Ministry of Foreign Affairs

THE CIRCULAR ECONOMY IN SOUTHERN GERMANY:

OPPORTUNITIES AND OBSTACLES FOR DUTCH ENTREPRENEURS IN THE INFRASTRUCTURE AND CONSTRUCTION SECTORS

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Market Study | Final Report | June 2019

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1. Summary

Based on the same European directive, the status quo of a circular economy and the framework to foster it in the construction industries differ in the Netherlands compared to southern Germany. While the Netherlands have set a clear political target to become 100 % circular by 2050, in Germany resource efficiency is the major policy to foster recycling. In Holland a geological shortage of construction raw materials, ambitious CO2 targets and an open mindset to circular approaches exist. On the other hand, southern Germany currently has no severe limitations of construction raw materials and construction waste is a rather costly disposal challenge rather than a material source. However, the need for using such demolition materials as raw materials in future is known in Germany as well as current political discussions on a CO2-tax may affect the construction industry soon. Incentives for circular economy, such as economic benefits or preferences in public procurements, do not exist on the same level in Germany. Here, legally binding regulations drive construction companies to new approaches, or the costs of the disposal slowly change the mind setting in favour of circularity. While the Netherland seems to favour a waste to raw material approach, it is rather a waste to disposal site approach in Germany.

Public authorities can play a key role in circular economy and the Dutch government is aiming to spend 2.5 % of its procurement budget on innovation, in southern Germany municipalities seem rather reluctant to circular approaches in public tenders. Construction planers and architects also an important role for the sector as circular economy starts with design, but so far many of them are not aware of it and have limited knowledge about characterises of recycling material. The Dutch construction industry seems open and understands circular economy as a growing business and often operate internationally. In Germany the construction industry acts mainly regionally and locally (apart from some large international companies) and is rather conservative thinking.

The recycling rate of demolition waste is high in both countries (more than 90 %) although it is usually not circular. Most of the construction and demolition waste is reused in foundation material for roads and industrial estates and may be considered as downcycling. For a sustainable circular economy new markets are required for the recycled materials rather than solely road construction work. The span of life of buildings become shorter and they become more complex due to the usage of sandwich and composite materials that will be difficult to separate at later stages and there is a need for new solutions for such materials in Germany. The increasing application of new electric technologies in smart buildings and higher energy standards are often high-tech based. Although they are aiming for more energy efficiency, they may present a challenge for recycling at the end of the life span in 30 to 100 years when it comes to demolition. Approaches like material and building pass or BIM (Building information system) can already help to reduce problems and costs at later stages.

Circular economy in the Dutch construction industry might be ahead of Germany and thus, may have an advantage when it comes to market entry. However, supply with construction materials as well as recycling takes place over short geographic distances. Overall, the atmosphere is still rather sceptical towards recycled material in southern Germany, but construction industry is a still growing market in Germany with large investments of the government planned in infrastructure projects demanding many resources.

2. Introduction

Circular economy (CE) has an annual turnover of about 76 billion € in Germany and employs about 290,000 people[1]. With a gross value of about 21.5 billion € it is an important economic sector to Germany.

Construction industry is a major target for circular approaches as it consumes 50 % of the natural resources, is responsible for 40 % of the energy consumption and 30 % of the water usage.Furthermore, the sector is responsible for 40 % of the waste produced and 35 % of the CO_2 emissions. Although about 90 % of the occurring waste from the demolition is reused, the recycling rate is less than 30 % and only a very low partition is returned to building construction.

Most companies providing innovative technologies or services in the sector are small and medium sized companies. Regarding a comprehensive recycling system in Germany, the cooperation with the citizens is essential for its success. However, circular economy demands markets. The success of recycled products depends on the quality of the recyclate and the demand for such products. Public authorities may play in future a crucial role as they can create as consumer a signal to foster the usage of recycled material.

In future, a shortage in the supply with raw materials will affect the construction industry as might a future CO_2-tax as it has currently been discussed by the German government. The German construction industries require about 550 million tons of mineral raw materials and produce 200 million tons of waste. Regional available resources such as sand and gravel already become scarce and mineral raw materials must be transported even longer distances which increases CO_2 emissions, energy costs and finally construction costs. On the other hand, the portion of waste re-used or recycled are decreasing, partly due to stricter regulations.

Circular economy might be a feasible approach to overcome such challenges. However, the level of circular approaches between the Netherlands and the south of Germany are different. This might be the case because as the initial positions are different. The Netherlands have almost no natural resources to use in construction, while for instance in Bavaria raw materials for construction are still available. The acceptance of recycled material is rather low in Germany, where only less than 13 % of the used aggregate in construction origin from recycled materials. A strong political commitment of the Dutch government fostered the development of a circular economy in construction industries. It seems to be much stronger than it is the case for southern Germany where stakeholders are rather reluctant to it. However, the vast majority of interviewed stakeholders from Bavaria see an increasing significance of the topic in the future.

3. Methodology

Aim of this market study is the identification of market opportunities for Dutch Enterprises and organisations of the construction and infrastructure industry related to circular economy in southern Germany. According to the terms of reference, the study addressed various aspects of circular economy in the Netherlands and South Germany. The focus in southern Germany was on the construction market in Bavaria.

Oral interviews were carried out with stakeholders from the Netherlands and Bavaria. As the terms addressed very different aspects within the construction industry, a variety of different stakeholders were questioned. Due to resource limitations single opinions could only be analysed and thus may not be statistically relevant. However, they mirror the situation according aim of the study. As a wide range of different stakeholder deal with CE in the construction and infrastructure industry, a statistic approach would multiply the number of interviews to an amount that is not feasible for the scope of the current study. The interviews carried out and analysed were descriptive.

[1]Source: Bundesverband Sekundärrohstoffe und Entsorgung. bvse

4. Results

4.1.1 Policy objectives in Southern Germany

The Dutch government initiated a national programme on Circular Economy in 2016 with the aim that the Netherlands become 100 % circular by 2050. Therefore, a strong commitment and political ambition to be in the lead in circular economy is politically manifested.

Germany

Germany has no overall policy on circular economy as it is the case in the Netherlands. However, on a federal level several strategies for resource efficiency have been initiated.

On the waste side, the **German Closed Substance Cycle and Waste Management Act** of 1994 increased the responsibility of producers and makes them responsible for coordinating the handling and utilization of the waste they produce.

