



ENERGY PARTNERSHIP  
CHILE-ALEMANIA



Fomentado por:



Ministerio Federal  
de Economía  
y Energía

en virtud de una decisión  
del Bundestag alemán

# Energy Transition and Entrepreneurship

*Opportunities for Startups in the framework of  
Cooperation between Chile and Germany*



# Imprint

This study was carried out by the German Chamber (AHK Chile), on behalf of the Energy Partnership Chile-Alemania, with the support of the German Federal Ministry of Economics and Energy (BMWi), and the Chilean Ministry of Energy.

Commissioned and published by:  
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

**Project:**  
Energy Partnership Chile-Alemania

**Project Leader:**  
Rainer Schröder,  
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

**Contact:**

Energy Partnership Chile - Alemania c/o Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH  
Marchant Pereira 150, 7500523 Santiago de Chile  
Email: [energyclde@giz.de](mailto:energyclde@giz.de) Tel.: (+56) 22 30 68 600  
Web: [www.energypartnership.cl](http://www.energypartnership.cl)

**AHK Chile**

Avenida El Bosque Norte 0440, Of. 601 Las Condes, Santiago de Chile  
Email: [chileinfo@camchal.cl](mailto:chileinfo@camchal.cl)  
Tel.: (+56) 2 3284 85 00  
Web: [www.chile.ahk.de](http://www.chile.ahk.de)

**Authors:**

Sara Borst Rodrigo Fortune Denise Kirschner  
Christoph Meyer Annika Schüttler Pamela Valdivia  
Iris Wunderlich

**Coordination:** Energy Partnership Chile-Alemania

**Printed by:**  
Online version

**Design and Illustration:**  
Cámara Alemana, AHK Chile

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Santiago de Chile, March 2021

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ACV	Life Cycle Analysis
BAND	German Business Angels Network
BMU	Federal Ministry of Environment, Nature Preservation and Nuclear Safety
BMWi	Federal Ministry of Economy and Energy
BVDS	German Federal Agency for Startups
CIFES	National Center for Innovation and Promotion of Sustainable Energies
CNE	National Energy Commission
CO <sub>2</sub>	Carbon dioxide
CONAF	National Forestry Corporation
COP	Conference of the Parties
CORFO	Chilean Corporation for Production Promotion
CSP	Concentrated Solar Power
DSM	Deutscher Startup Monitor
EE	Energy Efficiency
EEG	Renewable Energy Act
ERNC	Non-Conventional Renewable Energies
GDP	Gross Domestic Product
GEM	Global Entrepreneurship Monitor
GHG	Greenhouse Gasses
GIZ	German Society for International Cooperation
HTGF	High-Technology Entrepreneurship Fund
KfW	State Development Bank of the Federal Republic of Germany
MERCOSUR	Common Market of the South
MICITEC	Ministry of Science, Technology, Knowledge and Innovation
MINENERGIA	Chilean Ministry of Energy
MiSMEs	Micro, Small and Medium-Sized Enterprises
MUF	Thousands of Unidades de Fomento
MW	Megawatt
OCDE	Organization for Economic Cooperation and Development
R&D	Research and Development
R&D+i	Research, Development and Innovation

SERC	Research Center for Solar Energy
SME	Small and Medium-sized Enterprises
TWh	Terawatt/hour
UC	Catholic University
UTFSM	Federico Santa Maria Technical University
VAT	Value Added Tax
WEF	World Economic Forum

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# 1 Resumen Ejecutivo / Executive Summary

Enfrentar y mitigar el cambio climático es uno de los principales desafíos que como humanidad estamos enfrentando y que nos obliga a impulsar la transición hacia un modelo de desarrollo sostenible. En este contexto, la transición energética es una de las herramientas más eficaces, donde el recambio de los combustibles fósiles y nucleares por las energías renovables combinado con la eficiencia energética albergan el potencial para reducir de manera significativa y globalmente las emisiones de CO<sub>2</sub> y, con ello, limitar el aumento de la temperatura global a un máximo de 1,5°C en comparación con los niveles de temperatura existentes antes de la era industrial.

En vista de los consensos logrados en el marco del histórico Acuerdo de París adoptado durante la COP21 en el año 2015, Alemania y Chile formalizaron durante los años siguientes los compromisos adquiridos comprometiéndose a lograr la neutralidad de carbono al año 2050. En este contexto, el *Energy Partnership* entre Chile y Alemania iniciado oficialmente en abril 2019, una cooperación que apoya el diálogo intergubernamental de alto nivel en materia energética y permite un intercambio activo sobre cómo lograr las metas de la transición energética, busca, entre otros, fomentar el emprendimiento en energía a través de una colaboración binacional.

## 1.1 Resumen Ejecutivo (español)

### El emprendimiento: Factor Clave para la Transición Energética

El emprendimiento se ha convertido en un imperativo para el crecimiento y el desarrollo sostenido de empresas de todas las industrias y en vista de los desafíos que enfrentan Chile y Alemania para alcanzar las metas nacionales definidas en el marco de la transición energética, el emprendimiento innovador de base tecnológica se presenta como elemento fundamental para desarrollar las nuevas tecnologías, servicios y modelos de negocios requeridos.

Con el inicio de la 'Energiewende' en Alemania y la meta de la neutralidad de carbono al 2050 que Alemania y Chile se han propuesto lograr, para lo cual la transición energética constituye un pilar fundamental, se presenta una serie de oportunidades para emprendimientos que desarrollen y prueben tecnologías y modelos de negocio en mercados emergentes que en muchos otros países recién se irán desarrollando en unos años más. Los emprendimientos categorizados como 'startups' presentan una tasa de innovación más alta que las empresas establecidas y, por lo tanto, desempeñan un papel importante en el desarrollo de nuevas tecnologías y soluciones para la economía del futuro que busca transitar hacia la circularidad.

Las *startups* en energía se diferencian en algunos aspectos claves: Por un lado, requieren de un marco político y regulatorio bien definido y estable en cuanto al fomento de las energías renovables variables y la eficiencia energética, que dé señales claras al mercado. En muchos casos las startups en el ámbito energético se dedican al desarrollo de *hardware* de alta tecnología, que requiere montos de inversión superiores a lo que son las inversiones en *software*, además de tener ciclos más largos de pilotaje para lo cual es fundamental contar con una sólida infraestructura para actividades de I+D. Por lo mismo, también requieren de inversionistas y primeros clientes que tengan cierta apertura a tomar riesgos y agilidad en sus decisiones. Finalmente, el perfil del emprendedor en energía se caracteriza por un nivel educacional alto y enfrenta el desafío de requerir muchas veces de personal altamente especializado y con conocimiento tecnológico específico para elaborar su producto/servicio, que para una *startup* es difícil de pagar.

### El Ecosistema Emprendedor en Alemania y en Chile

Un ecosistema emprendedor sólido es esencial para el fomento del emprendimiento y según el enfoque desarrollado por Daniel Isenberg de Babson College, este consta de seis ámbitos: una cultura propicia, políticas públicas y liderazgo habilitadores, disponibilidad de financiamiento adecuada, capital humano de calidad, mercados favorables al riesgo para productos y una serie de apoyos institucionales. Con el objetivo de identificar posibles líneas de acción para la colaboración entre Alemania y Chile en miras de aumentar la tasa de emprendimientos en el ámbito energético, en el presente estudio se analizaron las fortalezas y debilidades

de los ecosistemas de emprendimiento de ambos países, considerando las particularidades descritas del emprendimiento en energía.

El ecosistema alemán para el emprendimiento en energía destaca por la política de investigación e innovación constante del Gobierno Federal de Alemania, que ha creado las condiciones marco favorables para una interacción sinérgica entre la ciencia, *startups* y la industria. Alemania se caracteriza por tener una economía "innovation-driven", lo cual hace referencia a su capacidad de producir nuevos productos innovadores mediante procesos sofisticados. El sector público y la industria han aumentado continuamente su gasto en I+D hasta alcanzar más del 3% del PIB, convirtiendo a Alemania en uno de los líderes internacionales en innovación, gracias, además, a la disponibilidad de mano de obra altamente calificada para la innovación tecnológica. Al mismo tiempo, la contratación de personal altamente especializado también conlleva gastos más altos, lo que destaca una vez más que las *cleantech startups* se ven enfrentadas a una situación financiera más compleja. Actualmente, la contratación de personal del ámbito de las TI es un desafío particular para todas las *startups*.

