock.</li> <li>• Sufficient information on the potential biomass available</li> <li>• Availability of other interesting waste streams such as agroindustry byproducts, sewage sludge, plastics and MSW (waste).</li> <li>• Already home to some algae pilots and great potential for larger algae plants as a result of strong solar radiation due to its Southern location</li> </ul>	<ul style="list-style-type: none"> <li>• The bio-refinery sector has not been developed in the region yet, apart from biobased industries and production of liquid biofuels.</li> <li>• Limited knowledge about alternative uses of different feedstocks and how to introduce alternative value chains.</li> <li>• Not clear yet how the potential demand for alternative feedstocks matches the availability of biomass.</li> <li>• Current feedstock logistics systems may not yet be optimized for alternative feedstock applications (e.g. pre-treatment, logistics centres).</li> <li>• Lack of detailed analysis of potential applications of available waste and potentially interested companies in the region (waste).</li> <li>• Known processes of transformation but with lack of development by means of technological difficulties, logistics etc.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• The region is partially using the biomass for other uses but there is still a large amount that</li> </ul>	<ul style="list-style-type: none"> <li>• Competition with cheaper products derived from fossil energy</li> </ul>

<sup>9</sup> Andalusian Energy Plan 1995-2000, Andalusian Energy Plan 2003-2006 and Sustainable Energy Andalusian Plan 2007-2013 (PASENER)

<p>is not currently use and therefore available for other sectors.</p> <ul style="list-style-type: none"> <li>• Increasing attention by European industry to use biobased feedstock and waste for which commercial process becomes available next year.</li> <li>• Existence of chemical production sites and initiatives that could apply bio-refinery concept.</li> <li>• Potential reconversion of abandoned and strategically located bio-diesel production plants into bio-refineries.</li> <li>• Algae and solar energy as alternatives for current biomass use for bioproducts</li> <li>• Increased knowledge on sustainable production and waste as raw material concept (waste).</li> <li>• Sewage sludge, MSW and farming waste have potential for fertilizer and other high added value products (waste).</li> <li>• Existence of a livestock where grazing is not alternative year-round and need external contribution</li> <li>• Important development of biological agriculture with needs of new products more sustainable</li> </ul>	<ul style="list-style-type: none"> <li>• The electric market and of those biofuels are subject to Regulation normative that conditions the market and distorts them prices of the biomass</li> <li>• Potentially cheaper or more high-quality feedstock by other European countries or other Spanish regions.</li> <li>• Seasonality of the biomass remains and inadequate collection infrastructure</li> <li>• Need to develop technologies adapted to the type of product and process.</li> </ul>
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## SWOT Analysis

In terms of **strengths**, Andalusia is one of the largest suppliers of specific types of feedstocks in Europe (e.g. olives, fruits). These **strengths** can be deployed to seize the **opportunities** by quantifying the feedstock potential in order to determine what could distinguish Andalusia from other regions. This goes beyond the mere quantification of biomass and waste resources, but to quantify its unique competitive characteristics (low price, high quality or unique side streams) may give it a unique position to attract European biobased industries to invest in the region or to trigger one of the local industries to make a transition towards biobased production. Also a more detailed mapping of waste streams and their quality for new applications could be the basis for the creation of new value chains.

The **strengths** can be deployed to counteract **threats** by assessing:

- For which types of biomass Andalusia has a unique position in terms of price or quality. This may put the region in a better position to face competition from other regions. It is clear that Andalusia has a competitive advantage in olive oil sector and use for energy applications. However, side streams and specific fractions in the olive pomace and olive marc could be valorized in higher added value applications.
- There is a great availability of biomass derived from the large primary sector, so there is capacity and need to expand the range of bio-industries in the region
- For which types of biomass there is competition and for which ones competition is not relevant:
  - There is competition in the olive stone, since this is a well demanded fuel in local and international market for thermal use, to the detriment of the use of olive marc, so in this case it would be necessary to establish a value chain that allowed that after extraction of high value of olive stone components is still possible using the rest as a high quality fuel

- For fruit, vegetables and agricultural, competition may be less likely and these could be diverted towards higher added value applications of specialty compounds, pectin and fibers.
- For forest feedstocks, olive pruning and lignocellulosic value chains could be established towards polymers or chemicals. The energy use of this biomass does not reach a percentage too significant, indicating that there would not be competition between both sectors. Competition from bio-energy is however quite likely since the supply of materials to these plants is probably arranged through long-term contracts.
- Algae remain an interesting outsider feedstock for which interesting results have already been achieved for the production of biogas and high valued added products
- Ample availability of sewage sludge, MSW and farming waste that offers opportunities to be applied as fertilizer or other high added value feedstocks.
- The potential for algae and solar energy to play a role in replacing current biomass use for and high value added products and water and CO2 treatments.

The **weaknesses** can be strengthened in order to seize **opportunities** and counteract **threats**. This can be done by performing a comprehensive study into the potential value chains which could be built in Andalusia taking into account the feedstocks available, but also the state-of-the-art in biorefinery and conversion technologies. Once this overview is available, a more specific overview of opportunities for Sustainable Chemicals is available and more concrete actions between stakeholders in these value chains can start.

## SWOT KF2: Infrastructure to handle feedstocks and production

On the feedstock side, there is some infrastructure available to collect, transport and pre-treat important feedstocks. The olive sector has well-developed infrastructures, but this is not the case for other sectors such as the horticultural sector. Here it is necessary to improve the profitability of the distribution of the remains to the final destination (midpoints, pretreatments etc..).

Figure 2 shows the industries, processes, main products and by-products obtained in the industry associated with the olive tree. For forestry, the use of biomass for electric and thermal energy production has favored the networks of logistics and specific infrastructures, which could be incorporated into complementary exploitation linked to sustainable chemistry. These logistics systems mainly rely on the good road connections and to a lesser extent on rail. The region's harbours in Cádiz, Huelva, Sevilla, El Puerto de Santa María, Algeciras, Almería, Málaga and Motril are well-equipped for import and export of biomass and many types of chemical products. On the other hand, in relation to major marketing support logistical infrastructure, Andalusia counts on a strong network of connections with northern Spanish regions and the Mediterranean. Two connections with Morocco and Portugal are also available. The available transport network had 5,942 km in 2015 and has shown an increase of 34% within the last ten years.

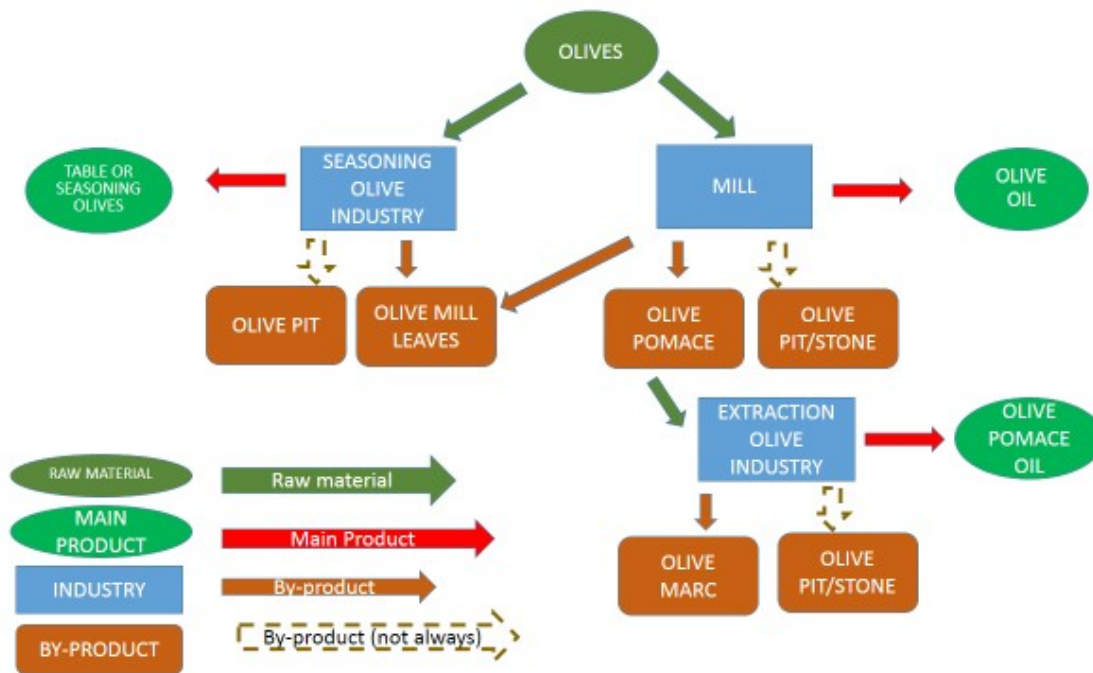


Figure 2. Olive sector scheme

Valorisation of waste streams is very much focused on energy applications, like bio-energy, wood pellet and cogeneration. The locations of the clusters of infrastructures in place are presented in figure 3 below in a very simplified way. In addition to the clusters with the highest degree of activity, there are also many more isolated plants throughout the region. In addition, a well-developed composting sector is in place with in total 24 plants. The region is home to two large chemical clusters: AIQBE in Huelva and AGI in Gibraltar. These chemical clusters are also home to some of the biofuel plants, which are still operational. In 2015, Andalusia had 11 operational biofuel plants (pure and additives) which had a joint production capacity of 1,281.8 ktoe/year. Of these plants, 7 are biodiesel factories and 4 are production units located in crude oil refineries of the company Cepsa for the production of biofuels as additives to fuels from refineries: two of ETBE (EtilTerButil-ether) and two of HVO (Hydrotreated Vegetable Oil).

