32nd Electric Vehicle Symposium (EVS32)
Lyon, France, May 19 - 22, 2019

International cooperation as a component for success industrialisation of future transport technologies

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Summary

Electrification and digitalisation in the mobility sector lead to an enormous shift in the automotive industry creating major challenges and opportunities for stakeholders along the value chain. Cooperation between industry and research as well as knowledge transfer across technology sectors are considered to be key factors for a successful industrialisation of future transport technologies. At the same time, both trends to lead to significant changes in national and international supply and innovation chains. New technology manufacturers and service providers enter the mobility sector and develop into new competitors. In future, players from industry and academia can only be successful when cooperating within strong regional innovation networks and with international partners at the same time. By supporting their partners in cross-border cooperation, cluster networks play an important role in shaping the successful industrialisation of future transport technologies. This paper gives an overview about the internationalisation strategy of Cluster Electric Mobility South-West, which connects more than 140 players in the automotive region of Baden-Württemberg and is one of Europe's leading innovation networks on future transport technologies.

Keywords: industrialization, strategy, consortium

1 Industrialisation of future transport technologies

Mobility of the future is automated, connected and electrified. Megatrends such as increasing global warming, the finite nature of fossil fuel resources, the growth of urban areas and increasing standards of living impose new demands on mobility of people and goods. Concepts for sustainable transport system, in which electric mobility and innovative mobility solutions are key elements, are required to cope with these challenges and, at the same time, create economic growth.

Electrification and digitalization in the mobility sector lead to a drastic transformation process in the automotive industry and a progressing merger with technological developments in the information and communication technologies as well as the energy sector. Automotive manufacturers as well as their component suppliers need to understand mobility of the future as a complex system of innovations across different technological disciplines (fig. 1) that go hand in hand with profound changes in our economic and social environment. A successful development of future transport solutions requires new forms of cooperation

between industry and research across technology sectors and also needs to involve competences from the fields such as urban planning, infrastructure development and social sciences.

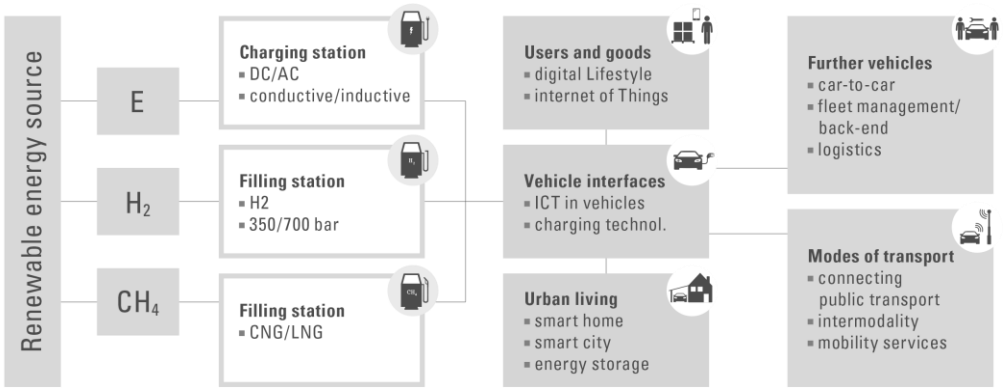

Figure 1: System approach to future transport technologies (source: Fraunhofer IAO)

The technology change towards future mobility creates major challenges but also significant economic opportunities for industrial stakeholders all along the automotive value chain. Depending on the development of major legal and economic framework conditions during the next years, battery electric vehicles will have a market share between 15% and 51% of all new vehicles sold in Europe by 2030. As shown in a recent analysis by major German research institutes and consulting companies, especially the development of carbon dioxide emission standards set by the European Union will be a major driving force for technology and market development. Even in a moderate “business as usual” scenario (CO2 fleet target of 67g/km), the authors expect market shares of 15% for battery electric, 13% for plug-in hybrid and 35% full hybrid drivetrains in new vehicles sold in Europe. A more progressive scenario, based on the assumption of an increased CO2 target of 50 g/km, even predicts a market share of more than 50% of battery electric and 47% of partially electric drivetrains in new vehicles [1]. This strong market development for alternative drive train solutions will strongly re-shape the automotive value creation chain and evoke severe effects for employment and the industrial ecosystem in many European regions.