The **National Sustainability Strategy** from 2002 was confirmed by all governments and its quantitative target is to increase raw material productivity between 1994 and 2020 by 100 %. The regulation was amended 2016 and was also aligned to the 2030 agenda of the United Nations. Basis of the strategy is a holistic and integrative approach: only when interactions of the three pillars ecology, economy and social are considered, solutions will result. The strategy aims for an economical productive, socially balanced and ecological compatible development.[2]

The second strategy is the **German Resource Efficiency Programme (ProgRess)** from 2012. It contains five strategic approaches, for instance raising resource efficiency in production and making consumption more resource-efficient as well as enhancing resource-efficient closed cycle management.[3] With regards to construction, it describes step-up research and development relating to life cycle management of buildings and infrastructures, the commitment of the German government to improve resource efficiency in the production of building materials and in the planning, use and demolition of buildings. In the field of sustainable construction energy efficiency and resource efficiency play together and have complex interactions. Furthermore, the reduction of using non-renewable resources in construction and the replacement by re-growable raw materials is attempted. Extending the life span of buildings and reconstruction using passivhaus standards are also considered.
As part of the sustainable building assessment scheme ("Bewertungssystem Nachhaltiges Bauen", BNB), the Federal Ministry of Transport, Building and Urban Affairs is introducing a building-specific assessment document that also records the building materials and compounds used. In concrete production, raw materials should be replaced by recyclate materials (RC materials), however it is not binding and therefore, finds not as much use as possible (see below). The government is examining if the obstacles hindering the use of recyclate materials and how they might be reduced.

2013 the federal cabinet has decided the programme for avoidance of waste **(Abfallvermeidungsprogramm)** with the contribution of the federal states. The programme determines systematic and comprehensive approaches of public administrations for waste avoidance providing specific recommendations, instruments and approaches. It analyses different waste avoiding actions in production, product design, trade and application of products.

Although Germany has no single circular economy strategy so far, the approaches seem to be based on the **five-step waste hierarchy**:
1. Avoidance of waste;
2. Preparation for the re-use of waste; 3. Recycling of waste;
4. Alternative usage of waste (e.g. energetic utilization, backfilling of mine working place); 5. Removal of waste.

The Dutch policy shows strong commitment towards the development of a circular economy. Germany policy focuses on resource-efficiency and waste issues; a political commitment to circular economy is not manifested yet.

2016 the Federal German cabinet decided on the **German Resource Efficiency Programme II (ProgRess II)** defining action fields of which for instance sustainable construction and urban development is of interest to this market study.[4] Enhancing material circuits in the construction industries is a dedicated task within the strategy. See more on Progress below.

The German Federal Ministry of Education and Research (BMBF) recently funded Research and Development projects on resource-efficient circular economy with focus on construction and material cycles[5]. Focus is the German construction industry with their high demand for resources and large amounts of mineral waste as part of construction residual waste. The expected utilization of high-quality secondary materials from residual waste as well as slag from metallurgic plants, dusts and ashes from incineration plants and mining residues shall

[2] https://www.bmu.de/themen/nachhaltigkeit-internationales/nachhaltige-entwicklung/strategie-und-umsetzung/nachhaltigkeitsstrategie/
[3] https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/progress_broschuere_en_bf.pdf
[4] https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/progress_ii_broschuere_bf.pdf
[5] Richtlinie zur Förderung von Forschungs- und Entwicklungsvorhaben zum Thema „Ressourceneffiziente Kreislaufwirtschaft – Bauen und Mineralische Stoffkreisläufe (ReMin)" im Rahmenprogramm „Forschung für Nachhaltige Entwicklung – FONA³", Bundesanzeiger vom 31.12.2018

contribute to protection of natural resources and a higher supply security in the construction industries.

In Germany as well as in Bavaria a political commitment for the secondary usage of construction waste is still missing according to the association circular economy construction industry Bavaria ("Aktion Kreislaufwirtschaft Bauwirtschaft Bayern"). So far, there is still no institutional framework for the circular economy. Germany's Recycling Act **(Kreislaufwirtschaftgesetz)** still focuses strongly on the waste side. Of great hope currently is the Resource Efficiency Programme II, which aims to double Germany's resource efficiency by 2020 (compared to 1994) including closed materials cycles (BMUB 2016). Digitalization will be important for the ProgRess II report due in 2020.

Bavaria

In Bavaria circular economy is driven by the Ministry for Environment and consumer protection. Recycling and waste management is based on the five-level hierarchy as described above. The ministry provides an information platform on waste management including information on the recycling of construction waste.[6] Quality insurance of RC materials is provided by a guideline on RC construction materials published by the ministry in 2005.[7] An agreement and commitment for circular economy in the construction industry is not mandatory. The agreement includes the application of quality management and monitoring of RC materials and should help to save on natural resources and the limited disposal space.
2017 the ministry addressed on RC materials in more detail with the publication of "Application of mineral recycling materials in structural and civil engineering" aiming to increase acceptance for RC materials in construction.[8]
Target group were public authorities and city planners in Bavaria. The increased consideration of RC construction materials in public procurement is included.
In 2016 the 87th conference of environment ministers strengthened in a resolution the increased application of RC materials with regards to economic and ecological aspects.[9]
2017 the Bavarian state parliament demands in a decision the increased application of RC materials instead of natural resources as long as this causes no additional costs.[10]

2018 the Free State of Bavaria decided on a 7-point plan on resource efficiency in the Bavarian economy as part of the Bavarian resource strategy. Part of this plan are for instance:

- the continuation of the Bavarian Centre for Resource Efficiency (Ressourcen-Effizienz-Zentrum Bayern, RZE) that will be funded 2019/2020 with about 2 million €[11]
- the continuation of the ForCycle Bavarian project association for the development of innovative technologies and processes; ForCycle II is funded with about 3 million €
- strengthening digital technologies in Bavarian companies to increase resource efficiency by providing more support services
- Information campaigns to increase the acceptance of RC construction materials in structural and civil engineering
- Targeted support of companies in the field of resource efficiency by special funding programs
- The Free State of Bavaria will continue their non-mandatory approach on cooperation as part of the continuation of the federal resource strategy within ProgRess III.

Important stakeholders and organisations addressing circular economy in the construction industries in Bavaria are also the Cluster of Environmental Technologies Bavaria[12] running projects and providing comprehensive support on the topic as well as initiatives such as the "Action Circular Economy Construction Industries Bavaria" (Aktion Kreislaufwirtschaft Bauwirtschaft Bayern).

The Free State of Bavaria has a 7-step approach on resource efficiency and supports voluntary approaches providing funding programs.The state of Hessen has a federal resource efficiency strategy and supports the usage of re-growing raw materials in construction. Baden-Württemberg has manifested sustainability as key issue in their coalition contract. It demands circular approaches in public procurements.