In Almeria, there are six composting plants, but treatment costs are very expensive and the final product not always has a good quality; it has been a topic addressed in the lines of action for the Strategy of Management of Vegetable Residues in Andalusian horticulture.

Increasingly, valuable molecules from olive residues are isolated as feedstock for the chemical industry. This includes new bioproducts with more or less value added (bioplastics, biopaint, biosurfactants, biomolecules for different purposes). Companies active in this area are mainly biotech companies.

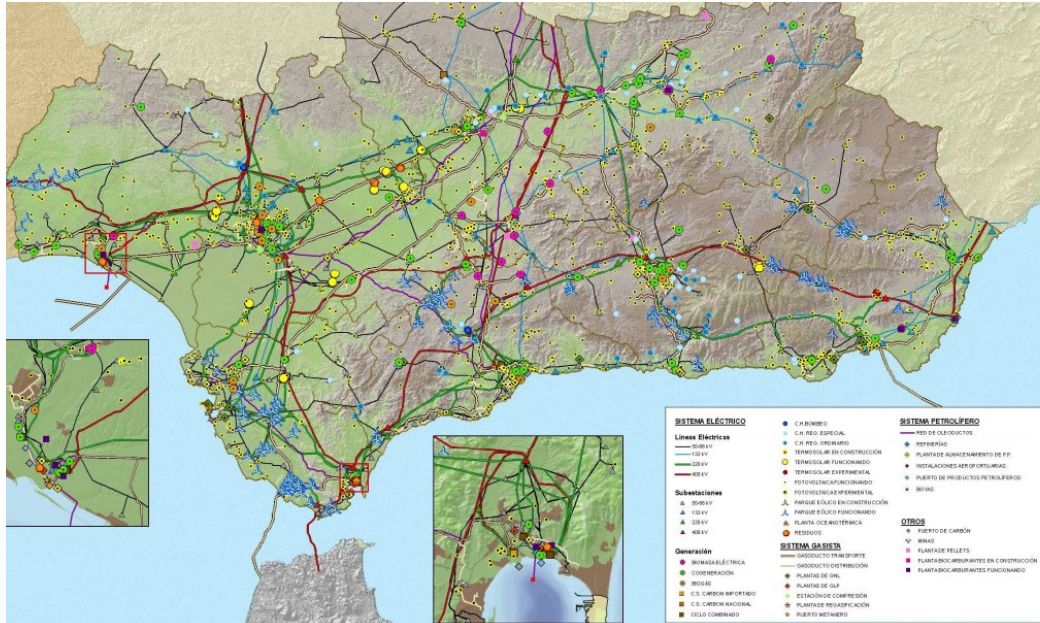


Figure 3: Energy and chemistry related infrastructures in Andalusia (main clusters, simplified)

The table below presents strengths, weaknesses, opportunities and threats for this factor.

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>The infrastructures required for the logistics of biomass are available in the region for olive sector and forestry.</li> <li>Logistics centers in the region in the related sectors (agroindustry, plastic waste, sewage sludge and waste in general) and intermediate storage facilities (waste).</li> <li>Good transport infrastructure network (roads, railways and harbours).</li> <li>Existence of infrastructure to implement the final use of biomass applying biorefinery concepts, in several sectors.</li> <li>Two large chemical clusters in the region which contain a diversity of companies and could serve as location for new Sustainable Chemical companies.</li> <li>One of the greater number of factories of biodiesel and facilities available in Europe.</li> </ul>	<ul style="list-style-type: none"> <li>Specialized biomass logistics centers available in the region, but are probably optimized towards existing value chain and owned by existing value chain stakeholders.</li> <li>There is no adequate infrastructure in horticultural sector</li> <li>Potential restrictions in the water supply, particularly in areas that do not have industrial activity already.</li> <li>For waste, the railway network sometimes limits logistics (waste)</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>Potential adaptation of existing forestry/sawmill/ agriculture cooperative/ waste logistic for managing different biomass feedstocks.</li> <li>Potential synergies among the industries involved (waste producers and waste users) in the region may exist, it should be assessed (waste).</li> </ul>	<ul style="list-style-type: none"> <li>Vested interests for infrastructure by existing users may create competition for new Sustainable Chemistry activities.</li> <li>A lack of commitment to specifically Sustainable Chemistry may imply 'loosing' strategic locations to other types of industrial development.</li> </ul>

<ul style="list-style-type: none"> <li>• Existing biomass transport companies possibly could deliver to new bio-based industries or bio-refinery.</li> <li>• Biodiesel infrastructure as a host for co-siting new plants</li> <li>• Refurbishment of existing old industrial installations</li> </ul>	<ul style="list-style-type: none"> <li>• High transport costs for certain low-density waste streams (waste).</li> <li>• Uncertainty in the waste production as linked to industrial activities (waste)</li> </ul>
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## SWOT Analysis

In terms of infrastructure, Andalusia is well positioned for attracting new investments for Sustainable Chemicals. In principle the infrastructure to set up new biobased or circular plants is there (industrial infrastructure, transport infrastructure and utilities) and there is no reason to assume infrastructure at this stage is a limiting factor for a transition towards Sustainable Chemicals business. The analysis below provides some ideas on how the infrastructure can be better put to use for Sustainable Chemicals.

The **strengths** can be deployed to seize **opportunities** by identifying the so-called ‘sweet spots’ in infrastructure. These are the locations where a lot of conditions that are crucial for a sound business case for Sustainable Chemicals production come together, like for example:

- Utilities (electricity, gas, water, piping) required for hosting chemical industry
- Proximity to feedstock or logistics centres which could provide this feedstock
- Shared production facilities or infrastructure
- Beneficial permitting situation
- Industrial symbiosis with other companies by exchange of product or waste streams
- Proximity to markets

Ideally, this analysis should be made for specific types of value chains enabled by the use of biomass or waste. This analysis will result in a number of specific locations that are very attractive to Sustainable Chemicals companies and could be further developed as part of a dedicated Sustainable Chemicals strategy. The starting point for this analysis could be mature European (not necessarily Andalusian) biobased business cases which are looking for a location to demonstrate their technology or even set up a commercial plant. For example:

- Biobased PEF is approaching commercial scale and could be an attractive opportunity for Cepsa in Huelva/Gibraltar, for example based on an aromatic fraction from olive pomace.
- Valorization of biofuels side streams (e.g. glycerine), co-siting at biofuel production sites or refurbishment of these plants for totally new products.
- Once optimally positioned in a specific location (e.g. close to feedstock), the Andalusian biotech companies could roll out their processes on commercial scale.
- The bundling of similar types of agro-food waste streams in one location may create the boundary conditions for a viable business case for based on fibres for composites, pectin for gels and sugars for food or biochemical applications.
- Integration of wastewater treatment facilities with algae production, which could subsequently act as a biomass source for biogas, bio-oils or biochemicals.

The **strengths** can be deployed to counteract **threats** (which mainly consists of competition by other industries for the same infrastructure) by exactly defining how attractive the current ‘sweet-spots’ are for innovative Sustainable Chemicals investments. Individual locations can best be developed based on a clear vision on how to use the unique characteristics of a site to attract new Sustainable

Chemicals industries. Obviously, it is not the intention to stop concrete investment initiatives from 'existing industries' in these sites, but based on a clear vision it is better possible to pro-actively attract investments and make clear decisions on what is the best investment for that site. Potentially particular strategic sites could also be developed as a cluster for certain strategic technologies (e.g. separation technologies for valuable fractions in olive oil or oil fractions from algae) or biotech conversion technologies.

The **weaknesses** can be strengthened in order to seize **opportunities** and counteract **threats** also by determining to which extent the limitations of the regions are actually limitations. Based on a clear overview of the actual opportunities of a specific site, a better judgement can be obtained about its attractiveness for Sustainable Chemicals investments. For example, the biodiesel plants could well serve as attractive 'sweet-spots' for Sustainable Chemicals investment, but the extent to which they actually have opportunities for this should be made more specific. Based on a more specific overview of good sites and actual cross-sectorial value chains, the actual limitations in transport (e.g. for waste) can be assessed which may not apply if a location is well chosen.