For the State of Baden-Wuerttemberg, located in the south-west of Germany, automotive manufacturing is a key industry sector and major determinant for economic growth and employment. In 2017, about 312.000 people were employed by OEM, automotive component and part manufacturers and engineering services located in this region and generated a total turnover of 105 billion Euro [1]. With major OEM facilities, world-leading component and system suppliers as well as internationally renowned universities and automotive research institutes located in this region, Baden-Württemberg is a leading international hub for automotive technology development and manufacturing.

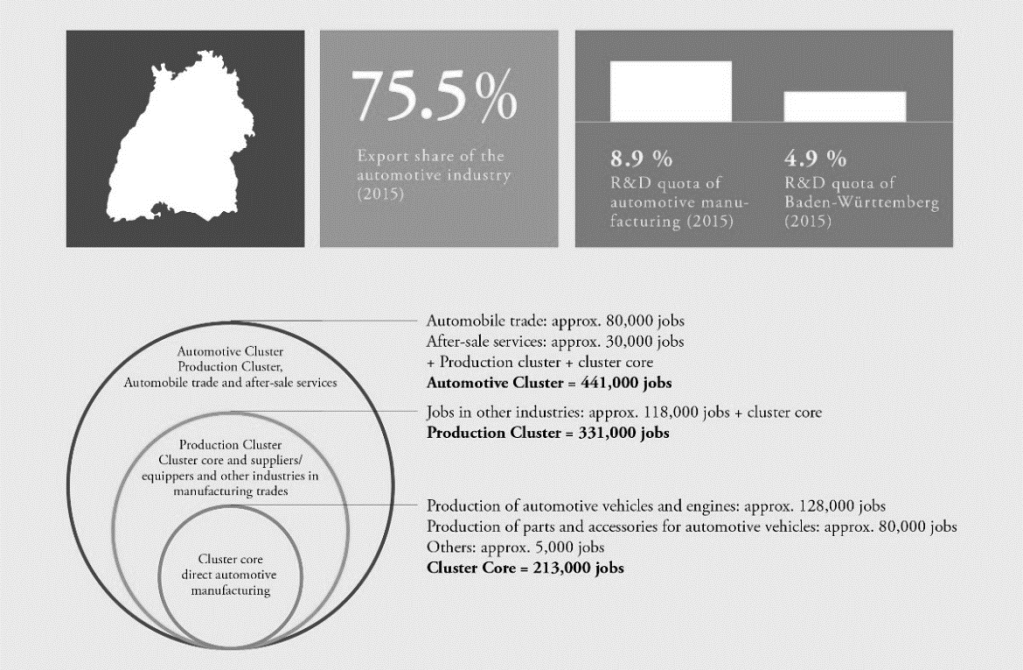

Figure 2: Key facts on the automotive sector in Baden-Württemberg
(source: Strategiedialog Automobilwirtschaft Baden-Württemberg)

Three major OEM in Baden-Württemberg are employing about 128,000 people in Baden-Württemberg [2]:

- Daimler AG
- Audi AG
- Dr. Ing. h.c. F. Porsche AG

Automotive component and part suppliers as well as machinery industry and material suppliers related to the automotive sector employ another 118,000 people [2]. The most important automotive suppliers in Baden-Württemberg are [1]:

- Robert Bosch GmbH
- ZF Friedrichshafen GmbH
- Mahle GmbH
- Schaeffler LuK GmbH & Co. KG
- Mann+Hummel Gruppe
- TRW Automotive GmbH
- Eberspächer Gruppe GmbH & Co. KG
- Companies within Continental Group
- KS Kolbenschmidt GmbH
- ElringKlinger AG
- IMS Gear SE & Co. KGaA
- A. Raymond GmbH & Co. KG
- Allgaier Werke GmbH

Including as well automotive trade and after-sales services, more than 441,000 people in Baden-Württemberg are dependent on the economic success of the automotive sector in a direct or indirect manner.

Numerous small and medium-sized enterprises represent the backbone of Baden-Württemberg's automotive supply chain and are important drivers for technology innovation. Within the industrial transformation process towards electrification and digitalization of transport, especially these small and medium-sized enterprises are confronted with significant economic and technological transformations and have to identify new fields of application for their technological expertise. Cooperation between industry and research as well as knowledge transfer across technological sectors are key factors for a successful industrialization of future

transport technologies in traditionally strong automotive regions such as Baden-Württemberg. Clusters and innovation networks are essential to include small and medium-sized enterprises into the innovation process and to support them in developing new business areas and cooperation opportunities [3].