Hessen

Similar as the Free State of Bavaria and other regions in Germany, the government in Hessen supports European strategies on resource efficiency and the federal ProgRess strategy. The resource efficiency strategy of the government in Hessen also includes resource efficient building and maintenance of infrastructure.[13] Recycling of construction waste is supported, although the challenges are like in other regions with low acceptance of RC materials. Hessens' government also fosters the use of wood and other re-growing raw materials as construction materials. Action areas in the field of circular economy in construction industries are for instance light house projects for resource saving

[6] https://www.abfallratgeber.bayern.de/gewerbe/recyclingbaustoffe/index.htm
[7] https://www.abfallratgeber.bayern.de/gewerbe/recyclingbaustoffe/doc/leitfaden_recyclingbaustoffe.pdf
[8] https://www.bvse.de/images/news/Mineralik/2017/04-11_Brosch%C3%BCre_Einsatz_von_mineralischen_Recycling-Baustoffen_im_Hoch-und_Tiefbau.pdf
[9] https://www.umweltministerkonferenz.de/documents/87- _UMK_Protokoll_16122016.pdf, TOP 44, S. 56
[10] Bayerischer Landtag, Drucksache 17/15975 vom 14.03.2017.
[11] https://www.umweltpakt.bayern.de/rez/
[12] https://www.umweltcluster.net/de/projekte/kreislaufwirtschaft-bau.html
[13] https://umwelt.hessen.de/sites/default/files/media/hmuelv/ressourcenschutz-_endgueltig.pdf

constructions. The regional government works on an action plan for the increased usage of wood materials or the compilation of an urban Rhein Main continuance land register until 2050.

The Ministry of Environment in Hessen promotes the usage of RC material by information campagna and addresses the obstacles that currently limit the request for RC construction materials. On a voluntary basis they aim to increase the consideration of RC materials in public procurements and appeal to public administration to give a good example.

The governmen published and updated an information guideline on disposal of construction waste[14] especially addressing regulation on HBCD-containing thermal insulation materials.

Baden-Württemberg

Sustainability is the guiding topic of the coalition contract of the government in Baden-Württemberg and the impact and significance of circular economy is manifested within this contract. Since Baden-Württemberg has only very few natural resources on its own, resource efficiency and environmental technologies are key elements of their policy. With this in mind, they founded Baden Württemberg's Environmental Technology and Resource Efficiency Agency (Umwelttechnik BW).

Legislative engine for CE in Germany is the waste problem

Construction and demolition waste play a key role for a closed circular economy. They alone made around 222.8 million tons accounting to about 54.1 % of the total waste in 2016. The major part with 85 % makes excavated soil that mostly is used. Most of the remaining mineral-based construction waste was further exploited too. The increasing amounts of construction and demolition waste reflects the positive economic development in construction industries.

As most of the waste flow in the state of Baden-Württemberg origin from structural and civil engineering, their ministry of environment understands circular economy as the key to address the challenge. The government successfully supported the usage of recycled concrete that has already found usage in many buildings. Further they support public administrations and municipalities on how to consider recycled construction materials in public procurements. Like other German ministries, they claim more responsibility of the public administration to consider circular approaches in public procurements.

Aim of the politics in Baden-Württemberg is to save resources and to give future generations the opportunity to further use raw materials and not to limit it. The government supports a comprehensive recycling with a holistic approach including the entire life cycle of materials. The transportation distance of recycled material is as crucial as issues like soil and ground water protection.

The state of Baden-Württemberg provides a digital platform on sustainable construction in Baden-Württemberg[15] with comprehensive information and tools on the topic. Target group are all stakeholders involved in the construction process from planning, execution and monitoring of the construction process.

[14] https://umwelt.hessen.de/sites/default/files/media/hmuelv/baumerkblatt_2018-09-01.pdf
[15] https://www.nbbw.de

4.1.2 Relevant legislation, guidelines and standards

The following political strategies and legal frameworks are relevant to Circular Economy in the construction sector in Southern Germany:

- The realisation of the EU waste management law/ Directive 2008/98/EC on waste and translation into Circular Economy Act ("**Kreislaufwirtschaftsgesetz"; KrWG**)
- The German Resource Efficiency Programme ("**Ressourceneffizienzprogramm**"; ProgRess)
- The upcoming Substitute Building Materials and Soil Protection Umbrella Ordinance („**Mantelverordnung**" and „**Ersatzstoffverordnung**")
- Regional strategies for raw materials (e.g. „Bayerische Ressourcenstrategie")

The EU Directive on waste as well the German Law on Closed Cycle Management and Waste (**Kreislaufwirtschaftsgesetz, KrWG**) demand a recycling rate of at least 70 % until the year 2020. The German construction industry had a rate of more than 90 % according to the German Association of construction industries in 2016. The EU Directive on waste as well the German Law on Closed Cycle Management and Waste (Kreislauf-wirtschaftsgesetz, KrWG) demand a recycling rate of at least 70 % until the year 2020. The German construction industry had a rate of more than 90 % according to the German Association of construction industries in 2016.[16]

A significant legislative driver for Circular Economy may be the "**Mantelverordnung**" as binding directive to be introduced in the near future.

Basis of the German federal legislation is the European Directive from 2008 on waste and repealing[17]. 2012 the German Bundestag has adopted the Act Reorganising the Law on Closed Cycle Management and Waste (**Kreislaufwirtschaftsgesetz, KrWG**) and thereby implements the European directives. Aim of the Law is to foster circular economy for the protection of natural resources as well as for to secure humans and environment during the production and management of waste. Fundamental of the law is the five-step hierarchy regarding waste (see above).

On the level of the federal states the KrWG is adapted. For instance in Hessen the state has with the Implementation Law on Circular Economy ("**Hessisches Ausführungsgesetz zum Kreislaufwirtschaftsgesetz, HaKrWG**")[18] an additional regional directive to strengthen the execution of the federal law on circular economy (Kreislaufwirtschaftsgesetz). The HaKrWG strengthens the change towards a circular economy and obliges public authorities to consider circular solutions in public procurements concerning work flows, the purchase or application of materials and consumer goods as well as with regards to building projects.

In Bavaria, public administrations are asked to proof according to the KrWG and the Bavarian waste economy law (Bayerisches Abfallwirtschaftsgesetz, BayAbfG) if RC material can be applied. The public tender of construction projects has to be product neutral and according to regulations of the call for tenders for constructions (Vergabe- und Vertragsordnung für Bauleistungen, VOB). RC construction materials that fulfil technical specifications and quality insurance, have to be considered as equal to primary raw materials.