### SWOT KF3: Access to Finance

The banking sector is still in the early recovery phase after the economic crisis. As such, it is fairly difficult to obtain loans from banks in Andalusia. The innovative nature and inherent market insecurities of biobased and circular projects add to the challenge to get support from local banks. In spite of these challenging conditions, foreign investment in Andalusia rose up to €565 million in 2015 (100% more than in 2014), which is a promising indicator for the extent to which foreign companies and investors consider Andalusia an attractive region for investment. For innovative projects and newly created companies, the Andalusian Government has dedicated finance instruments in place<sup>10</sup> and a revolving fund, which focuses also on less innovative projects (e.g. pure investment and internationalization projects) and a public agency (IDEA) that also collaborates actively with private investors.

In terms of public finance, as a region of transition, it has a large budget for the framework 2014-2020 in terms of structural funds and in particular in the ERDF operational programme and in the EAFRD Rural development program. But these funds are subject to an already established programming which, although it considers low-carbon economy, climate change and risk prevention and environment and resource efficiency, among its priorities, it is not specifically oriented to sustainable chemistry. Other important sources of public funding are European framework programmes (FP7, Horizon2020), which share the same objectives of the Europe 2020's economy low in carbon, action before the change climate, efficiency in them resources, etc

The table below presents strengths, weaknesses, opportunities and threats for this factor

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>• There are general credit lines for financing projects and initiatives in the sustainable chemicals area.</li> <li>• Existence of collaboration network among</li> </ul>	<ul style="list-style-type: none"> <li>• Financing in the region is available but on challenging conditions (e.g. banks are still very weak).</li> <li>• Access to traditional lending instruments (loans and credits) seems</li> </ul>

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<p>some private, public and financial institutions.</p> <ul style="list-style-type: none"> <li>• Support institutions/advisory service for building up new industrial projects in the field of sustainable chemistry available.</li> <li>• Both private and public EIB/EIF financial intermediaries established in the region. <ul style="list-style-type: none"> <li>• As a transition region there is a large amount of ESIF funds available</li> </ul> </li> </ul>	<p>rather limited.</p> <ul style="list-style-type: none"> <li>• The private sector, and particularly SMEs, has problems in accessing private finance.</li> </ul>
<b>OPPORTUNITIES</b>	<b>THREATS</b>
<ul style="list-style-type: none"> <li>• Possible synergies with other public financing lines available (national or European funding - EIB or Structural Funds).</li> <li>• Possibility of creating intermediate credit lines (combining regional public resources with national or European).</li> <li>• Positive evolution of the foreign investment in the region</li> <li>• Increasing interest for sustainable investment</li> <li>• Promotion of the purchase public innovative as tool to improve the provision of services</li> <li>• Plan Juncker to finance through the BEI</li> </ul>	<ul style="list-style-type: none"> <li>• National and/or international private investment and equity funds in the region going to sectors other than chemicals: energy and construction.</li> </ul>

### SWOT analysis

Even though some financing instruments are available in the region, obtaining finance in this theme is in practice quite challenging. On the one hand, this is due to the challenging economic situation of the last years, which leaves banks and private investors reluctant to invest, particularly in new businesses like Sustainable Chemicals due to the relatively high-risk profile. However, the lack of focus on Sustainable Chemicals does not help in attracting more investments.

The main **strength** which can be used to seize the **opportunities** is the availability of the existing public-private partnerships in finance and support institutions for financing projects. These can be used to

- Create access to additional sources of finance, be it European (EIB, EAFRD, H2020, Cleantech investors, Biobased Industries Funding), purchase public innovative FEDER, direct investment from multinationals. Andalusian Government could play a major role in this support research and development of new projects. However, securing funding for investment projects also implies the development of mature projects. For sustainable chemicals projects, this often requires multiple players in a value chain or a company that has already succeeded in establishing this cross-sectorial connection (e.g. a biorefinery). They must also take advantage the initiatives envisaged in the Juncker Plan through the EIB (European Investment Bank) and the EFSI.

- To create a shared vision by local stakeholders on potential biobased and circular value chains as part of a Sustainable Chemicals. This would help to concentrate the scarce resources in the region (in particular the regional investment funds) on Sustainable Chemicals projects. In the end, the amount of companies endorsing a Sustainable Chemicals strategy will determine to which extent resources can be diverted from existing sectors in construction and energy. New visions are available, like the Olive Grove Master Plan, but are still very much single sector oriented instead of the cross-sectorial vision which is needed.

The **weakness** of scarcity of finance is not easily mitigated given the challenging conditions (recovering from crisis, unstable banks, challenge to cover the regional budget) in the region. Vision development will help identifying promising value chains in Sustainable Chemistry and develop a clear profile of the regions for Sustainable Chemical investments which could be financed from sources (foreign venture capital, banks, multinationals) which are more potent than national or regional sources of financing. By clustering the existing Sustainable Chemicals companies in the region around this vision, the region will be more successful in attracting different types of investors which would like to invest in sustainable technology. The opportunity that sustainable chemicals offer to valorise currently un-used fractions of biomass towards higher added value in the end is an economic opportunity, which will strengthen the competitiveness of for example agri-food companies.

#### SWOT KF4: Skilled work-force, technical expertise, training

The Andalusian population has elevated substantially their levels of education. In 1981 about one third (36.5%, of which 32.7% corresponds to men and 55.1% women) of the active population had qualified training (secondary and university studies), i.e. 712,300 people. This percentage has more than doubled, reaching 85.6% (including 84.2% corresponds to men and 87.4 per cent women) in 2013, and to be 3.4 million people (1,858,300 men and 1,594,600 women).

The Andalusian public university system is made up of ten public universities, that play a key role both as entities of training as in the role of generators of knowledge, which is then transferred to the society.

Currently, the Andalusian scientific community is composed of a total of 2,756 research groups, of which 2,312 (83.9%) are assigned to universities. They comprise around 30,000 researchers, the scientific output amounting to 13,947 publications during 2015, of which 67.7% originate from the University

The Campus of international excellence food comprising the universities of Jaén, Cordoba, Huelva, Cadiz and Almeria has projects of relevance in the field of the valorisation of by-products of agriculture, biorefineries and algae

Other important institutions for academic training relevant to Sustainable Chemicals are the Andalusian Institute for Research and Training in Agriculture, Fisheries, Foods and Organic Production (IFAPA) and CIDAF, which has been conceived as a joint technological centre consisting of the University of Granada, CTAER (Innovation and Development Center in Renewable Energy), and the Spanish National Research Council (CSIC)

In volume, Andalusia is the third Autonomous Community that invests most resources in R&D in absolute terms (only behind Madrid and Catalonia), and is positioned as fifth concerning the

expenditure on the regional GDP. In data, the community invested in this chapter during 2014 on 1,465.74 million euros, which represents 1.03% of its GDP.

The low participation of the private sector in R&D spending is one of the main shortcomings in Andalusia. Thus, public investment is most of this spending, 63.7% compared with 36.8% of private sector, while at the national level this is more balanced (46.9/53.1 private and public expenditure).

For higher education relevant to Sustainable Chemicals and operator level, the region provides a basic work-force suited for working on advanced biorefinery and circular innovations and an adequate work-force due to its strong tradition in bio-energy. Given the fact that many of the current biofuel plants are on-hold, little limitations are expected in this area.

The table below presents strengths, weaknesses, opportunities and threats for this factor.

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>• The conversion technologies readiness in the region is adequate, existing promising research projects for the high added value chemical</li> <li>• Skilled workforce in the field of biomass use for chemical applications is available.</li> <li>• Operators available due to halted biofuel plants</li> <li>• Existing specialization training actions in the field.</li> <li>• High availability of workforce (high workforce availability, unemployment).</li> </ul>	<ul style="list-style-type: none"> <li>• Static training and educational system.</li> <li>• Low rate of researchers or people involved in the innovation process.</li> <li>• Weak connection between research and industry.</li> <li>• Low private investments in R&amp;D</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Education of new entrepreneurs and employees for Sustainable Chemicals innovations.</li> <li>• Research could solve key bottlenecks towards the creation of new value chains</li> <li>• Possible set up of a Center of Excellence (CoE) to provide leadership, research, support and training</li> </ul>	<ul style="list-style-type: none"> <li>• Competition over skilled workforce with other biomass final users (biomass/ bio-gas plants).</li> <li>• Decreasing grants and national expenditure for research and innovation.</li> <li>• Low-paid, though highly qualified, professionals in research and innovation. Risk of brain drain.</li> </ul>

### SWOT Analysis

Given the high number of investments that has taken place in biofuels (which to a large extent require similar skills and knowledge), this factor should not necessarily be a limiting factor to Sustainable Chemicals investments. In fact, in terms of operational skills for Sustainable Chemicals plant (operators, process engineers) the region has probably got the work-force available to man new plants and has proven to have the capacity (through existing training programs) to train these employees.

There is a need to synchronize universities' and applied sciences institutes' curricula with the needs of industry. Andalusia's main **strength** is that a lot of the required disciplines (e.g. chemistry, biotechnology, agricultural sciences) are being taught in the region, but in order to seize the **opportunities** of training the entrepreneurs and innovative employees for the region, a more industry-driven education and research system is needed (main **weakness** of the current system).