With more than 140 partners from industry, universities and research institutes, Cluster Electric Mobility South-West, founded in 2007 by major stakeholders from Baden-Württemberg, is one of the most significant innovation networks on future transport solutions in Europe. It brings together the unique expertise on automotive and mobility technologies in the region between Karlsruhe, Mannheim, Stuttgart and Ulm with its long tradition of automotive development and manufacturing. In more than 28 highly innovative joint research and development projects on key components of future transport solutions, the cluster has developed a vast technological expertise and profound understanding of the ongoing technology transformation process. The strategy-based integration of competences from the fields of automotive engineering, energy technology, information and communication systems as well as manufacturing technologies creates unique synergies and enables an important cross-sector knowledge transfer. The cooperation between international industry players, innovative small and medium-sized enterprises and renowned research institutes is a key factor for the successful industrialization of future transport solutions in Baden-Württemberg.

Through joint research and development activities, the members of Cluster Electric Mobility South-West intend to make a major contribution to a successful industrialization of future transport technologies in Germany. The cluster aims to hone new technologies and develop innovative mobility solutions. Its goal is to develop capabilities for new products and services, generating new potential for value creation in Baden-Württemberg and a cleaner automotive future to help reduce emissions.

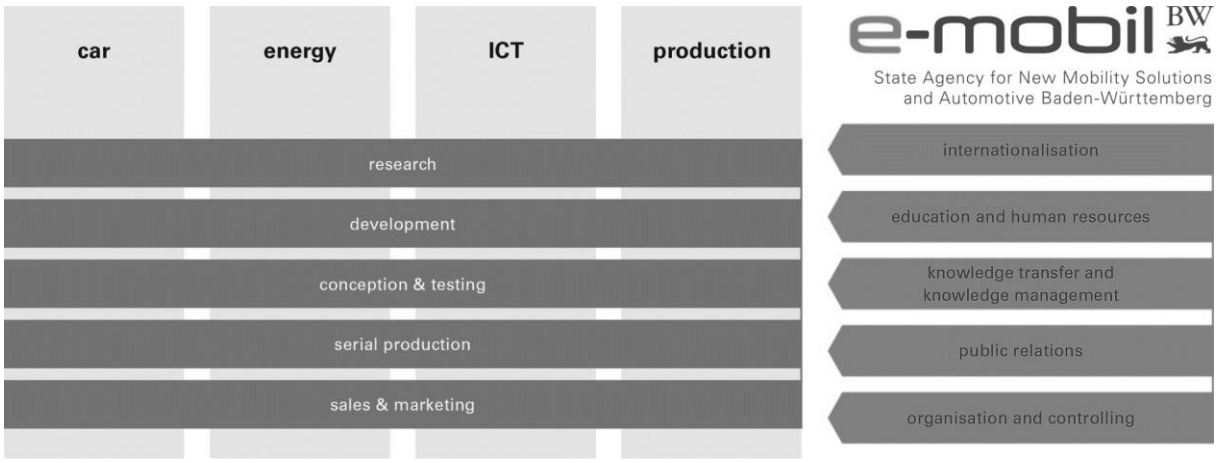

Figure 3: Structure of activities within Cluster Electric Mobility South-West (source: e-mobil BW)

By emphasizing collaboration across technology sector within a regional innovation network, the cluster links major technology providers as well as small and medium-sized companies to renowned universities and research institutes advancing knowledge development, specialization and international competitiveness. Research and development activities within Cluster Electric Mobility South-West address four fields of innovation (automotive technology, energy technology, information and communication technology and production technology) and follow three strategic goals: (1) market and costs (establishing competitive life-cycle costs), (2) handling and comfort (satisfying customer expectations on e-vehicles) and (3) networked mobility (raising usability of electrified transportation strategies). As State Agency for New Mobility Solutions and Automotive in Baden-Württemberg, e-mobil BW provides the management of Cluster Electric Mobility South-West and supports its members from industry and research with specific services in the fields of knowledge management, international cooperation, public relations as well as education and human resources.

In 2012, Cluster Electric Mobility South-West was selected as one of fifteen excellent German Leading-Edge Clusters by the Federal Ministry of Education and Research. The significant research and development

funding within this programme allowed the members of Cluster Electric Mobility South-West to realize a number of internationally relevant technology projects on systems and components of future transport.