The neutral description of tenders is also the case in Baden-Württemberg. The preference of RC material in public tenders must be avoided. Plants containing construction materials according to technical regulations (Technische Lieferbedingungen für Baustoffgemische und Böden zur Herstellung von Schichten ohne Bindemittel im Straßenbau, TL SoB-StB) are summarized in a „White list".

An important legislative regulation that still is in process is the so-called **Mantelverordnung** that exists since 2017 as a draft. This regulation might provide a binding federal standard for all states in Germany instead of the current status of a fragmented framework of regulations in each state. The **Mantelverordnung** may provide a binding legal directive as the current federal regulations are not binding and too general to foster the usage of RC material in the construction industries. However, construction associations criticise some issues in the current draft that may increase the portion of construction waste to be deposited and thereby, may be contra-productive for circular economy.

At the moment the consultations on the draft of the regulations are ongoing in the federal states, including more than 300 requests for changes since September 2018. Major concerns are higher requirements on substitutional materials, such as polycyclic aromatic carbohydrates in materials, that may lead to a change of the material flows in the direction of deposition sites. This would be critical considering the limitation of deposition space and also for a circular approach as the acceptance of secondary materials may further decline.

Furthermore, a challenge for recycling plants is the approval procedures according to the German

[14] https://www.bauindustrie.de/presse/presseinformationen/abfallentsorgung-bauwirtschaft-schreibt-erfolgsgeschichte-fort/
[15] https://www.nbbw.de
[16] https://www.bauindustrie.de/presse/presseinformationen/abfallentsorgung-bauwirtschaft-schreibt-erfolgsgeschichte-fort/
[17] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32008L0098&from=DE
[18] https://rp-giessen.hessen.de/umwelt-natur/abfall/sammlung-transport/überwachung
[19] https://www.recyclingbaustoffe.de/

legislative on emissions (**Bundesemissionsschutzgesetz, BImSchG**). Such permissions are usually difficult to obtain.

Certification

Basis of certification is DIN 18200 that describes a process to confirm the technical specification of construction materials. The process includes the production control (self-supervision), the external control and the certification. The certificate confirms that the construction material fulfils the technical specifications as well as self- and external control.

The federal associations of RC construction materials (Bundesvereinigung Recycling-Baustoffe e.V.) has published guidelines for such materials and their certification.[19]

In Bavaria for instance the Baustoff Recycling Bayern e.V. provides certification of RC material according to the DIN norm.

Certification of RC materials in Baden-Württemberg is carried out for instance by the Quality insurance systems Recycling construction material (Qualitäts-sicherungssystem Recycling Baustoffe Baden-Württemberg e.V., QRB).

In Hessen RC certification of recycled construction material may be addressed by Baustoffüberwachungs-verein Kies, Sand und Splitt Hessen – Rheinland-Pfalz e. V. (BÜV HR).

Comment: Certification of RC material is important to secure trust in the quality of the products and is carried out by different organisations in southern Germany. However, it seems that it has not provided significant benefits to the acceptance of such materials in South Germany yet.

Standards

As described above the ProgRess programme of the German government addresses the topic of certification and standards of construction products as one action field. The regional governments in the German federal states claim the responsibility of the public administrators and municipalities to consider RC materials in public procurements. However, the municipalities still seem to be reluctant request the usage and application of recycled construction materials in the tenders. This independence of municipalities in decision making is historically based in Germany as municipal self-administration. Although some federal states intend the usage of quality-assured recycled construction materials, such as the government of Rhineland-Palatinate founded an alliance of discrimination-free tenders of quality-assured RC material, this is not binding to the municipalities and does not exist in all German federal states.

As incentive for the usage of RC material a label with high public awareness and appreciation would be desirable, similar to the certification of the German Sustainable Building Council ("Deutsche Gesellschaft für nachhaltiges Bauen", DGNB).

Comment: Public authorities play a key role on the development of a circular economy in South Germany as they are responsible for large construction and infrastructure projects. However, circular approaches find no significant attention in public procurements yet.

[19] https://www.recyclingbaustoffe.de/

4.1.3 Main investors in Germany

Growing construction market

Germany is Europe's leading construction market and has experienced substantial growth in recent years and investments are expected to increase further. Strongest increase is from public contractors according to German construction industry association HDB and this year for the first time overtaking residential orders.[20]

The construction industry is a key role for the German national economy. In 2018 a construction volume of about 400 billion € was produced.[21] Alone in March 2019 an increase of 18.8 % compared to March 2018 was assessed according to Destatis[22] with a raise of 22.2 % in underground work and 18.5 % in building structure.

Market research predicts the market in Germany to post a CAGR of close to 5% during the period 2019-2023. A key driver for the construction market in Germany is the growing demand for housing units. According to the Federal Office for Building and Regional Planning, Germany requires about 350,000 new housing units per year by 2021. In 2018, the German government made an announcement regarding its plan to construct around 1.5 million housing units by 2021. Additionally, the high population growth in major cities and the increase in immigrant influx will drive the increase in residential construction projects.[23]

According to a study of PwC the segment of residential housing will have the strongest growth with a CAGR of 4.2 % until 2020, followed by commercial construction with 2.2 % and public construction 1.0 %.[24]

Construction Boom in Germany ongoing

For some time, a construction boom has been existing in Germany. The demand for accommodation and buildings is high in Germany and as a result of that prices in the construction economy are raising. Due to the low interest rates professional and private investors have acquired new buildings and properties and large investments were carried out for renovation measures. Accordingly, the volume has increased over the past years and is still ongoing. Available capacities and shortage of skilled labourer are currently the major limitations.

Members of the central association of the German building industry (Verband Das Deutsche Baugewerbe) had in March 2019 positive business prospects. The range of current orders in the construction industry is four months for surface structure and three months for underground work. The degree of capacity utilization is with 70 % very high. The forecast for investments remains on a very positive and high level.[25]

Comment: Infrastructure Road, tracks and water: 264.5 billion federal investments by 2030

Federal roads, tracks and water routes are responsibility of the federal government in Germany.

Every 10 to 15 years the German government and the Federal Ministry of transport publishes a masterplan on the Federal Transport Infrastructure Plan (**Bundesverkehrswegeplan, BVWP**) and is considered as the blueprint for federal investments in Germany. The latest was published in 2016 and is called "Bundesverkehrswegeplan 2030". This foresees a total investment sum of 264.5 billion € of which 49.3 % account to investments in roads, 41.6 % on tracks and 9.1 % on water routes. Highest priority has the maintenance of the existing infrastructure network with about 141.6 billion €, however due to increasing traffic new infrastructures need to be created too. In the BVWP 2030 about 2,000 suggestions for extending and novel infrastructure projects were proofed and about 94.7 billion € allocated.[26] Therefore, the BVWP estimates for the period between 2016 and 2030 an annual investment of about 15 billion €.