Again, the definition of key areas where the interests of Andalusian industry come together, could help in creating more active collaboration between academia and industry. Traineeships at local agro or chemical companies aimed at establishing cross-sectorial partnerships could prove a valuable means of collaboration. More industry-driven research could also **counteract the threat** of decreasing grants by accessing private (industrial) funding for research. The threat of brain-drain could also potentially be tackled by providing engineers and scientists with challenging industry-driven research jobs which are aimed at further developing their own region (rather than a foreign region).

## SWOT KF5: Existence of support institutions

Overall, many of the necessary support institutions to accelerate innovation in the region are in place. The Research and Innovation strategy (RIS3), which is the basis for the prioritization of public funding in the region does acknowledge the importance of biotechnology and sustainable process industries (including chemicals).

Also in the regional operational programmes of the structural funds (ERDF and the EAFRD) priorities are related to competitiveness, improving information and education, low-carbon economy, climate change and environment and resource efficiency. In these priorities the bioeconomy and circular economy are also relevant themes, specifically in the program of rural development (EAFRD) in the Focus 5C. , However, even though there is room for support directed to the transformation of by-products, there is still room for improvement, because also collection infrastructures, technology transfer and local development, will be necessary to support industries technologically and encourage them to engage in circular/biobased investments

Furthermore in the regional operational programmes of the structural funds (ERDF and the EAFRD) priorities are related to competitiveness, improving information and education, low-carbon economy, climate change and environment and resource efficiency. Bio-based and Circular Economy have been included within these priorities. Specifically in the programme for Rural Development (EAFRD) at Focus 5C, but although lines of support aimed at the transformation of by-products, improvement of remains, logistics infrastructure, taskforces for technology transfer and local development initiatives, are scheduled to be technologically assist industries that can be beneficiaries to encourage investments

Many of the tasks related to the support to regional companies in terms of public and private finance, business advice, incubator programmes and the promotion of collaborative projects are carried out by Consejería de Agricultura, Pesca y Desarrollo Rural; de Empleo, Empresa y Comercio y de Medio Ambiente y Ordenación del Territorio. In addition, some other research institutes provide consultancy services and contract research to companies, like IFAPA, CEyA3, Knowledge Agency, CTAER and CSIC among others. Much of these services are however still bound to one sector (either agriculture or energy) rather than in a true cross-sectorial way.

The table below presents strengths, weaknesses, opportunities and threats for this factor.

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>Support programmes for seed and start-up business in several sectors, which could be oriented for the Chemical Sustainable Industry.</li> <li>Bio-technology, bio-economy and circular</li> </ul>	<ul style="list-style-type: none"> <li>Reduced stability of the R&amp;D&amp;I system.</li> <li>Lack of specialized public Promotion Institute.</li> <li>No dedicated cross-sectorial strategy for biobased or circular economy</li> </ul>

<p>economy identified as major issues in the RIS3 of the region for 2014-2020.</p> <ul style="list-style-type: none"> <li>• Several centers and research groups that play an important role in knowledge transfer and technology within the sector</li> <li>• Strong and relevant infrastructure of public and private technological tools (labs and other facilities).</li> <li>• Experience in support of business incubators.</li> <li>• Raw material/waste information platform.</li> <li>• Transversal support by the Strong commitment from public and private relevant actors in the region.</li> </ul>	<ul style="list-style-type: none"> <li>• Lack of incubator of specific business for the recovery of waste.</li> </ul>
<b>OPPORTUNITIES</b>	<b>THREATS</b>
<ul style="list-style-type: none"> <li>• Investment or creation of bio-based and circular economy concept on R&amp;D&amp;I Campus.</li> <li>• Several initiatives at European level (Vanguard, ERRIN) in the field for knowledge sharing.</li> <li>• The region has a strong focus on Energy policy, which could be used as a good starting point to biomass management for other applications.</li> <li>• European initiatives (INTERREG, H2020) offer the possibility of developing joint activities with other stakeholders</li> </ul>	<ul style="list-style-type: none"> <li>• Support institutions seem to be not as widespread as others.</li> <li>• More focused on biomass resources as alternative feedstock than waste.</li> </ul>

### SWOT Analysis

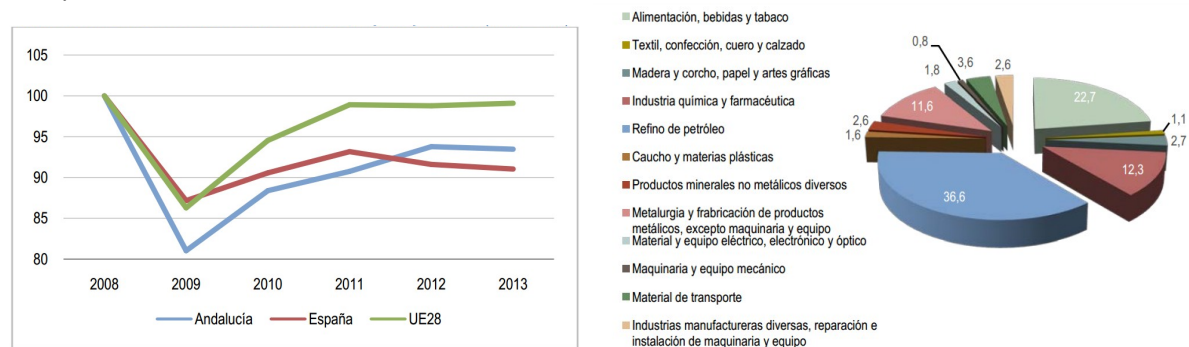
Andalusia has considerable strengths in terms of support institutions. However, public support to new emerging sectors which combine different traditional sectors is complex and these institutions are currently mainly dedicated to either separate sectors (e.g. agriculture and energy), which does not optimally facilitate the support for Sustainable Chemicals initiatives, but this is not a problem exclusive to Andalusia, as it is due to the origin of the funds. This hampers innovation in creating new biobased and circular value chains. In order to deploy these **strengths** towards **opportunities** like R&D campuses, joining international initiatives and developing more local collaborative projects, a dedicated strategy on Sustainable Chemicals is needed. This strategy should be implemented by a dedicated institution, which could act as the primary point of contact for liaising with international initiatives and creating cross-sectoral collaborations in the region. Since the stakeholders involved in the current bio-energy system are most likely also involved in the Sustainable Chemicals value chains (due to their ownership of infrastructure or biomass) they already have a natural stake in this strategy and the strategies for energy and Sustainable Chemicals can be integrated and balanced to mitigate the **threat** of competition. Specifically the Strategy Energy of Andalusia 2020 has a concrete action (MC\_12) for the development of the biorefineries in Andalusia and the promotion of the sustainable chemical industry from biomass

There are new needs related to chemical processes which must be implemented to reassess resources; for this the institutions, Andalusia in collaboration with the industrial sector and the areas

of innovation and research should develop a plan of coordinated action. As such a more dedicated strategy as described above could result in far more beneficial collaboration between innovative companies in Sustainable Chemicals and support institutions. The basis for such a strategy should be an integral approach focusing on new value chains taking into account both biomass at the beginning of the value chain and waste streams which are released in the value chain and could be applied in higher added value applications.

## SWOT KF6: Strength and Availability of regional markets

Whereas on a European level, industry output is recovering and is approaching pre-crisis levels, the Spanish industry is lagging behind being at only 90% of its pre-crisis output. The Andalusian manufacturing industry is a positive exception to this number, even though it is also well below European levels (see figure 3<sup>11</sup>). The return of foreign investment (see KF3) to Andalusia could be perceived as a sign of early recovery. The manufacturing industry is heavily dominated by oil refining (36.6%) followed by food and drinks (22.7%), chemical and pharmaceutical industry (12.3%) and mineral and metal processing industry (11.6%). It is estimated that between 75 and 120 chemical companies are active in the sector.



**Figure 4: total industrial output index of EU, Spain and Andalusia (left) and pie chart of structure of Andalusian economy**

Given the relative importance of the chemical sector in Andalusia, chemical markets based on traditional feedstocks are well developed. This also applies to the more traditional use of biomass. Markets for the use of primary products (olives, olive oils, vegetables, fruits) and their side-streams (pomace, peels, leaves, etc) are well-developed. Many of the side-streams are valorized towards more traditional applications, like composting and bio-energy. Since Andalusia is the leader region in Spain in bioenergy applications, this market can be considered particularly well-developed. However, more advanced biorefineries towards high added value chemicals and materials are hard to find and are currently mainly the domain of university spin-off companies and biotechnology suppliers, olive oil extracts for food, feed and cosmetics, (oleochemicals, bioplastics, omega-3 fatty acids) and many others. It is important to notice that these companies have big problems to commercialize their products because of the difficulty of recognizing them as functional foods by the Food Safety Agency<sup>12</sup>.