Durante los últimos años se ha puesto en marcha un programa de financiamiento de I+D+i bajo el paraguas de la Estrategia de Alta Tecnología, que ha llenado los "conductos" de la innovación y ha constituido una buena base para promover la creación de empresas a partir de procesos de I+D de una manera más específica y eficaz.

Este perfil innovador y basado en I+D va de la mano con la política energética de Alemania. Esta sinergia desemboca en el séptimo Programa de Investigación Energética (*Energieforschungsprogramm*) denominado "Innovaciones para la Transición Energética" (*Innovationen für die Energiewende*), persiguiendo una estrategia que se centra en la transferencia de tecnología e innovación. Alemania enfatiza la importancia de tecnologías orientadas hacia el futuro para lograr una transición energética y sus programas son orientados para alcanzar los objetivos fundamentales de la política energética alemana.

Para las *startups*, la proximidad con las universidades y la red de contactos con otras *startups* son los aspectos mejor valorados respecto del ecosistema de emprendimiento en Alemania. Además, existe una gran cantidad y variedad de instrumentos de apoyo, tanto a nivel nacional como regional, acompañados por mentores con experiencia técnica, una buena oferta de incubadoras, *hubs* y aceleradoras con redes internacionales y una excelente infraestructura para realizar pilotajes en I+D.

Aunque el financiamiento inicial no resulta ser un mayor problema para gran parte de las *startups*, la falta de fondos adecuados para la fase de crecimiento (incluido el capital de riesgo) se constata como una de las principales debilidades del sistema de innovación alemán. Si bien las inversiones de capital de riesgo en Alemania se duplicaron con creces entre 2015 y 2019, siguen siendo muy bajas en una comparación internacional. Las empresas de base tecnológica suelen requerir de 10 a 50 millones de euros por ronda de financiamiento para su crecimiento, un capital que las empresas de este tamaño difícilmente encuentran entre los inversionistas alemanes y/o europeos. A modo de comparación y según datos del año 2017: las inversiones totales de capital de riesgo son 300 por ciento más altas en Asia y los Estados Unidos que en Europa. Es precisamente en las últimas fases de crecimiento, donde la "brecha del capital de riesgo" en Europa se hace evidente en comparación con Asia y los Estados Unidos.

Un actor relevante del ecosistema emprendedor alemán son las grandes empresas que actúan como primer cliente al igual que como inversionista, debido a que su capacidad de innovación está cada vez más relacionada con su capacidad de cooperar con *startups*. Frecuentemente, las *startups* desarrollan nuevos productos o servicios complementarios junto con las empresas. Sin embargo, en relación con su rol como potencial inversionista cabe señalar que solamente unas pocas empresas alemanas han invertido sumas importantes en *startups*, entre ellas, grandes corporaciones como BASF, Bosch, Siemens, Evonik, Innogy, BMW y E.ON:agile. Esta última apoya hasta diez proyectos del ámbito energético por semestre. De todas maneras, las inversiones que superan los 100 millones de euros siguen siendo una excepción.

En relación con la cultura emprendedora en Alemania, esta sigue caracterizándose por una aversión a los riesgos y poca tolerancia al fracaso.



El ecosistema emprendedor chileno, en cambio, se desarrolla dentro de una economía actualmente todavía clasificada como ‘*efficiency driven*’, es decir, impulsada por mejoras en eficiencia de los procesos de producción donde la mayor parte de la tecnología se importa de los países desarrollados. Según el *Global Competitiveness Report 2019*, el indicador de innovación es el más bajo de todos los indicadores analizados. Las principales debilidades de Chile se encuentran en una baja capacidad de innovación, un bajo gasto en I+D alcanzando solo el 0,35 % del PIB en 2018 con muy poca participación del sector privado y una escasa colaboración en I+D entre universidad e industria. Esto contrasta con la disponibilidad de un recurso humano considerado como bien calificado para los procesos de innovación tecnológica.

Según los datos publicados en el *Global Entrepreneurship Monitor 2019*, la dimensión de ‘apoyo financiero’ es la peor evaluada de las dimensiones del ecosistema del emprendimiento en Chile por parte de los expertos encuestados en el marco del GEM. Existe el consenso de que hay una suficiente oferta de subvenciones públicas especialmente para las etapas de financiamiento temprano articulado principalmente a través de CORFO, sin embargo, se identifica como una gran falencia la falta de oportunidades de financiamiento privadas que logren apoyar los procesos de crecimiento del negocio. En relación con el capital de riesgo, en Chile actualmente operan alrededor de 50 fondos de capital de riesgo, que, sin embargo, tienen una cultura más bien conservadora y contraria al riesgo.

En comparación con Alemania la infraestructura para realizar actividades de I+D y de pilotaje de nuevas tecnologías en Chile todavía está muy poco desarrollada y de difícil acceso para las *startups*, aun cuando, actualmente se está buscando cambiar esto a través de los esfuerzos de diferentes actores al alero de CORFO y de la Agencia Nacional de Investigación y Desarrollo (ANID).

Finalmente, dentro del contexto latinoamericano, Chile destaca en términos de una cultura emprendedora, sin embargo, es una cultura emprendedora poco innovadora, por lo que falta instalar una cultura que incentive la innovación, creatividad y experimentación para que se generen más emprendimientos que se puedan clasificar como *startups*.

### **Tecnologías para la Transición Energética**

Entender las diferencias, fortalezas y debilidades de ambos ecosistemas brindan la base para elaborar líneas de trabajo colaborativo que apunten a aumentar el número de *startups* en energía en Alemania y Chile para lograr generar innovaciones necesarias en los diferentes ámbitos tecnológicos que cobran importancia para lograr la transición energética y los desafíos asociados para poder aprovechar el potencial de cada ámbito.

En Chile, se pueden enumerar los siguientes desafíos tecnológicos que requieren de innovaciones. Por el lado de las energías renovables, se presenta la necesidad de masificar soluciones energéticas relacionadas con la biomasa, que no sean leña, para los procesos de calefacción, además de la implementación de redes de calefacción distrital, para lo cual existen diferentes posibilidades con relación a la fuente de energía, siendo el “*waste to energy*” una de ellas.

En relación con la generación eléctrica, el Ministerio de Energía espera contar con una capacidad instalada de más de 20.000 MW de energía fotovoltaica al año 2050. Una medida importante para alcanzar esta meta es aumentar la eficiencia de los paneles. En Chile ya se están desarrollando y/o probando nuevas tecnologías – como los paneles bifaciales o tecnología que orienta los paneles siempre hacia el sol. También se requieren nuevos desarrollos tecnológicos que permitan hacer un mejor uso del espacio para lograr la integración de energía fotovoltaica en edificios, en actividades agrícolas y sobre el agua con paneles solares flotantes, al igual que en el ámbito del control y la mantención de las plantas fotovoltaicas, como, por ejemplo, tecnologías que permitan enfrentar problemas locales como es la suciedad de los paneles.

Con la promulgación de la Ley de Responsabilidad Extendida del Productor (Ley REP) en Chile y con una vida útil de los paneles solares en general de 20–30 años, existe la necesidad de reciclar los paneles solares después de su uso. Actualmente los paneles solares en uso en Chile contienen cerca de 250.000 toneladas de vidrio, cerca de 30.000 toneladas de aluminio y 4.000 de silicio. Esto va a requerir el desarrollo de soluciones de reciclaje para los paneles en los próximos años, en especial considerando que en la actualidad, Chile solamente tiene una planta de reciclaje para paneles.