2 Industrialisation of future transport technologies

The advancing process of electrification and digitalization in the transport sector will not only lead to significant changes in regional and national automotive supply chains, but will also trigger an enormous shift in global automotive value creation. New technology manufacturers and service providers, especially from Asia and North America, are entering the mobility sector and increasingly develop to new competitors for traditional automotive manufacturing regions [3]. In order to ensure a successful industrialization of future transport technologies and maintain their global market position, clusters and innovation networks have to define a comprehensive internationalization strategy that analyses their individual role in the global technology network and identifies major competitors from a technology-driven perspective. They can support their individual partners from industry and academia with joint internationalization activities that provide access to international key players and give them a strong international visibility.

Figure 4: Relevant international regions in the development of electric mobility
(source: Fraunhofer ISI, adapted from [3])

For a successful industrialisation of future transport technologies within clusters and innovation networks, it is essential to frequently analyse international market and technology development and to identify international competitors in research and development, component and system manufacturing as well as technology deployment. Resulting in a dedicated internationalisation strategy, this analysis provides the knowledge base to define specific activities and measures to support members from industry and academia in initiating cooperation and market development with leading international locations in the development and deployment of future transport solutions. In close dialogue with its partners from industry, academia and the public sector, Cluster Electric Mobility South-West follows a dedicated internationalisation strategy that continuously monitors the development and deployment of future transport technologies worldwide, identifying relevant market competitors and technology locations and recommending specific activities and measures. Central basis for this strategy is a scientific analysis of the international development of electric mobility in Asia, Europe and North America which the cluster carried out in cooperation with the Fraunhofer Institute for Systems and Innovation Research ISI.

Following the regional innovation systems approach, the study “Electric mobility worldwide – Baden-Württemberg in international comparison” [3] analyses 16 international economic locations with major

competences in the automotive and mobility sector, including detailed analyses of the ten most relevant regions in technology development and deployment. The scientific analysis includes quantitative as well as qualitative indicators addressing the following characteristics: framework conditions (political strategy, funding programmes, major industry and academia players), research and development (patents, scientific publications, national/international research and development networks), technology deployment (vehicles with electrified drivetrains, charging infrastructure, major project initiatives).

The following regions and their innovation networks (fig. 5) have been identified as the most important locations for technology development and deployment in the field of future transport solutions and significant competitors of Cluster Electric Mobility South-West [3]:

- Île-de-France (Paris metropolitan region) (2)
- California (3)
- Great Lakes (Detroit and Toronto metropolitan regions) (4)
- Seoul metropolitan region (5)
- Tokio metropolitan region (6)
- Aichi metropolitan region (7)
- Beijing metropolitan region (8)
- Shanghai metropolitan region (9)
- Shenzhen metropolitan region (10)

To ensure availability of statistical information and comparability of results, Cluster Electric Mobility South-West is represented by the region of Baden-Württemberg (1).

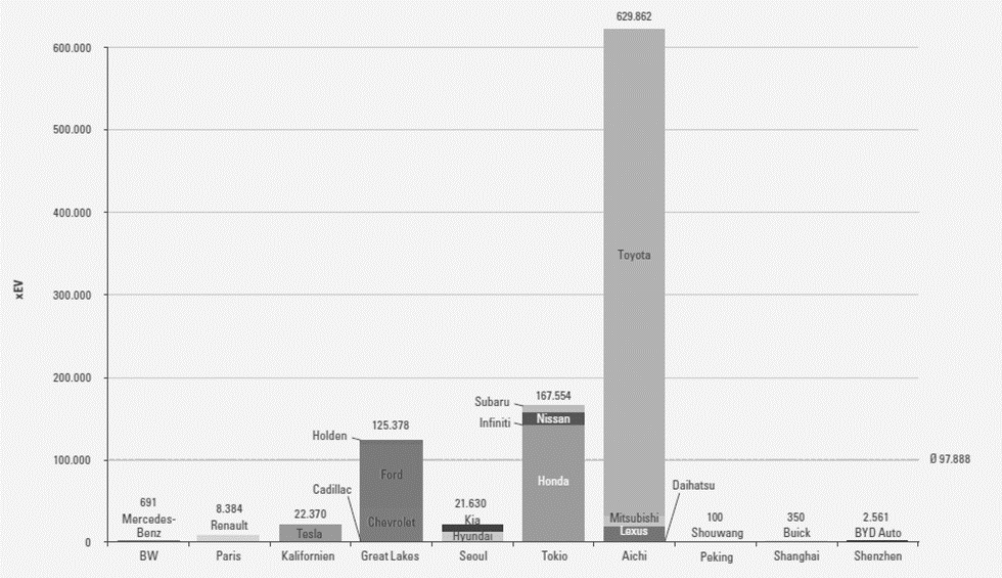

Figure 5: Production of xEV in compared regions in 2013
(source: Fraunhofer ISI, adapted from [3])