There is interest among the chemical industry to use biomass and waste streams as feedstock, but a lot depends on the concrete opportunity, which often still has to be determined. As such, the

<sup>11</sup>Graphs obtained from Andalusian Industrial Strategy

<sup>12</sup> In general them themes of certification of products, feasibility for uses alternative, security, legal, commercial, should study is in greater depth to count with an analysis integral of the chain of value

interconnection between the chemical sector and the biomass/waste sector still needs to be forged. Being a chemical producer of (intermediates for) polyesters, detergents and lubricants for which many biobased alternatives are currently produced, chemical companies could act as a starting point for demand-driven approach for the development of new biobased processes:

- At AIQBE cluster (Huelva): Algrý Química (fertilizer), Atlantic Copper (copper production), Bio oils (biodiesel), Cepsa (oil refinery and production of cumene, acetone, phenol, alpha-methylstyrene), Enagás (gas storage), Ence (bio-power plant), Endesa Generación (power plant), Ercross (chlorine production), Fertiberia Huelva (phosphates, urea and complex fertilizers), Gas Natural Fenosa (gas)
- At AGI cluster (Gibraltar): Abelló Linde (industrial gases), Abengoa Bioenergía (biofuels and biochemicals), Acerinox (steel), Air Liquide (industrial gases), Cepsa (biorefinery and Terephthalic acid, alcylic benzene), Grupo CLH (transport of petrol products), Endesa (Power plant), E-On (power plant), Gas Natural Fenosa (natural gas)

There are also more than 5,700 agro-alimentary companies which can act as small producers of new products by valorizing by-products in new value chains. They require technology, simple processes and adequate distribution of the products. Some companies run the new business to the power animal, nutraceuticals, fertilizers, products not food. At other times they form consortiums with companies for research and transfer for the development of more specialized chemical processes. However, it is also the aim Industrial Strategy of Andalusia 2020 to double the number of innovative manufacturing firms.

The table below presents strengths, weaknesses, opportunities and threats for this factor.

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>• Existing mature biomass market.</li> <li>• Security of the raw material supply is ensured based on a wide cast of suppliers.</li> <li>• Chemical industry is relatively important in the region.</li> <li>• Very well organized and structured chemical industry around two main industrial poles.</li> <li>• Strong agricultural and agrifood sectors.</li> <li>• Ports ensure access to international markets</li> </ul>	<ul style="list-style-type: none"> <li>• Large share of oil refining companies that cannot apply the bio-refinery concept.</li> <li>• Lack of coordination between economic sectors.</li> <li>• Weak market for recovered plastic waste</li> <li>• Low overall level of interest of companies to invest in new waste-to-resource application from manure, sewage sludge, agri-food or paper and pulp (waste)</li> <li>• Not many business cases of waste application as alternative raw material (waste).</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Incorporation of criteria for public procurement</li> <li>• Increasing demand for (high-added value) biobased and circular products.</li> <li>• New links between chemical industry (polymers, fibres and composite materials; and additives for lubricants, solvents) and biobased/circular feedstocks could be established.</li> <li>• The end-of-waste criteria application will enable new markets (waste)</li> <li>• Expected labelling at EU level for Green procurement facilitation.</li> <li>• Future standards for bio-based products developed by EU.</li> <li>• Excellent access to the Mediterranean and unique access to the African market</li> </ul>	<ul style="list-style-type: none"> <li>• Uncertainty regarding feedstocks regional market (price, amounts).</li> <li>• Lack of market information for new bio-commodities.</li> <li>• Low price of fossil feedstock.</li> <li>• No level playing field for biofuels and biochemical in CO2-reduction policies</li> <li>• Slow and complex application of end-of-waste criteria.</li> <li>• Other competing sectors more interested in agri-food waste.</li> <li>• Globalization: countries without restrictive regulations are more competitive.</li> <li>• Lack of agreement on methodological standards for product labelling and certification using</li> </ul>

## SWOT Analysis

Andalusia's regional market for biobased and circular products, intermediates and pre-treated feedstocks can be considered well developed in some sectors. However, to a large extent these markets are devoted to bioenergy and only to a lesser extent specifically to chemicals. Even though there are two big chemical clusters in the region, there are European regions that have a stronger presence of the chemical sector and a significant potential of agro-alimentary industries that can incorporate chemical processes. As such, there should be a clear focus on which target products or intermediate compounds to address in order to connect to the regionally available markets. Much of the agrifood industry is grouped in federations, structures of second grade and even in the main sectors exist interprofessional olive and fruits and vegetables that facilitate the dialogue and sectorial renewal.

In order to valorise Andalusia's **strengths** for seizing market **opportunities**, a feedstock driven approach is most likely to be successful. Given the fact that investors interested in a large amount of potential manufacturers of end-products will probably chose other regions to invest in, the choice of strategic markets for Andalusia could to a large extent be feedstock-driven, since it is the feedstock and the advanced infrastructures that make the region unique. Many interesting, but relatively small companies are currently active in creating new applications based on existing feedstocks. These companies should be clustered and their technology needs (e.g. separation technology, biotechnology) could become subject of new joint research programmes. In a demand-driven approach, local manufacturers of end-products, for polyesters, detergents, lubricants, for fertilizers could act as 'clients' for new biobased and circular production processes. Specific feedstock strengths and 'sweet-spots' in infrastructure could attract new players from within or outside Andalusia establishing new value chains towards end-products. Besides that, there is a lot of regulation under development which will provoke players to develop new business cases for which there will certainly be opportunities that match best with Andalusia's situation. Finally, the involvement of current chemical industry in the process is required to increase the chances of success for bio-based economy, both as a manufacturer of new products from biomass, as consumers of intermediate products from biomass in its traditional industrial processes.

Building on the **strengths** in feedstock and infrastructure is also the best to counteract the **threats** related to market uncertainty which are inherent to new biobased and circular business cases. These uncertainties can to a limited extent be tackled by the region, for example by introducing public procurement programmes for biobased/circular products. However, creating the strongest business case for a value chains connecting local strengths in feedstock, infrastructure and markets is the best way to create a viable business.

As for the market **weaknesses**, the low presence of really obvious manufacturers of end-products can likewise be tackled by focusing on the manufacturers which are available and attracting foreign investors with regional strengths in feedstock and infrastructure. Coordination issues between energy and chemicals can be well managed by involving the players that have a stake in both areas (e.g. biofuels) in the development of a Sustainable Chemicals strategy since also for them this strategy could have benefits. The situation seems more challenging for waste since there is little belief in actual business cases among local companies. However, this conviction should be put to the test by a state-of-the-art analysis of technologies, which should be the basis of the Sustainable Chemicals strategy.

In any case, it is worth to consider that in a context of global high prices of energy by shortage of oil, possibly the biofuels sector could be more profitable. This could also apply to other chemicals and materials derived from biomass. In any case, it is very important to analyse the dependence of these new value chains on the oil prices in order to ensure whether it makes sense to diversify supporting initiatives business of various types (bioenergy, biochemical, etc.).

## SWOT KF7: Entrepreneurship

Andalusia is characterized by a high enterprise birth rate (over 8%), but even more start-ups die every year, which results in a net destruction of businesses. This is an indication that the entrepreneurial initiative in the region is high, but also that the conditions for start-ups are apparently challenging. In spite of these challenging conditions, the region is home to at least 10-20 SME's (see KF6 and Annex I) that are the first-movers in circular and biobased chemicals, originating from their traditional competence in olive oil or biotech. Being caught between the well-organized agricultural sector (many cooperatives) and chemical sector (organized in to clusters in the Chemical, Basics and Energetic Industries Association of Huelva (AIQB) and the Association of Large Industries of the Campo de Gibraltar (AGI)), these companies may be in extra need of support. The absence of cross-sectorial events for the creation of partnerships further contributes to the challenge for these companies.

The table below presents strengths, weaknesses, opportunities and threats for this factor.