Con relación a la energía eólica y la energía undimotriz, también se presentan varios desafíos tecnológicos por resolver como son los costos de instalación de energía eólica marina, las condiciones extremas para que el material resista con el tiempo en el mar y en el caso de la energía undimotriz, también la extrema fluctuación de la generación por las olas, entre otros.

Otro gran desafío asociado a la transición energética es todo lo relacionado con la infraestructura de transmisión, donde hoy día se está buscando realizar la transmisión con cables de superconductividad donde hace falta mayor investigación para desarrollar cables que puedan resistir temperaturas más altas, además de la implementación de redes eléctricas inteligentes que permitan ir adaptando la demanda a la generación eléctrica. Esto además debe ser apoyado por diferentes sistemas de almacenamiento de energía eléctrica y térmica de gran y de pequeña escala, donde las baterías caseras descentralizadas, por ejemplo, pueden jugar un rol importante.

En este contexto cobra mucha importancia también el desarrollo de una economía de hidrógeno en Chile: Dado el gran potencial para generar energías renovables a bajo costo, Chile tiene la oportunidad de no solamente producir hidrógeno verde para el mercado nacional, sino que además para la exportación. Para que se desarrolle la economía del hidrógeno, Chile necesitará tecnología relacionada con el almacenamiento de hidrógeno como estanques, la purificación del hidrógeno, compresores para la inyección a la red, tecnología de producción de combustibles sintéticos, aumentar la eficiencia de los procesos de metanización y la construcción de bombas de combustible de hidrógeno para buses y camiones con toda la infraestructura como compresores, almacenamiento y el transporte de hidrógeno, etc.

Otro eje importante en el ámbito del sector de transporte es la electromovilidad, donde el gobierno de Chile busca alcanzar la meta de que el 100% del transporte público urbano sea eléctrico al 2040 y que al 2050 los vehículos particulares eléctricos constituyan el 40% del parque automotriz. Para esto, es necesario invertir en I+D para el desarrollo de baterías innovadoras y sistemas de gestión de baterías.

En el sector de la edificación, Chile todavía tiene un muy bajo estándar de eficiencia energética y en este contexto, el desarrollo de nuevos materiales aislantes juega un rol importante, especialmente el desarrollo de aislantes térmicos bio-basados.

Finalmente, se hacen imprescindibles importantes desarrollos en el ámbito de las tecnologías de la información y la comunicación para habilitar sistemas controlables, automatizar y gestionar.

### **Oportunidades de Colaboración entre Alemania y Chile**

Al comparar Alemania y Chile en relación con la implementación de tecnologías en el ámbito energético, podemos constatar que, en algunos campos, como la calefacción distrital, las baterías caseras y la eficiencia energética en edificaciones, entre otros, Alemania ya lleva un camino recorrido, mientras que en otros ámbitos, *startups* de ambos países están haciendo su contribución para desarrollar nuevas tecnologías y servicios, entendiendo que las metas políticas definidas en Alemania y Chile son las que van a ir gatillando la demanda por parte del mercado. Es en este contexto que se abren interesantes oportunidades de colaboración entre ambos ecosistemas de emprendimiento para apoyar el desarrollo de las *startups* de ambos países.

Aunque el ecosistema de emprendimiento en Alemania y Chile cuenta con el apoyo del gobierno, actores públicos y privados, este estudio demuestra que todavía hay espacio para mejorar, y que estos ecosistemas podrían beneficiarse del intercambio de buenas prácticas y de modelos de trabajo colaborativos a nivel nacional e internacional. Por esto, se proponen las siguientes líneas de acción:

- *Desarrollo de una agenda de trabajo bilateral de política pública de I+D+i+e*, que contemple establecer un canal de comunicación para el intercambio de buenas prácticas entre los encargados de fomento del emprendimiento en energía por parte de los ministerios e instituciones públicas involucradas, implementar mesas de trabajo binacionales de buenas prácticas en política pública para la eliminación sistemática de barreras y burocracia, además del mejoramiento del ecosistema de emprendimiento en energía y un Consejo público-privado para una estrategia binacional de largo plazo

- *Generación de redes de financiamiento chileno-alemanas* a través del establecimiento de una red de fondos de *Venture Capital* y *Corporate Venture Capital* en Alemania y Chile, encausando además a las empresas públicas para que inviertan un porcentaje de sus ganancias en la industria de alta tecnología en energía y creando un registro de las *startups* de energía que permita generar un perfil de cumplimiento de cada una para atraer inversionistas nacionales e internacionales.
- *Fortalecimiento de la cultura de innovación* a través de la implementación de una plataforma de colaboración entre los principales *stakeholders* de los dos ecosistemas de emprendimiento, incluyendo programas de pasantías al alero de incubadoras y aceleradoras de negocios tecnológicos en Alemania y Chile, la creación de dos *hubs* piloto en ambos países en los que se genere una red de colaboración entre *startups* chilenas y alemanas y la implementación de una red chileno-alemana de mentores expertos en el ámbito de la energía para apoyar a las *startups* de energía de ambos países.
- *Diversificación en los instrumentos de apoyo para las startups de energía* fomentando una infraestructura pública para *startups* de energía en Alemania y Chile, creando una plataforma pública de información para *startups* de energía de ambos países como instrumento de difusión de conocimientos y tecnologías nuevas, que permitirá la medición de avance de las innovaciones, y apoyando a los *co-works* que trabajan con el ecosistema de emprendimiento de energía para que ofrezcan servicios de consultoría
- *Diversificación y calificación del capital humano* a través de *Summer Schools* de emprendimiento en universidades de Alemania y Chile, un programa binacional de formación dual y educación continua, capacitación en energía y la generación de alianzas con incubadoras en Alemania y Chile para permitir la capacitación específica para el emprendimiento en energía
- *Sofisticación del mercado para startups de energía en Alemania y Chile* a través del apoyo para proyectos binacionales de I+D+i+e que cumplan con las directrices para el financiamiento de la investigación en los temas estratégicos para la Transición Energética, la creación de clústeres regionales de I+D+i+e en energía que ofrecen actividades de colaboración sistemática a un ecosistema *de multi-stakeholders* y la creación de una zona de I+D+i+e piloto en ambos países para generar experiencias mejorables y buenas prácticas inspiradas en las zonas francas para atraer inversionistas y capital humano especializado, entre otros.

La colaboración binacional en el ámbito del emprendimiento en energía alberga un gran potencial para acelerar la innovación dentro de la industria de la energía con la ayuda de las *startups* y para apoyar *startups* de energía que necesitan un tamaño de mercado razonable, que solo el continente latinoamericano o grandes mercados como Europa pueden ofrecer. Apoyar el desarrollo de *startups* innovadoras que no solo agreguen valor, sino que también tengan un impacto social y ambiental positivo, son la clave de la estrategia de innovación en el sector de la energía.

## 1.2 Executive Summary (English)

*One of the main challenges we are facing as humanity is to face and mitigate climate change, which requires us to promote the transition to a sustainable development model. An energy transition is one of the most effective tools in this context, where the replacement of fossil and nuclear fuels with renewable energies combined with energy efficiency has the potential to significantly reduce CO<sub>2</sub> emissions globally and thereby limit the increase in global temperature to a maximum of 1.5°C compared to pre-industrial temperature levels.*

*Building on the consensus achieved in the framework of the groundbreaking Paris Agreement adopted during the COP21 in 2015, Germany and Chile formalized during the following years the commitments made by committing to achieve carbon neutrality by 2050. The Energy Partnership between Chile and Germany, officially launched in April 2019, a cooperation that supports high-level intergovernmental dialogue on energy issues and enables an active exchange on how to achieve the goals of the energy transition, seeks, among others, to foster energy entrepreneurship through binational collaboration.*

### **Entrepreneurship: A Key Factor for Energy Transition**

*Entrepreneurship has become crucial for the sustained growth and development of companies in all industries and in view of the challenges faced by Chile and Germany to achieve the national goals as defined in the framework of the energy transition, innovative technology-based entrepreneurship is presented as a fundamental element to develop the new technologies, services and business models required.*