The results of the detailed analysis underline that the international development of electrification and digitalisation in the mobility sector follows very different paths. Japan has been identified as the internationally leading provider of electric and hybrid vehicles as well as components for electrified drivetrains (fig. 6). Its automotive innovation network is clearly dominated by Toyota Motor Corporation and its extensive supplier network. According to the analysis, the Japanese metropolitan regions around Aichi and Tokyo are the world-leading innovation hubs for the development of future transport technologies. A specific industrial competence in the development and production of energy storage systems for electric

vehicles is also located in Korea (fig. 7) where large companies like Samsung and LG increasingly apply their competence in the electronics sector on future automotive components [3].

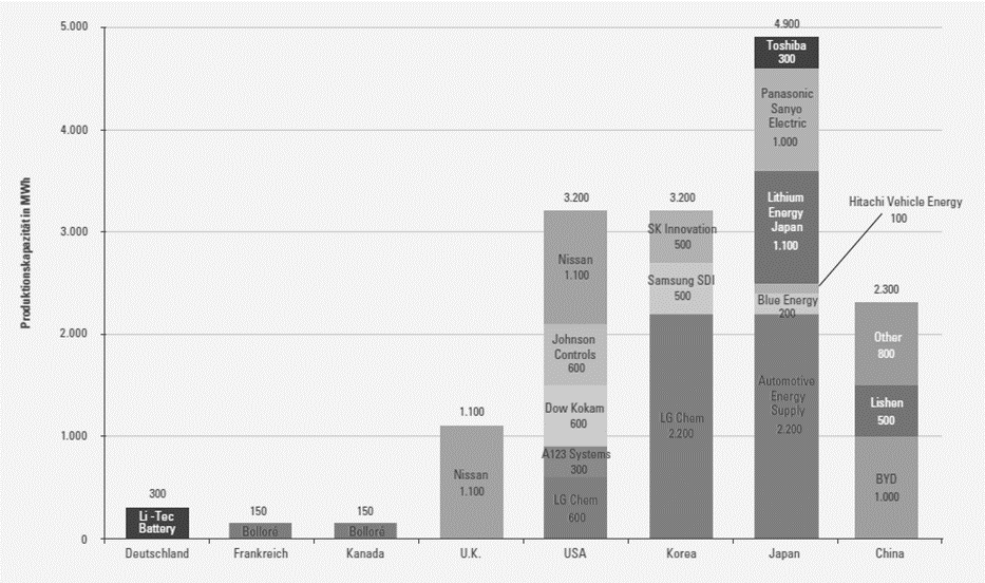

Figure 6: Production capacities of the globally most important manufacturers of lithium-ion batteries for xEV per country in 2013 (source: Fraunhofer ISI, adapted from [3])

Due to significant subsidies and a clear political strategy on emission reduction, California is currently the internationally leading region in the deployment of hybrid and electric vehicles (fig. 8) as well as EV charging infrastructure. With Tesla and internationally leading IT companies, major innovation drivers for future mobility solutions are located in this region. In Europe, the metropolitan region of Île-de-France has been identified as leading location in the deployment of electric vehicles and the establishment of a comprehensive charging infrastructure [3].

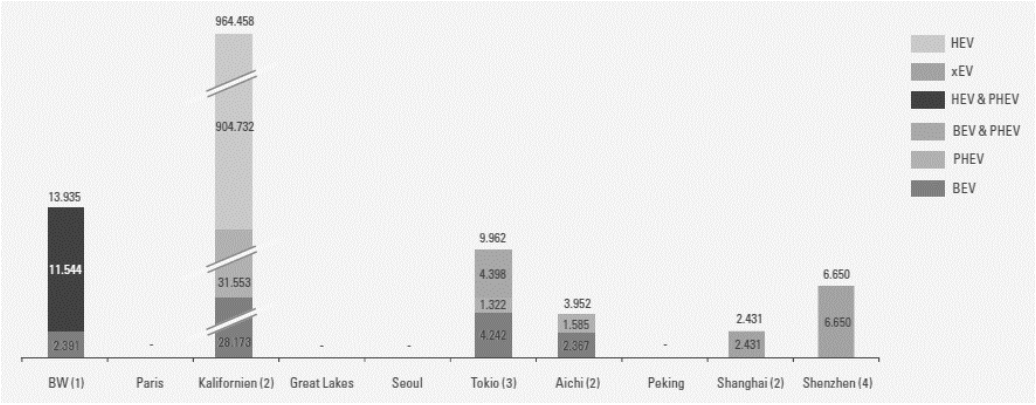

Figure 7: Stock of xEV at regional level, 2013/2014 (source: Fraunhofer ISI, adapted from [3])