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>• Presence of Chemical/Agri-food clusters.</li> <li>• High rate of starting firms - dynamic business environment.</li> <li>• Existence of 2 main entities leading the Sustainable Chemistry Industry (AIQB and AGI).</li> <li>• Structured organization accounts with industrial and entrepreneurial associations, cooperatives, trade or intertrade organizations, rural development groups and enterprises.</li> </ul>	<ul style="list-style-type: none"> <li>• Reduced awareness of the importance of innovation.</li> <li>• Net business destruction taking into account the death rate of new companies.</li> <li>• Expenditure on innovation below the EU average.</li> <li>• Networking and cross-value chain and cross-sector cooperation underdeveloped.</li> <li>• Business-as-usual thinking is strong.</li> <li>• Structural problems leading to low survival of starting business.</li> </ul>
OPPORTUNITIES	THREATS
<ul style="list-style-type: none"> <li>• Reinforce the clusters' activities and the creation of other clusters.</li> <li>• Development of inter-cluster relations.</li> <li>• Foreseen support for the creation panels to enhance cross sectorial synergies at regional level (European Bio-economy strategy).</li> <li>• Networking and cross-value chain and cross-sector cooperation.</li> <li>• Existing international clusters and the possibility to join in.</li> <li>• Joint European projects, initiatives, platforms and PPPs.</li> </ul>	<ul style="list-style-type: none"> <li>• Uncertainty on the side of companies about carrying out investments. Only short payback investments.</li> <li>• Significant investment reduction in the Chemical Industry due to economic crisis.</li> <li>• Insufficient funds available and economic support.</li> <li>• Sustainable chemicals production is often more expensive compared to the traditional routes.</li> <li>• High investments needed for the transformation of existing production facilities to green production.</li> </ul>

## SWOT Analysis

The entrepreneurial environment in Andalusia is challenging. New companies are struggling to survive, there is a low expenditure on innovation/R&D and business as usual thinking is strong in the region. However, the basis for a better entrepreneurial climate can be found in the cross-sectorial collaboration between the well-organized sectors of agriculture, chemistry and other waste and energy related bodies, which are important **strengths** of the region. Again, the development of a joint strategy towards a circular and biobased economy in order to deploy towards seizing **opportunities**:

- A joint strategy will clarify the potential relationships between clusters and sectors are based on the definition of clear circular and biobased value chains to be created. It is the small base of 10-20 SME's which could lead the way in the establishment of these value chains. This strategy will optimally make use of the strengths of the different stakeholders in these value chain.
- The strategy can be used to position the region internationally and team up with international companies and research institutes which match Andalusia's needs and which could invest in the region. This will also help in getting Andalusian companies in European projects, which will make available much needed funding for innovation.

Many of the **weaknesses and threats** are related to challenging economic situation in which the region is now and the shortage of resources for innovation, but also these could be counteracted by a clear joint strategy supported by the different sectors in the region. Particularly since the region is also home to a number of multinationals which probably see the potential of Andalusia and are still able to make investments which could strengthen the entrepreneurial climate in biobased/circular economy. The joint strategy as described above and the creation of a 'coalition of the willing' which are willing to take the initiative in creating these value chains could make much needed resources available. Even though the majority of companies in the region persists in business as usual thinking, the coalition can inspire them to become involved in creating new value chains. The coalition can also support the pool of innovative SME's in the area of biobased/circular economy in their efforts to grow by providing support and resources, sharing facilities. The creation of a central location where SME's in biobased/circular economy come together, exchange knowledge on business development strategies and are able to get some hands-on support, would be of great benefit to the region.

## SWOT KF8: Public support policies

The strategy to draw on biobased and waste feedstocks for industrial production is reflected in many different strategies developed by the Andalusian Government:

- The **Industrial Strategy for Andalusia (EIA2020)**. Through this policy, Andalusia aims to accelerate its industrial development, both in terms of revenues and jobs. It contributes to increasing the competitiveness of the industry through innovation and enhancing its energy efficiency. Other lines of action are internationalisation of the Andalusian Industry and strengthening the industrial eco-system. Through dedicated priorities on the stimulation of R&D (including finance), stimulation of high-tech companies and support of start-ups, companies in biorefining, chemical industry and circular economy are supported. For the chemical industry, an action line focused on the transition towards biobased feedstocks is included.
- The **Andalusian Sustainable Development Strategy 2020**. This strategy comprises action to establish biobased and circular value chain in amongst others the agricultural sector, water treatment sector, waste treatment sector. It also stimulates the use of biobased feedstocks for biofuels and chemicals. It also foresees the creation of an organisation which facilitates the exchange of waste streams between companies.

- **The Andalusian Strategy of Energy 2020** outlines the strategy to establish a more competitive and sustainable energy supply in Andalusia. Given the great synergies between energy (through a.o. the biodiesel sector) and the chemical sector, the governance measures and financial resources made available through this plan will also contribute to the creation of new biorefineries.
- The "**Olive Grove Master Plan**" outlines the strategy of the Olive Sector towards a competitive and sustainable olive sector. This plan can be seen as a basis for a more specific bioeconomy and circular economy strategy. Created by the olive sector, it is still a single-sector plan, but it involves different measures to increase the utilization of by-products from the current olive biorefinery complex. In fact, many SME's active in extracting new products from the olive are from the olive sector and could contribute to creating a bridge towards the chemicals sector.
- **Plan of Rural Development of Andalusia 2014-2020** has among its priorities promote resource efficiency and encourage the move to a low-carbon economy, contributing to the fight against climate change
- **Operative Program FEDER Andalucía 2014-2020**, which is The Annual Plan of action of the Institute's research and training agricultural and fisheries
- **Strategic Plan for Agroindustry in Andalucía 2016-2020**
- **Strategy for the Generation of Environmental Employment in Andalusia 2020**, which aims to refocus the Andalusian production model to a green economy in which the environment is perceived as an engine of socioeconomic development and recognized its potential as a site of employment.
- **RIS3**. Strategy of innovation of Andalusia. Its objective is lead a new model economic, focused in companies, and based in a firm committent and decided by it innovation, the science, the technology, the internationalization and the training.

The following policies are currently in the process of being developed::

- **III Andalusian Plan Andaluz Biological production, Horizon 2020**
- **Andalusian Strategy of Bioeconomy**. The strategy aims to general growth and sustainable development in Andalusia, promoting actions aimed to promote the production of renewable biological processes and resources.
- **Plan for the management of vegetable residues in Andalusian intensive horticulture.**

As a general measure to increase investment related to Sustainable Chemicals in the region, Andalusia has developed regulation rules for consideration of the relevant projects under this *proposal "as projects of strategic interest to the Autonomous Community" in the framework of Law 4/2011*, of measures to promote business investment and strategic interest for Andalusia. This aim of this initiative is to significantly reduce administrative burdens and simplification. The region is also actively involved in knowledge exchange with other European regions and initiatives, through available networks, such as European Federation of Agencies and Regions for Energy and the Environment (FEDARENE), the "European Energy Agency", the "Smart Specialisation Platform" managed by the Institute for Prospective Technological Studies of the European Commission and other European and National Platforms linked with agriculture and sustainable chemistry , as well as through European initiatives such as the Vanguard initiative. The table below presents strengths, weaknesses, opportunities and threats for this factor.

STRENGTHS	WEAKNESSES:
<ul style="list-style-type: none"> <li>• Complete and coordinated policy planning to</li> </ul>	<ul style="list-style-type: none"> <li>• Regulation related to the establishment of</li> </ul>

<p>stimulate Innovation, economic development and sustainability.</p> <ul style="list-style-type: none"> <li>• Public incentives stimulating the bio-economy sector up taking.</li> <li>• Existing sectorial strategies include supporting actions to foster the transition towards a more circular chemical value chain.</li> <li>• Public acceptance of bio-refinery concept and associated value chain.</li> <li>• Develop of legislation to streamlining of administrative procedures in relation to economic activities.</li> </ul>	<p>enterprises in the region should be checked in order to facilitate the process of their setting.</p> <ul style="list-style-type: none"> <li>• Insufficient fiscal and financial incentives to promote green chemical products, using waste.</li> </ul>
<b>OPPORTUNITIES</b>	<b>THREATS</b>
<ul style="list-style-type: none"> <li>• Government needs to assess the potential impacts on the different actors of the value chain to identify the most effective and appropriate measures.</li> <li>• Region has developed the concept "project of strategic interest" to facilitate and foster initiatives, such as bio-refineries</li> <li>• Forthcoming "Andalusian Agrifood Industry Plan 2016-2020" addressing the valorization of by-products and agricultural wastes.</li> <li>• Involvement in EU policies and initiatives (e.g. bioeconomy panel, revision of waste regulations)</li> </ul>	<ul style="list-style-type: none"> <li>• Public incentives uncertainty in the middle-long term due to policies constraints.</li> <li>• Too complex and rigid Waste Regulation, hampering demonstration of new process.</li> <li>• Regional strategies are more focused on the energy use rather than chemical use.</li> <li>• Slowness of end-of-waste criteria regulation.</li> <li>• Trade and import barriers.</li> </ul>

### SWOT Analysis

In terms of public support, it could be said that many public support measures are in place. Despite the fact that many instruments are not specifically dedicated to Sustainable Chemicals, they could be harnessed for its support. In order to use the **strengths** of the large number of existing instruments towards the **opportunities** available to accelerate a transition to a more biobased/circular region, a more focused approach is needed based on the joint vision of stakeholders in the new value chains. Existing initiatives like the "Olive Grove Master Plan and the Andalusian Agrifood Industry Plan are good elements which could be part of this strategy. However, the main step which needs to be made is to establish a truly cross-sectorial strategy, which builds on both Andalusia's strengths in Chemicals and in Agriculture.