*Germany's Energiewende and the goal of carbon neutrality by 2050 that Germany and Chile have set themselves to achieve, for which the energy transition is a fundamental pillar, a series of opportunities arise for startups to develop and test technologies and business models in emerging markets that in many other countries will only be developed in a few more years. Ventures categorized as 'startups' have a higher rate of innovation than established companies and therefore play an important role in the development of new technologies and solutions for the economy of the future as it seeks to move towards circularity.*

*There are some key aspects that differentiate energy startups: On the one hand, they require a well-defined and stable political and regulatory framework for the promotion of variable renewable energies and energy efficiency, in order to give the market strong signals. In many cases, startups in the energy field are involved in the development of high-tech hardware, which requires higher investment amounts than software investments, in addition to having longer pilot cycles, for which it is essential to have a robust infrastructure for R&D activities. For the same reason, they also require investors and first customers who are open to taking risks and agile in their decision-making. The profile of the energy entrepreneur is characterized by a high educational level and faces the challenge of often requiring highly specialized personnel with specific technological knowledge to develop their product/service, which is difficult for a startup to afford.*

### **Entrepreneurial Ecosystem in Germany and Chile**

*As Daniel Isenberg of Babson College has argued, a strong entrepreneurial ecosystem is essential for the promotion of entrepreneurship and, according to his approach, it consists of six areas: a conducive culture, enabling public policies and leadership, availability of adequate financing, quality human capital, risk-friendly markets for products and a range of institutional supports. This study analyzed the strengths and weaknesses of the entrepreneurship ecosystems of both countries, considering the described specificities of energy entrepreneurship, in order to identify possible lines of action for collaboration between Germany and Chile to increase the rate of entrepreneurship in the energy field.*

*Germany's ecosystem for energy entrepreneurship is characterized by the German Federal Government's consistent research and innovation policy, whereby favorable framework conditions have been created for a synergistic interaction between science, startups, and industry. Germany is characterized as an "innovation-driven" economy, which refers to its ability to produce innovative new products through sophisticated processes. The public sector and industry have consistently increased their R&D spending to more than 3% of GDP, which makes Germany one of the international leaders in innovation, thanks to the availability of a highly skilled workforce for technological innovation. The recruitment of highly specialized human resources also entails higher costs, which once again highlights the fact that cleantech startups are faced with a more complex financial situation. Currently, the recruitment of IT staff is a particular challenge for all startups.*

Over the past few years, an R&D+i funding program has been implemented under the umbrella of the High Technology Strategy, thus filling the innovation “pipeline”, and providing a good basis for promoting the creation of companies from R&D processes in a more targeted and efficient manner.

Such an innovative and R&D-based profile goes hand in hand with Germany's energy policy. This synergy leads to the seventh Energy Research Program (Energieforschungsprogramm) called “Innovations for the Energy Transition” (Innovationen für die Energiewende), in pursuit of a strategy that focuses on technology transfer and innovation. Germany emphasizes the importance of future-oriented technologies to achieve an energy transition and its programs are geared to achieve the fundamental objectives of Germany's energy policy.

For startups, closeness to universities and networking with other startups are the most valued aspects of the German entrepreneurship ecosystem. Further, there is a large number and variety of support instruments, both at national and regional level, coupled with technically experienced mentors, a good supply of incubators, hubs and accelerators with international networks and an excellent infrastructure for R&D pilots.

While early-stage funding does not turn out to be a major problem for a large share of startups, the lack of adequate funds for the growth phase (including venture capital) is noted as one of the main weaknesses of the German innovation system. Whereas venture capital investments in Germany more than doubled between 2015 and 2019, they are still very low when compared internationally. Technology-based companies typically require 10 to 50 million euros per funding round for growth, which is a capital that companies of this size are unlikely to find among German and/or European investors. By way of comparison and according to 2017 data: total venture capital investments are 300 percent higher in Asia and the United States than in Europe. And it is precisely in the later stages of growth that the “venture capital gap” in Europe becomes apparent in comparison to Asia and the United States.

Large companies are an important player in the German entrepreneurial ecosystem, acting as a first customer as well as an investor, because their innovative capacity is increasingly linked to their ability to cooperate with startups. Startups frequently develop new products or supplementary services together with companies. However, only a few German companies have invested significant sums in startups as potential investors, including major corporations such as BASF, Bosch, Siemens, Evonik, Innogy, BMW and E.ON:agile. This latter supports up to ten projects in the energy field per semester. However, investments in excess of 100 million euros are still the exception.

Germany's entrepreneurial culture is still characterized by risk aversion and low tolerance for failure.

In contrast, the Chilean entrepreneurial ecosystem is developing within an economy currently still classified as 'efficiency driven', that is, driven by improvements in the efficiency of production processes where most of the technology is imported from developed countries. The Global Competitiveness Report 2019 shows that the innovation indicator is the lowest of all the indicators analyzed. Chile's main weaknesses are low innovation capacity, low R&D spending reaching only 0.35 % of the GDP in 2018 with very little participation of the private sector and little collaboration in R&D between academia and industry. However, this contrasts with the availability of well qualified human resources for the technological innovation processes.

The Global Entrepreneurship Monitor 2019 data shows that the 'financial support' dimension ranked the worst among the dimensions of the entrepreneurship ecosystem in Chile by the experts surveyed in the framework of the GEM. Consensus exists that there is a sufficient supply of public subsidies especially for the early funding stages articulated mainly through CORFO, however, the lack of private funding opportunities that manage to support the business growth processes is identified as a major shortcoming. In relation to venture capital, there are currently around 50 venture capital funds operating in Chile, albeit with a rather conservative and risk-averse culture.

The infrastructure for R&D activities and piloting of new technologies in Chile is still very poorly developed and difficult to access for startups compared to Germany, although this is currently being changed through the efforts of different stakeholders under the auspices of CORFO and the National Agency for Research and Development (ANID). Ultimately, within the Latin American context, Chile stands out in terms of entrepreneurial culture, however, it is an entrepreneurial culture that is not very innovative, which is why it is necessary to promote a culture that encourages innovation, creativity, and experimentation so that more ventures that can be classified as startups can be launched.

### **Technologies for Energy Transition**

An understanding of the differences, strengths and weaknesses of both ecosystems provides the basis for collaborative work to increase the number of energy startups in Germany and Chile so as to generate the necessary innovations in the different technological areas that are important to achieve the energy transition and the associated challenges in order to harness the potential of each area.

The following technological challenges that require innovation can be outlined in Chile. As for renewable energies, there is a need to expand energy solutions related to biomass, other than firewood, for heating processes, in addition to the implementation of district heating networks, for which there are different possibilities concerning the energy source, one of them being “waste to energy”.

With regards to electricity generation, the Ministry of Energy expects to have an installed capacity of more than 20,000 MW of photovoltaic energy by 2050. Increase the efficiency of the panels is an important measure to achieve this goal. New technologies are already being developed and/or tested in Chile – such as two-sided panels or the technology that aligns the panels always towards the sun. New technological developments are also required to better use footprint to achieve the integration of photovoltaic energy in buildings, in agricultural activities and on water with floating solar panels, as well as in the field of control and maintenance of photovoltaic plants, for instance, technologies to deal with local problems such as fouling of the panels.

The enactment of the Extended Producer Responsibility Law (REP Law) in Chile and with an overall lifespan of solar panels of 20–30 years, there is a need to recycle solar panels after use. The solar panels currently in use in Chile contain about 250,000 tons of glass, about 30,000 tons of aluminum and 4,000 tons of silicon. Therefore, recycling solutions for the panels will need to be developed in the coming years, especially considering that Chile currently has only one recycling plant for solar panels.

As for wind and wave energy, there are also several technological challenges to be solved, such as offshore wind energy installation costs, extreme conditions for the material to withstand the weather at sea and, in the case of wave energy, the extreme fluctuation of the generation due to waves, among others.