Due to its traditionally strong competence in automotive engineering as well as established innovation and supply chains, Baden-Württemberg is well positioned to play an internationally leading role in the electrification and digitalisation of transport technologies. Especially innovation networks such as Cluster Electric Mobility South-West have been identified as crucial factors for a successful industrialisation of electric mobility. They enable cooperation and knowledge transfer between industry and academia across

technological sectors that, together with international benchmarking and networking, is considered to be a major success factor for innovation and technology leadership in an international comparison [3].

Since 2011, a cluster working group with representatives from industry, universities and research institutes continuously evaluates the internationalisation strategy, makes recommendations for adjustments and ensures that it addresses the interests and needs of the network partners. Following significant changes in the international political, economic and technological landscape during the last years, the working group recently initiated a strategic process that examines the international priorities and target regions of the cluster and reformulates its internationalisation strategy.

On the basis of the internationalisation strategy, the management of Cluster Electric Mobility South-West has developed a broad portfolio of activities that supports the network partners from industry and academia in initiating and deepening their international business and cooperation relationships. Regular business missions with representatives from industry and academia significantly contribute to the visibility of the cluster organisation and its members, help to identify business and cooperation contacts and support the continuous evaluation of the international market position of the cluster. Since 2011, delegations from Cluster Electric Mobility South-West have visited all leading economic locations identified in the internationalisation strategy (fig. 8). The visits have significantly contributed to the development of a broad knowledge about the international development of electric mobility and established cooperation contacts to major mobility innovation networks in Europe, North America and Asia.

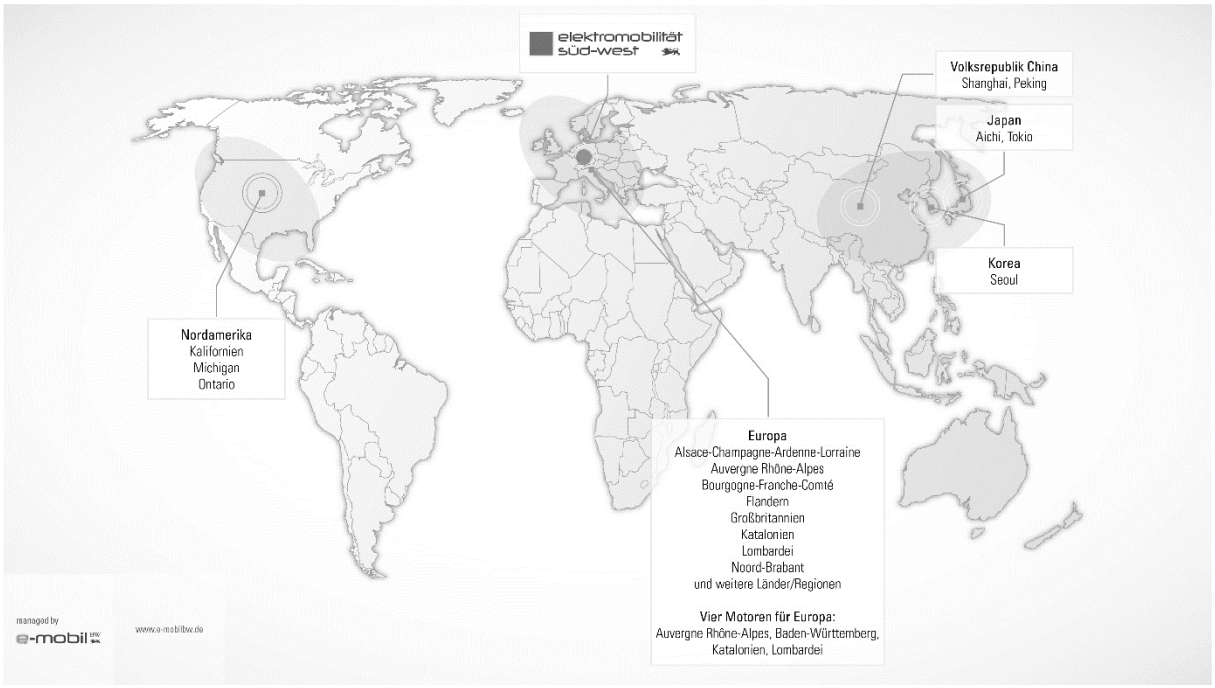

Figure 8: Overview of international missions of Cluster Electric Mobility South-West (source: e-mobil BW)