## Conclusions – Analysis of synergies

### The creation of value chains: key factors feedstock(1), infrastructure(2) and markets (6)

The key factors which are most related to the *physical* creation of new biobased or circular value chains are feedstock (KF1), infrastructure (KF2) and markets (KF6). It is these factors that are most influential in attracting/creating investments in a region, since they form an important part of the

actual business case underlying any investment. They contain the unique characteristics of a region for building a value chain and are as such key to analysing what is possible in a region. The potential value chains have been illustrated in Annex I.

### **Feedstock**

In terms of feedstock (KF1), Andalusia has a very strong position due to the importance of the agricultural sector and forestry. In particular the following areas could serve as starting points for building new biobased or circular value chains:

- Waste products and oils, derived from amongst others the olive groves (pruning, mill leaf, olive pomace, olive marc, and olive pit) is a large and attractive feedstock for new value chains. The fact that Andalusia is the major olive producer and olive oil biobased industries are well developed could result in economics of scale or build on specific oil refining expertise which allow it to be more competitive than other European regions. The region is already home to a growing number of innovative SME's which could create new connections between the olive sector and more advanced chemical applications (nutraceuticals, lubricants, bioplastics, oleochemicals and food additives) or refurbishment of these plants for totally new products are an additional opportunity.
- Fruit and vegetables are also an important sector and could be applied as a competitive feedstock in new value chains. It is especially important because of the volume of vegetable remainders by intensive horticulture, for which the Andalusian Government has carried out a specific diagnosis. Also sunflower and vineyard residues may be attractive feedstocks. Building on the existing logistics systems, the bundling of similar types of agro-food waste streams in one location may create the boundary conditions for a viable business case for based on fibres for composites, rheology modifiers, pectin for gels and sugars for food or bioplastic applications. Pectin could also be the source of building blocks towards biobased PEF, a biobased alternative for PET. Potentially, links could be created with the activities of Cepsa in Huelva/Gibraltar.
- For forest feedstocks, lignocellulosic value chains could be established towards paper, composites, polymers or chemicals. This is however also the value chain for which feedstock competition is most relevant due to the large bio-energy sector. Initiatives targeting this value chain are rather limited, but potentially also the collaboration with partners outside the region could accelerate developments in this value chain. In fact, in recent years there have been significant production changes in the forestry sector in response to the modification of the electrical energy legislation and the stimulus this created in the thermal energy market. These changes have had impact on other market niches of forest biomass such as wood products and pulp, still in a phase of redefinition of balances between the different productive purposes (power / wood products / pulp). In this context, the maturation of a new niche opportunities linked to sustainable chemistry products can be a source of opportunities if Andalusia enrolls in complementary development strategies, or, conversely, the region can generate new imbalances in the productive ecosystem.
- The widely available feedstocks sewage sludge, MSW and farming waste which offers opportunities to be applied as fertilizer or other high added value feedstocks. Integration of a waste water treatment facilities with algae production, which could subsequently act as a biomass source for biogas, bio-oils or biochemicals. Due to its sunny climate and intensity of solar irradiation (because of Andalusia's Southern location), algae are an interesting feedstock on the longer term. In fact, in the region already interesting results have been achieved with algae in several projects

Current use of these feedstocks is very much energy-driven, since Andalusia has a large number of biofuel and bioenergy plants. These plants could be seen as competition for Sustainable Chemicals projects because they overlap in feedstock use. However, the current biofuel plants also offer

opportunities for the valorization of waste streams (e.g. glycerine), which is why in fact they are also a stakeholder in new Sustainable Chemical value chains. The above feedstocks should be taken as a starting point to analyse potential new value chains, but it is necessary to perform a mapping on its availability, characteristics and location.

### **Infrastructure**

In terms of infrastructure (KF2), Andalusia is well positioned for attracting new investments for Sustainable Chemicals. In principle the infrastructure to set up new biobased or circular plants is there (industrial infrastructure, transport infrastructure and utilities) and there is no reason to assume infrastructure at this stage is a limiting factor for a transition towards Sustainable Chemicals business. However, in order to further put this infrastructure to use for developing new biobased and circular value chains, a 'sweet-spot' analysis could help in selecting locations which are very attractive for investments. This analysis should be made based on specific potential value chains and take into account the availability of utilities, proximity to feedstock, shared production facilities, beneficial permitting situation, opportunities for industrial symbiosis and (very important) proximity to markets. The strong existing infrastructure by the agroindustry, together with its organizational capacity is also a strong asset that should be considered in the development of these locations.

It is these locations that offer the best opportunities for local or international companies to settle and secure the optimal conditions for their business case. Very obvious candidates at this stage are the two chemical clusters at Huelva and Gibraltar, but also the biodiesel plants which are more spread throughout the region. However, their attractiveness should be assessed and benchmarked for specific new value chains in order to be able to attract new biobased and circular companies.

### **Markets**

In order to valorise Andalusia's strengths for seizing market opportunities (KF6), a feedstock driven approach building on the feedstock and infrastructure described above is most likely to be successful. Given the fact that investors interested in a large amount of potential manufacturers of end-products may prefer other European regions, the choice of strategic markets for Andalusia could to a large extent be feedstock-driven, since it is the feedstock and the advanced infrastructures that make the region unique. Specific feedstock strengths and 'sweet-spots' in infrastructure could attract new players from within or outside Andalusia establishing new value chains towards end-products. Besides that, there is a lot of regulation under development which will provoke players to develop new business cases for which there will certainly be opportunities which match best with Andalusia's situation.

## **Enabling conditions for the creation of value chains**

The other 5 key factors (3, 4, 5, 7 and 8) are more enabling factors, which contribute to the creation of value chains rather than being part of these value chains. As such, they have a more indirect influence on business cases underlying investments.

The availability of finance (KF3) in Andalusia is challenging. Even though some financing instruments are available in the region which could in principle be used to finance Sustainable Chemicals investments, obtaining finance in this theme is in practice quite challenging. On the one hand, this is due to the challenging economic situation of the last years, which leaves banks and private investors reluctant to invest, particularly in new businesses like Sustainable Chemicals due to the relatively high risk profile. However, the lack of focus on Sustainable Chemicals does not help in attracting more investments. By using the existing institutions to coordinate requests for external sources of finance,

be it European (EIB, EAFRD, Cleantech investors, Biobased Industries Funding) or actively attract direct investment from multinationals. In order to attract more regional financial resources, a shared vision by local stakeholders on potential biobased and circular value chains is essential. This would help to concentrate the resources in the region (in particular the regional investment funds, investments by industry) on Sustainable Chemicals projects.

As for skills and technical expertise (KF4), given the high number of investments that has taken place in biofuels (which to a large extent require similar skills and knowledge), this factor should not necessarily be a limiting factor to Sustainable Chemicals investments. In fact, in terms of operational skills for Sustainable Chemicals plant (operators, process engineers) the region has probably got the work-force available to man new plants and has proven to have the capacity (through existing training programs) to train these employees. Also in terms of training scientist for the development of new processes, the Andalusian universities provide a good basis. However, there is a need to synchronize universities' and applied sciences institutes' curricula with the needs of industry. Again, the definition of key areas where the interests of Andalusian industry come together, could help in creating more active collaboration between academia and industry and develop centres of excellence or demonstration infrastructure for new biobased and circular value chains.

Andalusia has considerable strengths in terms of support institutions (KF5). However, these institutions are currently mainly dedicated to either separate sectors (e.g. agriculture and energy), which does not optimally facilitate the support for Sustainable Chemicals initiatives. This hampers innovation in creating new biobased and circular value chains. In order to deploy these strengths towards opportunities like R&D campuses, joining international initiatives and developing more local collaborative projects, a dedicated strategy on Sustainable Chemicals is needed. The permeability of the strategies of bio-based economy, sustainable chemistry and circular economy in different areas of economic activity and public services requires a necessary institutional coordination that will allow progress in that direction.

The entrepreneurial environment for innovative businesses (KF7) in Andalusia is challenging. There is a low expenditure on innovation/R&D and business as usual thinking is strong in the region. However, since many of the factors for this environmental have a structural character and are difficult to resolve directly, the basis for a better entrepreneurial climate can be found in the cross-sectorial collaboration between the well-organized sectors of agriculture, chemistry and other waste and energy related bodies which are important strengths of the region. This will create a 'coalition of the willing' 'which are willing to take the initiative in creating these value chains could make much needed resources available. The coalition can also support newly created SME's in the area of biobased/circular economy in their efforts to grow by providing support and resources, sharing facilities. As such, the currently active SME's in Sustainable Chemicals should be cherished. A more transversal policy regarding bioeconomy and circular economy would thus be of great benefit to the region.

In terms of public support (KF8), it could be said that many public support measures are in place. However, many instruments are not specifically dedicated to Sustainable Chemicals and many even favour energy over chemicals. In order to use the strengths of the large number of existing instruments towards the opportunities available to accelerate a transition to a more biobased/circular region, a more focused approach is needed based on the joint vision of stakeholder in the new value chains. The creation of dedicated sector plans for the Olive sector, Agro-food sector and biodiesel sector is a first step towards a more overarching strategy which maps all the promising circular and biobased value chains in Andalusia. Also here, a joint cross-sectorial biobased/circular

strategy will enable dedication of a significant amount of the public resources (e.g. regional funding, EFRD, EARFD and others), policies and regulations towards these themes.