Transmission infrastructure is another major challenge associated with the energy transition, where transmission is currently in the process of developing superconductivity cables, where further research is needed to develop cables that can withstand higher temperatures, as well as the implementation of smart grids that allow demand to be adapted to power generation. Moreover, different large- and small-scale electrical and thermal energy storage systems should support this, where decentralized home batteries, for example, can play an important role.

The development of a hydrogen economy in Chile is also very important in this context: Given the great potential for low-cost renewable energy generation, Chile has the opportunity to not only produce green hydrogen for the domestic market, but also for export. For a hydrogen economy to develop, Chile will need technology for hydrogen storage such as tanks, hydrogen purification, compressors for feed-in, synthetic fuel production technology, increasing the efficiency of methanation processes, and the construction of hydrogen fuel pumps for buses and trucks with all the accompanying infrastructure such as compressors, storage, and transport of hydrogen, to name a few.

Electromobility is another important pillar in the transportation sector, where the Chilean government seeks to achieve the goal that 100% of urban public transportation will be electric by 2040 and that by 2050 electric vehicles will make up 40% of the automotive base. Investment in R&D for the development of innovative batteries and battery management systems is necessary to achieve this goal.

Chile still has a very low standard of energy efficiency in the building sector and the development of new insulating materials plays an important role in this regard, especially the development of bio-based thermal insulators. Lastly, significant developments in the field of information and communication technologies are essential to enable controllable systems, automate and manage.

### **Collaboration Opportunities between Germany and Chile**

A comparison between Germany and Chile concerning the implementation of energy technologies shows that in some fields, such as district heating, home batteries and energy efficiency in buildings, among others, Germany is already well on its way, while in other areas, startups from both countries are making their contribution to develop new technologies and services, with the understanding that the political goals defined in Germany and Chile are the ones that will trigger the demand from the market. There are interesting opportunities for collaboration between the two entrepreneurship ecosystems to support the development of startups in both countries.

While the entrepreneurship ecosystem in Germany and Chile is supported by government, public and private stakeholders, this study shows that there is still room for improvement, and that these ecosystems could benefit from the exchange of best practices and collaborative working models at the national and international level. To this end, the following courses of action are proposed:

- Development of a bilateral work agenda for public policy on R&D+i+e, including the implementation of a communication channel for the exchange of best practices among those responsible for the promotion of energy entrepreneurship by the ministries and public agencies involved, the implementation of binational working groups on best practices in public policy for the systematic elimination of barriers and bureaucracy, as well as the improvement of the energy entrepreneurship ecosystem and a public-private board for a long-term binational strategy.
- Creation of Chilean-German funding networks through the networking of Venture Capital and Corporate Venture Capital funds in Germany and Chile, also encouraging state-owned companies to invest a percentage of their profits in the high-tech energy industry and creating a directory of energy startups to generate a performance profile for each one in order to attract national and international investors.
- Strengthening innovation culture through the implementation of a collaboration platform between the main stakeholders of the two entrepreneurship ecosystems, including internship programs hosted by technology business incubators and accelerators in Germany and Chile, the creation of two pilot hubs in both countries to generate a collaboration network between Chilean and German startups, and the implementation of a Chilean-German network of energy mentors to support energy startups in both countries.
- Diversification of support instruments for energy startups by promoting a public infrastructure for energy startups in Germany and Chile, creating a public information platform for energy startups in both countries as an instrument for the dissemination of knowledge and new technologies, which will enable the measuring of progress of innovations, and supporting co-works that work with the energy entrepreneurship ecosystem to offer consulting services.
- Diversification and training of human capital through entrepreneurship summer schools at universities in Germany and Chile, a binational dual education and continuing education program, energy training and the creation of alliances with incubators in Germany and Chile to enable entrepreneurship-specific training in energy.
- Market sophistication for energy startups in Germany and Chile through support for binational R&D+i+e projects that meet the guidelines for funding research on strategic topics for the Energy Transition, the creation of regional energy R&D+i+e clusters that offer systematic collaborative activities to a multi-stakeholder ecosystem, and the creation of a pilot R&D+i+e zone in both countries to generate scalable experiences and best practices inspired by free trade zones to attract investors and specialized human capital, among others.

There is great potential for binational collaboration in the field of energy entrepreneurship to accelerate innovation within the energy industry with the help of startups and to support energy startups that need a reasonable market size, which only the Latin American continent or large markets such as Europe can offer. The key to the innovation strategy in the energy sector is to support the development of innovative startups that not only add value, but also have a positive social and environmental impact.

## 2 Introduction

Dealing with and mitigating climate change is one of the main challenges that humanity is facing, and we are forced to make the transition to a sustainable development model that, moreover, enables us to eradicate poverty. In this context, energy transition is one of the most efficient means to do this. Replacing fossil and nuclear fuels by renewable energy in combination with energy efficiency has the potential to significantly reduce CO<sub>2</sub> emissions at global level and, thus, limit the rise of the temperature around the world to a maximum of 1.5° C in comparison with the existing temperature levels before the industrial era.

In view of the consensus reached in the framework of the historical Paris Agreement<sup>1</sup> adopted during the COP21 in 2015, the following years Germany and Chile formalized the commitments acquired by committing themselves to strive for carbon neutrality by 2050. To achieve this, both countries have defined long-term goals in matters of energy policy to attain the energy transition. In April 2019, the Energy Partnership between Chile and Germany was officially started. This is a platform to support high-level intergovernmental dialogue on energy formed by the German Ministry of Economy and Energy (BMWi) and the Chilean Ministry of Energy (ME).

Considering the great importance of this venture, not only as an imperative for growth and sustained development, but also as an essential agent to achieve the energy transition goals by developing the new technologies, services and business models required, a new study was created to get to know the strengths and weaknesses of both countries' entrepreneurship ecosystems, taking into consideration the particularities of entrepreneurships in energy to identify concrete lines of action to increase entrepreneurship in this area and technology transfer between Germany and Chile.

In view of the above, the present study in the first chapter briefly outlines the goals of the energy policy in Germany and Chile and in the second chapter it makes an extensive analysis of the strengths and weaknesses of the different dimensions of both entrepreneurship ecosystems to identify how suitable the conditions are to promote entrepreneurship in energy. The third chapter analyses the main technologies necessary for the energy transition to identify the business needs and opportunities in this field and the study finalizes with an analysis of the opportunities for collaboration between Chile and Germany to promote entrepreneurship in energy and define some possible lines of action.

The information this present study is based upon was mainly gathered in reports and statistics available in both countries. However, a gap was identified between the availability of data from the entrepreneurship ecosystem in Chile as compared to Germany, especially regarding specific data on entrepreneurship in the energy sector. Due to this lack of equilibrium in available information, chapter 2 applies a methodological focus that considered quantitative as well as qualitative data. The bibliographical information was completed with qualitative interviews with stakeholders from the entrepreneurship ecosystem: startups, incubators, investors, foundations, and the like (see Annex 1). Due to the lack of bibliographical information in Chile, in total, more Chilean (25) than German (6) stakeholders were interviewed. At the same time, the qualitative focus revealed new aspects to be considered in the analysis. On the other hand, in order to get a coherent data base to make comparisons between the two countries, a quantitative survey was conducted and answered by 22 experts in Chile and 20 experts<sup>2</sup> in German (see Annex 2). These data complemented the bibliographical information available and represent a valuable base to explore the strengths and weaknesses of the entrepreneurship ecosystems in both countries.

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<sup>1</sup> United Nations Climate Change (2018): *¿Qué es el Acuerdo de París?*, <https://unfccc.int/es/process-and-meetings/the-paris-agreement/que-es-el-acuerdo-de-paris> (updated on 21-12-2020)

<sup>2</sup> Some questions were not answered by all the experts. In the relevant place of the analysis reference is made to the real numbers. Additionally, all results can be found in Annex 2.