The recently published Panel on investments of municipalities (KfW-Kommunalpanel 2019) showed a backlog of investments in infrastructure and road of about 36.1 billion €, partly due to capacity limitations in the construction industry.[27]

» With the 2030 Federal Transport Infrastructure Plan and its upgrading acts as well as the investment ramp-up, we have launched the largest ever investment programme for transport infrastructure in Germany. We will consistently implement this programme in the years ahead. «

Andreas Scheuer, Federal Minister of Transport and Digital Infrastructure

Bavaria
The Free State of Bavaria invests annually about 1.5 billion € into building construction and around 2 billion € into infrastructure of federal and state roads.[28]

Baden-Württemberg
The federal state invested around 950 million € into building construction and 1.5 billion € into the infrastructure of roads in 2018.[29]

Hessen
The federal state of Hessen invests 2018-2019 around 356 million € into infrastructure of roads[30].

[20] Source: Die Deutsche Bauindustrie. Mai 2019.
[21] Source: Federal Ministry of the Interior, Building and Community.
[22] Statistisches Bundesamt, census bureau.
[23] Source: technavio (2018): Construction market in Germany 2019-2023. The report analysis leading construction companies in Germany, such as BAUER Group, Bilfinger, Hochtief, Max Bögl Group, Strabag, Stumpf Group.
[24] Source: PwC (2018): Baubranche aktuell. Wachstum 2020 – Digitalisierung und BIM.
[25] https://www.zdb.de/zdb-cms.nsf/id/geschaeftslage-und-erwartungen-im-fruehjahr-2019-weiter-gut-de?open&ccm=020020
[26] Source: Bundesverkehrswegeplan 2030
[27] Source: KfW Kommunalpanel 2019.
[28] Source: Bavarian Bauindustrieverband 2018.
[29] Ministry for Finances, Ministry for Transportation. Baden-Württemberg.
[30] Source: Hessische Landesregierung.

4.1.4 Expectations of Dutch parties

Eight telephone interviews were carried out with stakeholders from the Netherlands. According to the terms of references, the interviews focused on a) the situation of CE in construction industries in the Netherlands compared to Bavaria; b) the experience and challenges in Southern Germany related to the key competence as well as the demand of Dutch stakeholders for entering the southern German market; and c) expectations and opportunities for cooperation.

Framework for CE in the Netherlands compared to Southern Germany (from the perspective of the Dutch stakeholder)

While the Dutch government has manifested Circular Economy as political aim ("A circular economy in the Netherlands by 2050") and signed a deal with business and non-governmental organisations demonstrating the commitment to the topic, this is not the same for (southern) Germany. Dutch stakeholders miss in Germany the political drive to foster CE in general and in the constructions industries in particular. The political commitment is considered as prerequisite for the development of a functioning CE most important for foreign investors and Dutch companies to build plants in Germany. Currently, the framework for setting up business in Germany is not in favour of such investments and commitment of the interviewed Dutch companies. The lack of political empowerment is seen on the federal as well as on the regional level.

Comment: Dutch stakeholders miss political commitment for Circular Economy in Germany.

Market for CE in Southern Germany – experience and challenges of Dutch stakeholders

Furthermore, the development of a circular economy is hindered by large industry associations in Germany such as the Heidelberger CementGroup or the Remax group. The impacts of these groups on local and federal decision makers is considerable and impede the development of circular approaches and market entry of entrepreneurs offering alternative solutions. According to the interviewed actors, the cement and concrete industries in Germany have monopoles that try to avoid the progress of CE and therefore, market entry of foreign investors.
According to the Dutch stakeholders, it is not understandable how on the hand a ban for new deposit sites exist in southern Germany, on the other hand most of the construction and infrastructure waste is still deposited and not recycled. From their point of view, the deposit site operators in Germany have a major impact on this and actively prohibit recycling by pricing and betting competition.

Comment: Interests of large associations in concrete industry as well as operators from disposal sites impede circular economy.

Many of the interviewed parties criticized the attitude of architects towards circular construction. As in Germany architects are more involved in the design of building constructions, the planning and realisation is carried out by engineers and finally, the contractors. As designer, the architects are more interested in individualised solutions than modular and pre-set buildings. In case of the planning of recycling sites for instance a flexible and modular approach is hindered.
The implementation of CE in public procurement is also a major difference between the Netherlands and Southern Germany. The Dutch government gives a mandate to CE in public tenders and thereby, creates a market. Tenders with circular solutions are favoured in the application process and projects have advantages receiving more attractive bank grants. In Bavaria however, CE is not allowed to be favoured in the public procurement process and municipalities have a rather dismissive attitude towards CE in public orders.
Larger interviewed Dutch companies, like Sqape Technology and Heijmans Infra B.V., are rather sceptical of approaching the German market. Heijmans was on the German market before 2017 but had to leave it due to financial losses; currently, they have no particular interest in the German market and only sell products to it. Sqape Technology have no approach how to address the German market yet and due to the above described challenges require a different concept from that used in other countries.
A major difference in CE industries in Germany compared to the Netherlands is that the construction industry is rather national. While Dutch companies collaborate in coalitions to offer solutions to other countries, German firms act regionally and cooperate locally. This might be due to language skills, law and financing issues.

Innovations and Technologies

The interviewed organisations have developed the following innovations that might be of interest to the South German market:

- Stichting BioDelta: Lignin as renewable resource in Asphalt; cellulose fibre in cement
- Madaster: building pass indicator for circularity of buildings
- Sqape: Geopolymeres as alternative to cement
- Reko: Recycling of tar containing Asphalt
- Modulo Milieustraten: flexible and modular recycling sites

Expectations and Opportunities

For advancing CE in Germany, a political commitment in favour of new circular solutions is required in southern Germany to enable foreign investments. Some of the Dutch stakeholders favoured Bayern Innovativ to take over an influencing role on governmental bodies. However, the Bavarian Association of Construction Material Recycling (Baustoff Recycling Bayern e.V.) would be more suitable from the point of Bayern Innovativ.
The interviewed Dutch companies are keen on getting access to contacts in the engineering and construction industries. Such contacts could function as license partners as well as cooperation partners and potential clients as part of business cooperation.

Opportunities for technological cooperation is rather on the development level (TRL smaller 6) and great chances are foreseen in the asphalt industry, for instance the application of lignin replacing bitumen. In the construction industries, the usage of cellulose fibres in cement applications could be a project of interest. Cooperation and building trust and confidence is crucial to be successful in CE industries from the view of the Dutch stakeholders.
Continuous digitalisation within the construction industries will raise in the next 5 years: modular building, assembly halls and mass production of pre-fabricated units. BIM (Building Information Modelling) will have a significant impact

4.1.5 Expectations of German parties

Interviews from eight Bavarian stakeholders were analysed according to the terms of reference focusing on policies, future market opportunities (investments) and demand (technologies, challenges).