At the same time, representatives from Cluster Electric Mobility South-West regularly participate in international conferences and trade fairs. Since 2010, the cluster organises an annual participation of partners from industry and academia at the Hannover Industry Fair presenting the network's key competences, innovations and products to an international audience. Furthermore, cluster management and network partners regularly contribute to international conferences and symposia that address recent technological developments in automotive engineering and the design of future transport systems.

The support of small and medium-sized enterprises in international cooperation is a specific focus of the internationalisation strategy of Cluster Electric Mobility South-West. Different analyses of the regional

automotive supply chain in Baden-Württemberg underline that many small and medium-sized automotive suppliers are currently focussed mainly on regional and national markets [4]. In the context of the advancing electrification and digitalisation in the automotive sector and its increasingly international perspective, they risk to lose their economic and technological competitiveness. In order to introduce these stakeholders to the characteristics of international cooperation, Cluster Electric Mobility South-West provides specific support and events that allow small and medium-sized enterprises to initiate new business contacts and identify potential partners for cross-border innovation projects.

Internationalisation activities that have been implemented so far show that a major interest of small and medium-sized companies is the cooperation with innovation networks in Europe. The proximity to potential cooperation partners, a reliable legal framework and the availability of significant funding schemes for innovation and technology development in the transport sector are considered to be the main advantages of European cooperation. Since 2011, Cluster Electric Mobility South-West has developed a comprehensive cooperation network with different innovation clusters in leading European regions. The cooperation with the cluster network CARA – European Cluster for Mobility Solutions in the French region Auvergne-Rhône-Alpes and the participation in the initiative "Four Motors for Europe and Associates" are major examples of this active European network.

3 Case study: German-French cooperation project AllFraTech

The exchange and close cooperation with leading European clusters and innovation networks in the field of future transport technologies is a major strategic priority of Cluster Electric Mobility South-West. As one the leading countries in the technological development and deployment of electric vehicles in Europe, France is an important target country in the internationalization strategy [5]. Especially the regions of Auvergne-Rhône-Alpes and Île-de-France are major centers for the development of future automotive technologies and innovative mobility concepts.

Since 2011, Cluster Electric Mobility South-West maintains an active partnership with the cluster CARA – European Cluster for Mobility Solutions that shapes the development of future transport solutions in the French region Auvergne-Rhône-Alpes. Being home to more than 900 automotive-related companies, this region is a major center of the French automotive and mobility industry. Its industry structure with major OEM and automotive suppliers as well as small and medium-sized enterprises is similar to Baden-Württemberg and provides an excellent basis for cross-border innovation and research partnerships. Recently being relabeled as one of the French excellence clusters, CARA has a strong technological expertise in designing transport solutions for people and goods in urban environments as well as a vast experience in cross-sectoral collaboration between industry and academia.

Together with CARA, Cluster Electric Mobility South-West has initiated the cross-border project "German-French alliance for innovative mobility solutions (AllFraTech)" in 2017 to enhance the research and innovation partnership in the mobility sector between Baden-Württemberg and Auvergne-Rhône-Alpes. The project extends the international cooperation network of Cluster Electric Mobility South-West by providing access to new technological expertise and cooperation opportunities as well as to strategic partnerships with other French technology clusters. The project is funded by the Federal Ministry of Education and Research in the framework of the internationalization scheme "Internationalization of German Leading-Edge Clusters, Forward-Looking Projects and Comparable Networks".