### 3 Energy transition in Germany and Chile

The term 'energy transition' refers to the shift from fossil and nuclear fuels in energy supply to renewable energy.<sup>3</sup>

In Germany, the Energy Concept of the German Federal Government and the resolutions from the German Federal Cabinet guide the energy transition process. The goal is to ensure reliable, accessible energy supply compatible with the environment<sup>4</sup> to reduce the emission of greenhouse gases by 55% by the year 2030, considering the year 1999 as the reference, to gradually eliminate nuclear energy by 2022 and to reach carbon neutrality by 2050, which was adopted in the framework of the Paris Agreement and concretized by the 2050 Climate Protection Plan.<sup>5</sup>

#### Fundamental pillars of the energy transition in Germany<sup>6</sup>:

- 1) Expansion of renewable energies
- 2) Energy efficiency
- 3) Replacement of nuclear and fossil energy plants: a short-term goal of transforming the energy system is eliminating nuclear energy by 2022 and covering electricity supply with renewable energies
- 4) Intelligent infrastructure for the electricity network and integration of renewable energies
- 5) Renovation of buildings with energy efficiency and sustainable construction
- 6) Electromobility strategy
- 7) Research and Development (R&D) in the energy field to generate innovations and new technologies

It is necessary to create stable political and legal conditions to give the market a push and, therefore, for the energy transition to be successful. The macro conditions create the base for security of the planning necessary for investment and have an influence on profitability of the different business models in the energy sector. From historical point of view, the political and legal framework in Germany plays an important role to mark the trends in the energy markets. In Germany, "new" energy sources have always been initially subsidized by the government, which has had great effects on the electricity sector. With the Law on Electricity Feed (*Stromeinspeisungsgesetz*), introduced in 1991, the later Laws on Renewable Energies (*EEG - Erneuerbare-Energien-Gesetze*) have established in the past 25 years the macro conditions for a greater expansion of power generation based on renewable sources. Its share in the gross power generation went from 6.6 in 2000 to 44.6 percent in 2020, which caused a reorganization of the energy market.<sup>7</sup>

<sup>3</sup> CO2Online (2016): *Energiewende: Definition & Ziele – die Übersicht*, <https://www.co2online.de/klima-schuetzen/energiewende/energiewende-definition-ziele-uebersicht/> (reviewed on 21-12-2020)

<sup>4</sup> Federal Ministry of Economy and Energy (2016): *Eine Zielarchitektur für die Energiewende: Von politischen Zielen bis zu Einzelmaßnahmen*, <https://www.bmwi.de/Redaktion/DE/Artikel/Energie/zielarchitektur.html> (reviewed on 21-12-2020)

<sup>5</sup> Federal Ministry of Environment (2020): *Der Klimaschutzplan 2050 – Die deutsche Klimaschutzlangfriststrategie*, en: <https://www.bmu.de/themen/klima-energie/klimaschutz/nationale-klimapolitik/klimaschutzplan-2050/> (reviewed on 21-12-2020)

<sup>6</sup> Federal Ministry of Economy and Technology (2010): *Energiekonzept für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung*, [https://www.bmwi.de/Redaktion/DE/Downloads/E/energiekonzept-2010.pdf?\\_\\_blob=publicationFile&v=5](https://www.bmwi.de/Redaktion/DE/Downloads/E/energiekonzept-2010.pdf?__blob=publicationFile&v=5) (reviewed on 21-12-2020)

<sup>7</sup> Statista (2021): *Anteil Erneuerbarer Energien an der Bruttostromerzeugung in Deutschland in den Jahren 1990 bis 2020*, [https://de.statista.com/statistik/daten/studie/1807/umfrage/erneuerbare-energien-anteil-der-energiebereitstellung-seit-1991/#:~:text=Erneuerbare%20Energien%20%2D%20Anteil%20an%20der%20Bruttostromerzeugung%20bis%202020&text=Im%20Jahr%202020\\*%20wurden%20rund,inklusive%20des%20Eigenbedarfs%20oder%20Kraftwerke](https://de.statista.com/statistik/daten/studie/1807/umfrage/erneuerbare-energien-anteil-der-energiebereitstellung-seit-1991/#:~:text=Erneuerbare%20Energien%20%2D%20Anteil%20an%20der%20Bruttostromerzeugung%20bis%202020&text=Im%20Jahr%202020*%20wurden%20rund,inklusive%20des%20Eigenbedarfs%20oder%20Kraftwerke) (reviewed on 18-02-2021).



Since the implementation of the EEG, the German electricity market has changed considerably. With the finance model established in the EEG, not only the share of renewable energies in the power grid has increased, but also the structure of the energy market agents has changed, and new stakeholders, technologies and business models have been included.<sup>8</sup>

To orient the national energy policy, the Ministry of Economy and Energy has defined a series of medium-term goals (2030) for the energy transition<sup>9 10</sup>, which will be outlined below. According to the Energy Transition Index (*Energiewende-Index*) published in September 2020 by McKinsey<sup>11</sup> to monitor the advance in fulfilling the defined goals, 8 of the 15 indicators assessed in the reports can still be reached. However, at least 5 indicators will not be achieved in a realistic scenario. Likewise, the world pandemic caused by COVID-19 is exacerbating the problems to achieve the energy transition. Even now the temporary quarantines to contain the COVID-19 have managed to briefly reduce the CO<sub>2</sub> emissions, the German energy transition is slowing down due to the pandemic. There are no new wind projects, and the expansion of the grid is not progressing. Moreover, the number of jobs in the field of renewable energy is dropping. In order to briefly analyze the main challenges to concrete the energy transition, below a brief summary is presented of the current state of those environment and climate protection-related energy transition goals in Germany:

- **Reduction of CO<sub>2</sub> equivalent emissions:**
  - Target: 2020 – 40% fewer CO<sub>2</sub>eq emissions than in 1990 (equal to 750 MtCO<sub>2</sub>-eq in 2020), 2030– 55% fewer CO<sub>2</sub>eq emissions than in 1990 (equal to 563 MtCO<sub>2</sub>-eq in 2030).
  - Current state: Should be moderately adapted, since at the end of 2019 emissions were still at 805 MtCO<sub>2</sub>-eq.
  - Comment: Reductions are mainly due to a greater share of renewable energies in power supply and smaller carbon share. Achieving greater reductions will depend on the development of renewable energies, the energy demand, the development of the price for CO<sub>2</sub> and the developments in the construction and transport sectors.
- **Reduction in primary energy consumption:**
  - Target: By 2020 having saved 20% of consumption as compared to 2008 (11,504 petajoule (PJ) in 2020) and by 2050 having saved 50% of consumption as compared to 2008 (linearly interpolated this means 10,066 PJ by 2030).
  - Current state: Should be drastically adapted since end 2019 the amount was at 12,832 PJ and the goal for 2020 of 11,504 PJ will not be achieved.
  - Comment: Even if economic growth can be disengaged from energy consumption, the current results are not satisfactory to reach the proposed targets.
- **Renewable energy share in the final gross energy consumption:**
  - Target: Share in the final gross energy consumption by 18% by 2020 and 30% by 2030.
  - Current state: Achievable target since end 2019 share was 17.1%.
  - Comment: Especially in the power sector the share of renewable energies has strongly increased, however, in transport and heat generation their share has only gone up slightly.
- **Renewable energy share in gross electricity consumption:**
  - Target: 35% al 2020 y 65% al 2030.
  - Current state: Achievable target since, according to data published by the Fraunhofer ISE Institute, the renewable energy share (including conventional hydraulic power) in the power

<sup>8</sup> ZEW (2014): Potenziale und Hemmnisse von Unternehmensgründungen im Vollzug der Energiewende, [https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/potenziale-und-hemmnisse-von-unternehmensgruendungen-im-vollzug-der-energiewende.pdf?\\_\\_blob=publicationFile&v=5](https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/potenziale-und-hemmnisse-von-unternehmensgruendungen-im-vollzug-der-energiewende.pdf?__blob=publicationFile&v=5) (reviewed on 18-02-2021), p.13.