Current situation of CE in Southern Germany

The interviewed Bavarian stakeholders foresee an increasing demand for solutions in the field of recycling and the market of circular economy in southern Germany. The reasons given were for instance the limited capacities of waste disposal sites as well as legal regulations and restrictions regarding the disposal of construction waste will become stricter in future. Many materials used in the past may in future be considered as harmful and therefore, require special and costly disposal. However, the installation of new disposal sites is more and more restricted in southern Germany. This impact can be considered as driver for circular economy on the one side, however the power of the operators on the other hand as barrier. As mentioned before, disposal site operators may prevent the application of new technologies that risk their own business model.

Incentives and preference in public procurements – exchanging information cross border
The Netherlands has implemented several incentives to foster circular economy, such as discounts on investments, preferences in public tenders, special credits and financial advantages. This seems to lack in southern Germany. An information exchange between the Netherlands and southern Germany could set new ideas on how to promote the topic in Germany.

Comment: Stricter regulations on harmful compounds in RC material may challenge their application and increase the amount of waste despite a shortage of disposal sites.

Although there is no significant shortage on mineral construction materials, such as sands and gravel in Bavaria, this might change in future. Limitations are only regionally occurring, for instance in Bavaria in the regions around Ingolstadt, Nürnberg or Pfaffenhofen.

So far, the construction material is received from local providers. However, river sands are limited already and the replacement of such limited raw materials by RC material has potential. As alternative to concrete, geopolymers were mentioned as a source with high market potential.

Geopolymers are studied on a research level so far. Geopolymers contain sand, gravel, soda, clay, water and alkali. They can be used as cement-free binding material. The major advantage are savings in energy consumption as only low temperatures are required for their production compared to cement requiring temperatures of about 1400 degree Celsius. Geopolymers have additional material advantages. So far, there is no approval for the application of geopolymers as construction material in Germany yet.

Comment: Future limitations of sand and gravel may foster CE in southern Germany. A time horizon of 10 to 20 years is expected. Geopolymers as alternative construction material replacing cement in future?

In future more construction waste will incur. The demand for living space and new constructions is increasing by limited available areas in cities. Thus, more demolishing and reconstruction of old building will be required in future in order to satisfy the demand for living space.

Incentives fostering CE in the construction sector as they are offered in the Netherlands, do not exist in southern Germany yet. Representatives of municipalities strengthened that a preference of circular solutions in public tenders cannot be realised due to public procurement constraints

Construction waste is complex – new technologies required

Compared to centuries ago, construction material these days contain more and more composite materials. The mixtures of concrete, bricks, ceramic need to be separated from non-mineral fractions. Especially, thermal insulation composite materials present a challenge for recycling companies as well as harmful substances in construction materials (e.g. wood with finish) and fibre concrete.
The complexity of construction waste requires new technologies and innovative solutions. These include technologies for re-construction, separation, sorting, quality control and analytics of the construction material.

Comment: Sandwich constructions and new composite materials will challenge recycling of constructions in future. Technologies and solutions from the Netherlands could fit the future. Especially, a demand for HBCD in EPS is a problem. In the Netherlands plants for EPS-recycling are set up already and may have a good chance on the German market.

In southern Germany, RC materials still have a rather negative reputation and do not find such significant usage in buildings as in the Netherlands. Certification and labelling ensuring quality requirements may improve the application of RC material. As well as novel fields of applying RC material may improve the awareness for circular economy in southern Germany. However, as long as RC material has no functional or cost advantage, construction firms will continue to use raw materials instead.
In this regard, a general disadvantage are the high logistic costs at low material costs due to the transportation over long-distance in south Germany that make RC material from other regions not economic.

Recycling sites in Bavaria have a good capacity utilisation rate. However, if the demand for RC materials is not growing, they may shut down the receipt of goods. A market pull for RC materials is required.

Only two plants exist for the recycling of plaster in Germany (one in east Germany, one in Baden-Württemberg). The demand for Recycling Plaster will increase in future as due to the exit of coal mining in Germany, less REA-plaster will be available from the flue gas desulphurisation. New sites for natural plaster are no longer approved.

Although bricks could be reused as they do not wear of during their lifetime, the removal of residues is not economical. Only bricks from historic buildings are currently recycled due to their value. Application fields for RC bricks will not exist in the near future.
The production of bricks is based on regional available raw materials. No shortage in the supply with such materials is expected within the next 100 years.

Fibre concrete (carbon fibre, plant fibres, wood fibres) will increase in the disposal waste in future. Currently, no recycling technologies exist and especially, carbon concrete is difficult to separate.

Comment: A demand for RC plaster and separation technologies for carbon concrete was strengthened by stakeholders in south Germany.

Decision makers: Principal, architects and construction companies

Recycling has no role for the purchase of real estate. The location, price, size etc. play a role. Planning agencies and architects consider RC material not enough and have only limited knowledge about the material characteristics and advantages of recycled construction materials. Therefore, they are hardly considered as construction materials. Future recycling of materials plays no role in the decision making. A change of the perspective from planners and architects may foster the re-use of materials.

Investors show no interest in a future deconstruction of the buildings and are not willing to pay additional charges for later recycling. Usually the most cost-efficient approach to fulfil the legislative regulations is realised. Environmental technologies are only applied when legislations are binding. This may change in future with BIM because criteria for the sale of buildings may be considered that evaluate the building according to its materials, sustainability or energy efficiency.

In construction companies the view is changing by now. Thinking in life cycles of constructions is taking place and they are aware of costs related to it. The life span of buildings in urban areas is decreasing which is taken in account by contractors and construction companies. However, still many of the contractors do not calculate the future costs for demolition or deconstruction as well as life cycle analyses or multiple cycle environmental analyses are still not as common as necessary.

New concepts for pushing CE in Southern Germany

To establish a circularity within the construction industries in southern Germany, the interviewed partners mentioned that an increased classification and certification of the RC material as part of BIM (e.g. digital product data, classification of compounds) would be beneficial. Therefore, Madaster's approach using digital platforms with building passes would also be suitable for southern German regions.
Other suggestions mentioned were alternative concepts for a secondary usage that is already considered in the planning phase. This would require a closer cooperation with architects in Germany and opening their scope for applications outside buildings as example. Business ideas

of Dutch entrepreneurs for alternative applications may therefore be suitable.
Material and building passes or BIM may foster the selective reconstruction of buildings and high-quality recycling. Unclear is who can administrate and who has access on the data. Of advantage would be an overview on the exchange cycles, the utilised materials and harmful compounds and the exact position within the construction. A time horizon of 10 to 20 years is expected for an area-wide introduction.