During a one-year concept phase in 2017, the managements of Cluster Electric Mobility South-West and CARA, in close dialogue with their network partners from industry and academia, have defined a long-term strategy to deepen their cooperation on research and innovation in the field of future transport technologies. In different workshops, partners from both clusters discussed strategic approaches to current challenges in the transport sector and identified potentials as well as needs for international cooperation. Four focus areas for cross-border innovation projects have been identified throughout the strategy process and represent the strategic basis for all technology-related activities within the cross-border cooperation initiative:

- future charging technologies for electric mobility
- thermal management for future electric vehicles
- connected and automated driving

- reduction of life cycle costs in electric vehicles

The specific support of small and medium-sized enterprises in international cooperation is a specific goal within the cooperation strategy. A scientific analysis of the structural and technological framework conditions for cross-border cooperation between both regions furthermore provides an important knowledge base for the internationalization concept and identifies perspectives for a long-term cooperation between Cluster Electric Mobility South-West and CARA.

Within the implementation phase that started in July 2018, up to three joint research and development projects with participants from both clusters will be initiated based on the funding provided the German Federal Ministry of Education and Research within the scheme "Internationalization of German Leading-Edge Clusters, Forward-Looking Projects and Comparable Networks". Two joint research and development projects have been launched so far:

- Efficient Modular Convenient Charging Platform (EMCC)
- Innovative Predictive High Efficient Thermal Management System (InnoTherMS)

In both projects, funding for the French consortia member is provided by the "RDI Booster" scheme of Auvergne-Rhône-Alpes region. A third joint research and development project is in preparation At the same time, Cluster Electric Mobility South-West and CARA aim to initiate additional cross-border technology projects in other bilateral or European funding schemes.

In addition to the technology-oriented cooperation projects, Cluster Electric Mobility South-West and CARA have also organized a joint workshop on necessities for cooperation in the field of education and training for future mobility technologies. This workshop brought together experts from universities and institutions for vocational trainings not only initiated a cross-border exchange on existing activities and their evaluation but also identified first opportunities for cross-border cooperation in this field of action. Further activities in the fields of innovation support and knowledge transfer were specifically targeted to small and medium-sized enterprises and supported their qualification for international cooperation activities. The bilateral cooperation initiative AllFraTech has made a significant contribution to the engagement of Cluster Electric Mobility South-West in the Four Motors for Europe as well as its position in other European networks.

4 Case study: Four Motors for Europe

An important foundation of the international cooperation network of Cluster Electric Mobility South-West is the multilateral initiative "Four Motors for Europe". This network of strong European economic regions has been initiated in 1988 by the governments of Auvergne-Rhône-Alpes (France), Baden-Württemberg (Germany), Catalonia (Spain) and Lombardy (Italy) as a basis to enhance cross-regional European exchange. While the cooperation in the early years had been primarily related to economics and research as well as to art and culture, the focus more and more shifted to areas such as exchange on innovative technologies or environment and climate protection [6].

As strong and innovative industrial regions, the Four Motors for Europe provide an ideal framework for a successful industrialization and deployment of sustainable transport technologies in Europe. With dedicated strategies, innovative cluster networks and relevant project initiatives, all member regions are European frontrunners in the development of the future transport system. At the same time, all regions face similar economic challenges in the ongoing process of electrification and digitalization in the transport sector.

In 2010, the Four Motors for Europe established a regular dialogue of innovation clusters and networks in the field of future transport technologies. The network dialogue "Electric mobility and future transport technologies" brings together experts from cluster networks, public institutions and research institutes from Auvergne-Rhône-Alpes, Baden-Württemberg, Catalonia and Lombardy as well as associated partners from Flanders (Belgium) and Noord-Brabant (Netherlands).

Regular meetings of the network dialogue "Electric mobility and future transport technologies" provide the basis for a continuous exchange of information and experience on the development of future transport technologies in the Four Motors for Europe. At the same time, the partners initiate cross-border activities and projects to support the development of future transport solutions in Europe. Meetings with representatives of

the European Commission in Brussels, joint projects proposals as well as conference and trade fair participations are just a few examples of activities in the network dialogue. In 2019, the Four Motors for Europe organized a joint trade mission to the Netherlands to enhance cooperation on innovative transport solutions and other technology areas.

As management of Cluster Electric Mobility South-West, e-mobil BW represents the activities of Baden-Württemberg's future transport innovation cluster in the Four Motors for Europe and Associates and coordinates its network dialogue "Electric mobility and future transport technologies". The active participation in this network of European regions gives Cluster Electric Mobility South-West access to other major automotive technology networks and innovators in Europe. With its strong associations to relevant EU institutions, the network of the Four Motors for Europe and Associates allows Cluster Electric Mobility South-West as well as its partners from industry and academia furthermore to communicate its strategic priorities to European decision makers and policy networks.

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