<sup>9</sup> Federal Ministry of Economy and Energy (2019): *Klimaschutzprogramm 2030 der Bundesregierung zur Umsetzung des Klimaschutzplanes*, <https://www.bundesregierung.de/resource/blob/975226/1679914/e01d6bd855f09bf05cf7498e06d0a3ff/2019-10-09-klima-massnahmen-data.pdf?download=1> (reviewed on 22-12-2020)

<sup>10</sup> Federal Ministry of Economy and Energy (2019): *Eckpunkte für das Klimaschutzprogramm 2030*, <https://www.bundesregierung.de/resource/blob/997532/1673502/768b67ba939c098c994b71c0b7d6e636/2019-09-20-klimaschutzprogramm-data.pdf?download=1> (reviewed on 22-12-2020)

<sup>11</sup> McKinsey & Company (2020): *Energiewende-Index 2020*, en: <https://www.mckinsey.de/branchen/chemie-energie-rohstoffe/energiewende-index> (reviewed on 23-12-2020)

grid in Germany on December 20th reached 50.5%, wind energy being the main source of renewable energy generation with a 26.8% share and 127.59 TWh<sup>12</sup>.

- Comment: The development of new wind projects has slowed down so additional efforts are needed to facilitate new projects.
- **Linking sectors: renewable energy share in heat generation**
  - Target: 14% by 2020 and 27% by 2030.
  - Current state: Target can be reached by 2020 since end 2019 a renewable energy share of 14.5% was registered in heat generation.
  - Comment: However, to reach the 2030 target, the renewable energy share should grow eight times more than it did during the past ten years, which implies strengthening promotion measures to increase the share.
- **Linking sectors: transport - number of electrical vehicles**
  - Target: 7 million electrical vehicles by 2030.
  - Current state: Target unlikely to be reached since in April 2020 only 283.504 electrical with vehicle registration certificate were registered.
  - Comment: In 2020 several new electrical vehicle models for a more massive consumption were launched and the support measures launched in the context of the COVID-19 pandemic may give a positive impulse to the purchase of new electrical vehicles.

In addition, the 2050 Climate Protection Plan developed by the Ministry of Environment defined the following CO<sub>2</sub> emission reduction targets per sector for the year 2030<sup>13</sup>:

**Table 1: CO<sub>2</sub> emission reduction targets**

Field of action	2030 emission goals in millions of t of CO <sub>2</sub> equivalent	Reduction as compared to 1990 in %
Energy industry	175 – 183	62 – 61
Construction	70 – 72	67 – 66
Transport	95 – 98	42 – 40
Industry	140 – 143	51 – 49
Agriculture	58 – 61	34 – 31
Others	5	87
Total	543 – 562	56 – 55

In Chile the '2050 Energy Agenda' defines the targets of the energy sector by 2050 and draws a planning for energy policy in general, with a vision of creating a "reliable, inclusive, competitive and sustainable energy sector".<sup>14</sup> For this purpose, four key pillars for the energy transition have been established:

- 1) Pillar 1: Certainty and quality of supply
- 2) Pillar 2: Energy as the motor of development
- 3) Pillar 3: Environment-compatible energy
- 4) Pillar 4: Energy efficiency and education

<sup>12</sup> Fraunhofer ISE (2020): *Energy Charts - Jährlicher Anteil erneuerbarer Energien an der Stromerzeugung in Deutschland*, [https://energy-charts.info/charts/renewable\\_share/chart.htm?l=de&c=DE&partsum=1](https://energy-charts.info/charts/renewable_share/chart.htm?l=de&c=DE&partsum=1) (reviewed on 21-12-2020)

<sup>13</sup> Federal Ministry of Environment, Nature Protection and Nuclear Safety(2019): *Der Klimaschutzplan 2050 – Die deutsche Klimaschutzlangfriststrategie*, <https://www.bmu.de/themen/klima-energie/klimaschutz/nationale-klimapolitik/klimaschutzplan-2050/#c8420> (reviewed on 21-12-2020)

<sup>14</sup> Ministerio de Energía (2015): *Energía 2050*, [https://www.energia.gob.cl/sites/default/files/energia\\_2050\\_-\\_politica\\_energetica\\_de\\_chile.pdf](https://www.energia.gob.cl/sites/default/files/energia_2050_-_politica_energetica_de_chile.pdf) (reviewed on 21-12-2020), p. 41

Table 2: Main targets of the long-term energy policy<sup>15</sup>

MAIN TARGETS FOR 2035	
1	Interconnection of Chile with other SINEA member-states, as well as other countries in South America, particularly those of MERCOSUR is a reality.
2	The unavailability of average power supply, without considering force majeure, does not exceed 4 hours/year in any place in the country.
3	100% of housing of vulnerable families with continuous access of high quality to energy services.
4	All energy projects developed in the country have community-company associativity mechanisms that contribute to local development and a better performance of the project.
5	Chile is among the 5 OECD countries with lowest average power supply prices at residential and industrial level.
6	At least 60% of domestic power generation comes from renewable energy.
7	By 2030, the country reduces at least 30% of the intensity of its greenhouse gas emissions as compared to 2007.
8	100% of the large energy consumers in the industry, mining and transport sectors should make efficient use of energy with active energy management systems and active implementation of energy efficiency improvements.
9	By 2035 all communities have a regulation declaring forestry biomass as a solid fuel.
10	100% of new vehicles tendered for public passenger transport include energy efficiency criteria among the variables to assess.
MAIN TARGETS FOR 2050	
1	The unavailability of average power supply, without considering force majeure, does not exceed 1 hour/year in any place in the country.
2	GHG emission of the Chilean energy sector is coherent with the limits defined by science at global level and with the national reduction target, thereby contributing to a low-carbon energy.
3	Guarantee universal and equal access to modern, reliable and accessible energy services for the entire population.
4	The regional and communal territorial planning and organization instruments include the directions of the Energy Policy.
5	Chile is among the 3 OECD countries with lowest average power supply prices at residential and industrial level.
6	70% of domestic power generation comes from renewable energy.
7	Energy consumption increase is disengaged from the growth of the gross domestic product.
8	100% of new buildings meet the OECD standards of efficient building and have intelligent energy control and management systems.
9	100% of the main categories of artefacts and equipment sold on the market are energy-efficient equipment.
10	The energy culture has been installed at all levels of the society, including trading producers, consumers and users.

<sup>15</sup> Ministerio de Energía (2015): *Energía 2050*, [http://www.energia.gob.cl/sites/default/files/energia\\_2050\\_-\\_politica\\_energetica\\_de\\_chile.pdf](http://www.energia.gob.cl/sites/default/files/energia_2050_-_politica_energetica_de_chile.pdf) (reviewed on 21-12-2020)

In the past years, Chile has managed to make considerable progress in the installation of renewable energy plants. In December 2020, 26.8% of the installed capacity in the power grid are Non-Conventional Renewable Energy (NCRE) sources and, if we add the conventional hydraulic energy which in Germany is also considered renewable energy, this percentage grows to 50.4% of renewable energy in the Chilean power grid.<sup>16</sup> The current state and the main technological challenges of the energy transition in Chile will be analyzed in more detail in chapter three.

### 3.1 Energy transition and entrepreneurship

Entrepreneurship has become an imperative for sustained growth and development of all industries, and it is a global phenomenon because it has the power to impulse economic growth of the countries, provided the edge conditions are present that enable the successful development of ventures with a high growth potential.<sup>17</sup> In view of the challenges Chile and Germany face to reach the targets described in relation to the energy transition, innovative technology-based entrepreneurship is presented as an essential element to create new technologies, services and business models required. With the beginning of the 'Energiewende' in Germany and the target of carbon neutrality by 2050 that Germany and Chile have posed themselves to achieve, for which the energy transition is a fundamental pillar, several opportunities are shown for entrepreneurship that may develop and test technologies and business models in emerging markets that in many other countries will be developed only in a few years from now. Therefore, promoting entrepreneurship is essential to reach the goals proposed in energy matters, since the energy transition requires technological innovation and services<sup>18</sup>. Ventures categorized as 'startups' show a higher innovation rate than established companies and, therefore, play an important role in the development of new technologies and solutions for the economy of the future that aims at becoming more circular.