Comment: Innovative approach for the recycling of concrete: electrodynamic fragmentation
The challenge of separating composite materials is described. The technology of electrodynamic fragmentation allows the selective separation of a wide range of different composite materials including waste concrete into their initial parts. The Fraunhofer IBP is working on it.[31] The concept of a pilot plant exists but investors (3 to 5 million €) are sought.

Legislations and regulations

Regulations, guidelines and standards for the application of RC material need to be adapted in order to ensure quality requirements and thereby improve the reputation of RC material. Although technical regulations exist already, such are usually not monitored or even practised. Certification is crucial for the success of RC material. Although certification of RC material already exists, even the acceptance of certified RC material is still very low. However, materials without any kind of certificate have no chance on the market at all. Such certifications are required on the federal site, but in practise the regulations are often not realised by the municipalities.
The legislation on commercial waste (Gewerbeabfall-verordnung, GewAbfV) was renewed since 1st August 2017 and has impact on CE in Germany. It requires the separate collection of reusable materials and thereby may foster recycling. The legislation results in stricter requirements for separation and documentation. According to some statements, however, the legislation only increased the amounts of materials ending up on deposit sites and thus may fail its original objective.

Comment: The "Mantelverordnung" was mentioned by the interviewed stakeholders as a major future change that may increase recycling and CE in the construction industries, while other interviewed groups were critical about the effect of the new legislation.

According to the statements made in some interviews, RC asphalt is not considered in regulations.

Further characteristics of the situation in Bavaria
The construction industries in Southern Germany is mainly recruited by SMEs and medium sized companies, however almost no global companies. The companies receive goods locally with rather short distances for delivery and transportation. Traditionally, the construction sector in South Germany appears more conservative and less open to innovations compared to the Netherlands. So far, RC material is not a significant major field of interest. The main barriers for RC material mentioned in the interviews are the price that usually is not lower than that of native raw material, quality issues and the reluctance of planners and contractors to apply RC material.

Comment: Construction industry is working regionally and thinking conservative in Bavaria

Claims **of the Bavarian government**
Regarding Circular Economy in the construction industries the Bavarian Ministry of the Interior, for Building and Transport claims:

Intelligent planning, building and usage of constructions: the CO_2-foodprint must be reduced through technological solutions, intelligent usage behaviour and regionalisation of the construction materials as possible.

More investments in protective constructions as a result of a climate change: by 2030 continuous investments in intelligent flooding and avalanche protection as well as drainage systems are required.

Protection of natural resources and the implementation of circular economy in construction: excavated soil contains valuable resources. The material should be used in local distance, such as for the construction of technical buildings or as filling for pits or quarries. A high recycling quote for mineral construction and infrastructure materials has already been achieved and saves natural soil resources. Stricter and excessive regulations should not decrease the rate in future. Enough disposal site space is required for the remaining construction waste.

[31] https://www.ibp.fraunhofer.de/content/dam/ibp/en/documents/Information-material/Departments/BBH/Produktblaetter/IBP_087_PB_Bauchemie_Fragmentierung_03_web_en.pdf

4.1.6 Matching technology and market demand between southern Germany and the Netherlands

Bavaria is missing waste deposition sites for low contaminated soil (DK 0 and DK 1): The result is an increasing export of contaminated soil in other German states and other countries (waste export).
Request: Alternatives for the waste or decontamination technologies.

Midterm limitation of raw materials: currently not an urgent challenge in most regions of the state, but in future the supply with sand, gravel and stones for the construction industries is in danger. Construction industry in Bavaria is aware of it but serious actions are currently not undertaken yet.
Request: alternative solutions of materials, such as geopolymeres. As the Netherlands currently already have such shortage, they may have a time advantage to offer solutions that already work in their country. Sqape from the Netherlands is working on geopolymers and may re-consider their activities in southern Germany.

Technical potentials are not sufficiently applied: during demolition, separation, sorting and selective dismantling, the technical potential is not used to gain clean waste fractions that could be recycled. Costs of the procedure are the main reason. A selective dismantling is only carried out when contamination loads require it.
Request: fast and cost-efficient alternatives.

Technical challenges for recycling and dismantling: (i) novel technical solutions for the separation and reutilization of inseparable glued material composites and sandwich constructions; (ii) elimination of harmful and interference factors, especially sulfate from plaster, mortar and finery but also flame protectors and impregnation; (iii) missing reutilization and processes for the fine fractions, mixed fractions and residual fractions form sorting.
Request: technological solutions and approaches from the Netherlands.

Future challenges for the recycling and deconstruction industry: (i) increasing amounts of EPS-based and HBCD-containing thermal insulation composite systems; (ii) fibre composite and filled bricks will mid-term appear in construction waste and require new technological solutions for separation and disposal; (iii) increasing complexity of construction with regards to the implementation of more technologies (e.g. solar technologies, heating systems, e-charger, microelectronics from smart home technologies etc.); in future 60 to 70 different material compounds will be integrated in buildings; (iiii) regulations for harmful substances will further tighten as more and more substances are considered dangerous (e.g. flame retardants, PFC).
Request: technological solutions and approaches from the Netherlands as mentioned above.

Solutions for concrete & bricks: (i) RC concrete is used as fraction in concrete production. However, the potential is not fully used yet. The reasons are regional availability, acceptance, demand and price; (ii) correctly sorted crushed bricks can be used for lightweight concrete or other mineral bound construction materials as well as pure sand-lime bricks could be returned to the production.
Request: cheaper solutions for gaining pure fractions

Quality standards and certificates: Certificates exist (see above) and assure harmlessness and quality of RC materials; however, RC materials have not the same acceptance as primary construction materials. RC materials are considered from a legislative point of view as waste and therefore, more strict regulations apply to them as well as long-lasting approval procedures and limitations in their installation.
Request: approaches from Holland to increase the acceptance

Product responsibility (§23 KrWG) of construction material manufactures: many manufactures of construction materials use regional natural materials and have limited interest in recycling. The development of construction materials based on secondary raw materials mainly exists on an academic level. Life Cycle considerations are rare as well as decisions on end of life usage for construction materials.
Request: approaches from Holland to increase the acceptance. In the Netherlands, the environmental performance of a building is already measured as standard over a single cycle.[32]

CE construction approaches: avoidance of inseparable material composite and sandwich constructions and application of innovative joining technologies, such as clip systems, plug and screwing systems; glue materials that are easily removable (e.g. using microwaves) as well as modular and system constructions.
Request: price competitive construction solutions

Increasing awareness for CE solutions: contractors, architects, public authorities, investors understand the necessity for recycling, however they do not see it as their responsibility. Often there is a limited knowledge about the characteristics and opportunities of RC materials and therefore, they are not considered. CE solutions are not preferenced in public procurements.
Request: best practise and knowledge exchange with solutions from the Netherlands, especially in terms of architects and municipalities.