## Recommendations

Based on the SWOT analysis and the conclusions above, the following recommendations apply to the region of Andalusia.

The region should carry out a **feasibility study** into all the potential advanced biobased and circular value chains that have a good chance of leading to commercially viable investment initiatives in the region. The Olive Grove Master Plan and the feasibility study into the reconversion of the non-operational biofuel plants (University of Córdoba) could feed into this overall feasibility study, which should be broadened to value chains starting from the agro-food sector, water treatment sector (including algae) and the forestry sector (including other lignocellulosics like olive stone). The study should take into account the European or even global state-of-the-art in biobased and circular technology, since the technology does not necessarily have to come from Andalusia itself. Multinational biobased companies that see the potential of Andalusia's large olive oil sector, its biofuel sector and other strengths may well attract investments in the region.

A **Coalition of the Willing** should be forged including players from the agricultural sector, chemistry sector, knowledge institutes and the SME's which are already creating new biobased and circular value chains. This group could act as an advisory board for the definition of new initiatives and should be continuously involved and managed.

A **benchmark study** should be made of specific features, in order to create a competitive position for establishing new biobased and circular value chains of Andalusia compared to other European regions. For example:

- The size of Andalusia's olive sector will certainly have created certain economies of scale in production and logistics, which enable it to produce olive oil or interesting by-products more competitively than other regions. This could be used as a Unique Selling Proposition (USP's) to companies wanting to invest in olive-based biorefineries or biobased products.
- The same applies to Andalusia's biofuel sector, which is the largest in Europe. Also here economies of scale may apply which may cause the biofuel plants to become a unique competitive source of by-products (e.g. glycerine).
- Olive stones are a highly homogenous lignocellulosic feedstock which is collected in large volumes. This could be a highly attractive feedstock for a lignocellulosic biorefinery combined with additional forestry feedstock.
- The development of sustainable chemistry products can be a source of opportunities for forest biomass complementary to other productive purposes (wood products, electrical and thermal, cellulose). There is in this sense an important potential both of forest formations of dedicated eucalyptus or poplar species, and forests protection, in which the sustainable exploitation of the surplus biomass is an essential tool in the context of sustainable forest management.
- The agri-food and horticultural sector could be home to very specific crops which are unique in Europe or for which Andalusia has the largest sector. Again, economies of scale (for example in orange production?) or the ability to produce unique feedstocks for Europe could attract biobased companies.

- Andalusia's unique potential and experience of large scale algae cultivation could be further exploited.
- Specific locations (so-called sweet-spots) which for example enable biobased companies to settle close to feedstock sources and at the same time close to potential clients (e.g. in the chemical clusters) could also boost competitiveness in certain new biobased value chains.

By combining the results of the feasibility and benchmark studies described above, **a business plan should be made based on a selection of promising value chains**, in close discussion with the companies which are part of the Coalition of the Willing. This business plan will describe where Andalusia anticipates to attract investments, which will build on its specific strengths. This business plan will serve multiple purposes:

- It can be used to position Andalusia towards European stakeholders. For example: Andalusia could be THE region for companies interested in using olive-oil or olive-oil by-products as their feedstock. The business plan will enable much more **effective acquisition of investments by foreign companies** and will enable stakeholders from the region to become involved more easily in EU projects or even coordinate EU projects. Also attracting private equity investors will become easier based on a clear business plan for the region.
- It can be used to **direct own public resources** (e.g. regional funds), but also **private resources** towards strategic objectives described in the business plan. It could for example serve as a guide for identifying **joint technology needs** (olive pomace separation/conversion technologies) identified by stakeholders in the region. These needs could be addressed together with knowledge institutes from the region.
- It should serve as a guide **location development**. By identifying which locations are most suitable for establishing new biobased and circular value chains, innovative (SME) companies which are active in these value chains should be clustered as much as possible. This will increase their chance of success. In these locations, the appropriate infrastructure and permits should be created in order to enable direct investments.

## Next steps

Based on the above recommendations, the next steps are:

1. Organizing a stakeholder conference involving stakeholders from both stakeholders from the feedstock side (olive, agro/horticulture, forestry, water treatment, algae), owners of existing infrastructure (e.g. biodiesel plants) and representatives of market parties in order to define potentially viable biobased or circular value chains and the actions needed to do or attract investments to make these value chains a reality. The 10-20 SME's active in Sustainable Chemicals also form a key group of participants to this stakeholder conference.
2. Make a start with the benchmark on the competitiveness or unicity of certain feedstocks in relation to other European regions as a starting point for biobased or circular value chains based on the visions of the stakeholders involved.
3. Based on actions 1 and 2, identify potential 'sweet spots' in the region. A sweet-spot is a location which combines optimal access to utilities, proximity to feedstock, shared production facilities, beneficial permitting situation, opportunities for industrial symbiosis and proximity to markets.
4. Set up a joint strategy which combines the outcomes of the studies above into a concrete strategy which defines:
  - The value chains to be developed for the region
  - The locations which will be the hubs for the development of these regions

- The coalitions of stakeholders (industry, government, research institutes) working on these value chains
  - Definition of actions for these stakeholder groups
5. The joint strategy will ensure dedication of much needed other resources, like finance, knowledge, creation of an entrepreneurial environment and public support as described above.

## Impact assessment

The bioeconomy is estimated to amount to 2.1 trillion euros and representing over 18.3 million jobs<sup>13</sup>. This number involves also the more ‘traditional’ bioeconomy sectors, like agro-food and paper. In the years to come, the bioeconomy is expected to rapidly expand by replacing non-biobased products by biobased alternatives. When excluding the traditionally biobased industries, like food, beverage, tobacco, forestry and agriculture, the ‘biobased economy’ represents €600 billion euro and 3.2 million jobs.

## General impact of transition towards biobased chemicals

Chemicals currently form only 5% of the biobased economy and biofuels only 1%. However, given the fact that the other sectors are significantly more biobased and offer less potential for additional use of biobased feedstocks, it is in particular for biobased chemicals and biofuel that there is significant potential for biobased growth. Andalusia is already firmly positioned in the current bioeconomy with a large agricultural sector. Its biofuel sector is unique in size and as such Andalusia could be considered as belonging to one of the leading biobased regions in Europe. However, Andalusia’s feedstock potential may be better valorised towards chemicals to diversified its final applications some studies provide data that the relative increase in employment is higher, both from a revenue and feedstock perspective<sup>14</sup>. Per million tonnes of feedstock, employment generated in chemicals double that of biofuels (12.000 vs 6.000 jobs).

However, regardless of the development of biofuels or biochemicals, establishing a transition to a biobased economy on the scale of the current biofuels sector, either by refurbishing the existing biofuel plants or by creating new biobased value chains, could increase Andalusian employment in biobased fuels and chemicals by 50% to 100%.

## Specific impacts in particular value chains based on recommendations

Due to its great feedstock potential and presence of biofuel and chemical industry, Andalusia is an attractive candidate for biobased investments. The estimated investments for some of the biobased value chains identified in this report in the last years (2014-2015) are substantial<sup>12</sup>. The recommendations provide above are expected to contribute significantly to the ability of Andalusia to actually ‘capture’ some of these investments. Based on an inventory made for the Biobased

<sup>13</sup> European Bioeconomy in Figures, Piotrowski, Carus, Carrez, March 2016

<sup>14</sup> Piotrowski, S., Essel, R., Carus, M., Dammer, L., Engel, L. 2015: Sustainable biomass potential for biofuels in competition to food, feed, bioenergy and industrial material use in Germany, Europe and worldwide

Industries initiative<sup>12</sup>, an indication can be given of the increase in (foreign) investment as a result of a transition towards Sustainable Chemicals:

- In lignocellulosic value chains, 11 projects were foreseen at a total investment amount of €330 million. This would mean that attracting one project to Andalusia would correspond to a net investment of €30 million. Andalusia large forest area together with the availability of some logistically well-organized lignocellulosic waste streams (e.g. olive stones) could be an attractive basis for these investments.
- In agricultural value chains, a maximum of 3 project were foreseen at a value €17 million corresponding to a net investment of €6 million if Andalusia is able to attract one of these projects. For projects targeting olive oil or fruits and vegetables, Andalusia is a very attractive location.
- In organic waste based value chains, 4 projects were foreseen representing an investment value of €24 million. Attracting one project would result in an investment of approx. €6 million.

These estimations are based on the European projects that are currently being developed in the field of biobased chemicals. On the longer term, the investments will increase up to €100 million for large lignocellulosic plants. However, apart from attracting investments, Andalusia should develop its ability to innovate and create environment where leaders in biobased products (being SME's or large companies) can thrive. This report is meant as a first step towards an overarching Andalusian strategy for biobased and circular chemicals production.