[32] Source: Circular economy in the Dutch Construction sector. A perspective for the market and government (2015)

Dismantling as source of raw materials: material and building passes or BIM may significantly contribute to a selective dismantling and high-quality recycling. Ideally, a concept for dismantling is already proposed during the construction phase with a clear localisation of the used materials and their position
Request: solutions from the Netherlands are available (e.g. building pass by Madaster). Projects and experience to implement design during the planning and the reuse of houses in multiple cycles already exists in the Netherlands.[33]

Blockage of investments on a municipal level: many municipalities have the need for more constructions (see above), however are limited due to constraints on the availability of capacities in the German construction industry.
Request: the limitations may be advantages for Dutch construction companies.

4.1.7 Other factors to consider

As mentioned above, construction industries in southern Germany are mainly working on a regional and larger companies on a national level. Only exceptions of large companies are internationally operating. The small and medium-sized enterprises usually have no interest or activities in research.

Main vendors of RC materials are regional construction companies. Construction materials are transported in a distance less than 50 km. Recycling companies also work on a regional level.

Therefore, mobile recycling plants from the Netherlands may be considered. The advantage of such solution is that they do not require time-consuming approval procedures as long as they are placed at the site for less than 12 months.

[33] Exploratory project carried out by the National Institute of Public Health and the Environment (RIVM) and Rijkswaterstaat for the Ministry of Infrastructure and the environment (IenM). Source: Circular economy in the Dutch Construction sector. A perspective for the market and government (2015).

5. Results of Workshop on "Circular Economy in the Construction Industry"

During the event "Kreislaufwirtschaft in der Bauindustrie" on 6th February 2019 a world café was carried out with five tables. One table addressed during one round of discussion with interested participants "Chances and approaches of bilateral collaboration between the Netherlands and Bavaria". Results of the workshop are summarised as follows:

Chances of Innovations and Technologies from the Netherlands

New technologies in the field of recycling and CE from the Netherlands may experience difficulties entering the Bavarian market. Workshop participants mentioned the readiness of Bavaria as "good technologies at the wrong location". As analysed above, construction industry in Bavaria is local and conservative and has had established collaborations over a long period of time. A strong and competitive industry in Bavaria will avoid new cooperation from outside unless they allow significant improvements. Regulations in Bavaria differ from such in the Netherlands, especially the rules and situation for public procurements.

Opportunities for cooperation Bavaria and the Netherlands

The participants stated that Bavarian SME are rather small and not internationally experienced and thus, may have disadvantages towards dominant, larger and international operating companies from abroad. Material flow from Bavaria to the Netherlands or vice versa would be contra-productive regarding the aim of reducing the CO_2 footprint. Foreign companies should therefore consider to setup subsidiaries in Bavaria. The long distance between the countries was considered as challenge for this kind of industries.
However, co-operation in R&D has been pointed out as great chance and doubtless, the Netherlands are one of the most important partners for such cooperation.

Potential topics for cooperation

Demand for new solutions for the recycling of thermal insulation composite systems and particular the mineral fraction was mentioned to be of interest to Bavarian participants. Other technological solutions are required for tar-containing asphalt (Note: potential field of application for Reko B.V.) and recycling of electric waste.
EU guidelines exist for all countries of the EU but are translated differently in each country. Exchange of information and knowledge on a bilateral level is a chance to push the topic of circular economy together.

6. Digital Platforms illustrating CE

Furthermore, we suggest utilizing the digital innovation platform of Bayern Innovativ for either illustrating results and future steps for instance as trend radar or roadmap. The Digital Innovation Platform (DiP) is a software-based innovation management tool which allows a highly collaborative work together with a holistic integrative approach for topic scouting, visualization as radars and generation of roadmaps. This facilitates the possibilities to illustrate dependencies, e.g. between trends and technologies which then can be directly implemented into a roadmap process. Moreover, the estimations of different experts can be aggregated in the DiP for trends or technologies which leads to a better view on the impact of the trend or technology. In this context one can generate for a selected topic, such as tar recycling in infrastructure, a topic radar and then continue in a roadmap on visualizing the required steps to reach a defined goal. For this, the market, technology, drivers and barriers can be determined on different layers on the roadmap in the DiP. Due to the foretold nature of the DiP, stakeholders from the Netherlands and Bavaria could evaluate the various aspects of the topic and the results can be illustrated on the digital platform.

7. Outlook

The results of this market study show differences in the Dutch versus the south German approach on circular economy within the construction industry. The motivation, drivers and realisation of circular economy show national differences. Nevertheless, the significance of circular approaches in the construction industry in future is confirmed from interviewed stakeholders from both countries. The southern German market is not quite that dependent on RC materials yet as a shortage of construction materials is only foreseen mid- and long-term. One decisive criterion are the costs and quality aspects of RC materials. As long as they are not far below the price of raw materials, they will not be considered as alternative by the stakeholders. Future drivers for circular economy in Germany may be legislative changes, especially the "Mantelverordnung" and the possible introduction of a CO2-tax in the construction sector to achieve the national climate protection targets. Public authorities in Bavaria are rather reluctant to the usage of RC materials as they are afraid of quality disadvantages. Future negative publicity on substances that might be harmful and used in public buildings, such as schools, may be the reason for their reluctance. Exchange of knowledge between public authorities from the Netherlands and south Germany may be an approach to handle it.

Impressum

Published by: Bayern Innovativ GmbH on behalf of the Consulate-General of the Kingdom of the Netherlands in Munich and Netherlands Enterprise Agency (RVO)
Executed by: Borris Haupt, PhD
Date: June 2019
Status: Final

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This publication was commissioned by the ministry of Foreign Affairs.

Publication number: RVO-070-1901/RP-INT

NL Enterprise Agency is a department of the Dutch ministry of Economic Affairs and Climate Policy that implements government policy for Agricultural, sustainability, innovation, and international business and cooperation. NL Enterprise Agency is the contact point for businesses, educational institutions and government bodies for information and advice, financing, networking and regulatory matters.

Netherlands Enterprise Agency is part of the ministry of Economic Affairs and Climate Policy.