#### Startups

The term 'startup' does not appear in official statistics and is not defined uniformly in all places. The German Federal Association of Startups (*Bundesverband Deutsche Startups - BVDS*), founded in 2012, distinguishes 'startups' from other enterprises by three characteristics: 1. The age of a company of less than ten years. 2. An innovative business model or the use of innovative technologies and 3. A significant (foreseen) growth in job positions or business volume.<sup>19</sup> Additionally, a startup is also characterized by a dynamism due to flat hierarchic structures which facilitate decision processes. For the purpose of this study's analysis, a startup is defined as follows: a young, innovative company with an important growth potential.<sup>20</sup>

<sup>16</sup> National Energy Commission (2020): *Reporte Mensual Sector Energético Julio 2020*, [https://www.cne.cl/wp-content/uploads/2020/07/RMensual\\_v202007.pdf](https://www.cne.cl/wp-content/uploads/2020/07/RMensual_v202007.pdf) (reviewed on 21-12-2020), p. 6

<sup>17</sup> Valliere, D. & Peterson, R. (2009): *Entrepreneurship and economic growth: Evidence from emerging and developed countries*, *Entrepreneurship & Regional Development*, 21:5, 459 – 480, <https://www.tandfonline.com/doi/full/10.1080/08985620802332723> (reviewed on 10-12-2020), p. 477

<sup>18</sup> Schabel, A. & Fichter, K. (2018): *Inkubationsprogramme in der Energiewirtschaft. Merkmale, Erfolgseinschätzungen und Gestaltungsansätze*, Berlin: Borderstep Institut, [https://www.borderstep.de/wp-content/uploads/2018/10/Studie\\_Inkubationsprogramme\\_in\\_der\\_Energiewirtschaft.pdf](https://www.borderstep.de/wp-content/uploads/2018/10/Studie_Inkubationsprogramme_in_der_Energiewirtschaft.pdf) (reviewed on 05-10-2020), p. 8

<sup>19</sup> Kollmann, T., Stöckmann, C., Hensellek, S., & Kensbock, J. (2017): *Deutscher Startup Monitor 2017: Mut und Macher*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2017.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2017.pdf) (reviewed on 10-12-2020), p. 16

<sup>20</sup> Schabel, A. & Fichter, K. (2018): *Inkubationsprogramme in der Energiewirtschaft. Merkmale, Erfolgseinschätzungen und Gestaltungsansätze*, Berlin: Borderstep Institut, [https://www.borderstep.de/wp-content/uploads/2018/10/Studie\\_Inkubationsprogramme\\_in\\_der\\_Energiewirtschaft.pdf](https://www.borderstep.de/wp-content/uploads/2018/10/Studie_Inkubationsprogramme_in_der_Energiewirtschaft.pdf) (reviewed on 05-10-2020), p. 10

## 4 Entrepreneurship ecosystem

To promote entrepreneurship a country needs to have a solid entrepreneurship ecosystem. An entrepreneurship ecosystem can be defined as: “a set of interconnected (potential as well as existing) entrepreneurship agents, organizations and institutions linked to entrepreneurship (e.g., companies, venture capital, private investors, banks), institutions (universities, public entities, financial entities) and entrepreneurship processes (such as the company creation rate, the number of high-growth companies, successful ventures, the number of serial entrepreneurs, the degree of commercial mentality within companies and the levels of entrepreneurship ambition) that join formally and informally to connect, mediate and rule performance within the environment of local entrepreneurship”.<sup>21</sup>

In order to analyze how favorable an entrepreneurship ecosystem is, different studies have analyzed its fundamental elements. For this study, the focus by Daniel Isenberg of Babson College was used, which identifies six fields to be considered to analyze the solidness of the entrepreneurship ecosystem: a favorable culture, enabling public policies and leadership, availability of proper finances, high-quality human capital, risk-favorable markets for products and several institutional supports (see chart 1).<sup>22</sup> Within these fields there are several elements that interact in a complex way depending on the particularities of each place, reason why identifying the generic causes is of illimited value. Therefore, Isenberg puts emphasis on the context, since each entrepreneurship ecosystem arises under a unique set of conditions and circumstances.<sup>23</sup>

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<sup>21</sup> Mason, Colin & Brown, Ross (2014): *Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship*, [https://www.researchgate.net/publication/260870819\\_ENTREPRENEURIAL\\_ECOSYSTEMS\\_AND\\_GROWTH\\_ORIENTED\\_ENTREPRENEURSHIP\\_Background\\_paper\\_prepared\\_for\\_the\\_workshop\\_organised\\_by\\_the\\_OECD\\_LEED\\_Programme\\_and\\_the\\_Dutch\\_Ministry\\_of\\_Economic\\_Affairs\\_on](https://www.researchgate.net/publication/260870819_ENTREPRENEURIAL_ECOSYSTEMS_AND_GROWTH_ORIENTED_ENTREPRENEURSHIP_Background_paper_prepared_for_the_workshop_organised_by_the_OECD_LEED_Programme_and_the_Dutch_Ministry_of_Economic_Affairs_on) (reviewed on 05-10-2020), p. 5

<sup>22</sup> Isenberg, Daniel (2011): *The entrepreneurship ecosystem strategy as a new paradigm for economy policy: principles for cultivating entrepreneurship*, Babson Entrepreneurship Ecosystem Project, Babson College, Babson Park: MA, <http://www.innovationamerica.us/images/stories/2011/The-entrepreneurship-ecosystem-strategy-for-economic-growth-policy-20110620183915.pdf> (reviewed on 16-10-2020), p. 7

<sup>23</sup> Mason, Colin & Brown, Ross (2014): *Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship*, [https://www.researchgate.net/publication/260870819\\_ENTREPRENEURIAL\\_ECOSYSTEMS\\_AND\\_GROWTH\\_ORIENTED\\_ENTREPRENEURSHIP\\_Background\\_paper\\_prepared\\_for\\_the\\_workshop\\_organised\\_by\\_the\\_OECD\\_LEED\\_Programme\\_and\\_the\\_Dutch\\_Ministry\\_of\\_Economic\\_Affairs\\_on](https://www.researchgate.net/publication/260870819_ENTREPRENEURIAL_ECOSYSTEMS_AND_GROWTH_ORIENTED_ENTREPRENEURSHIP_Background_paper_prepared_for_the_workshop_organised_by_the_OECD_LEED_Programme_and_the_Dutch_Ministry_of_Economic_Affairs_on) (reviewed on 05-10-2020), p. 5-6

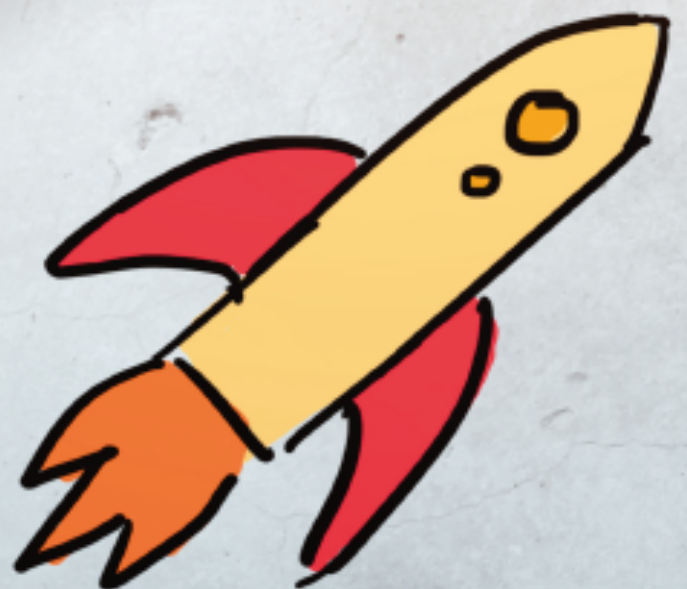
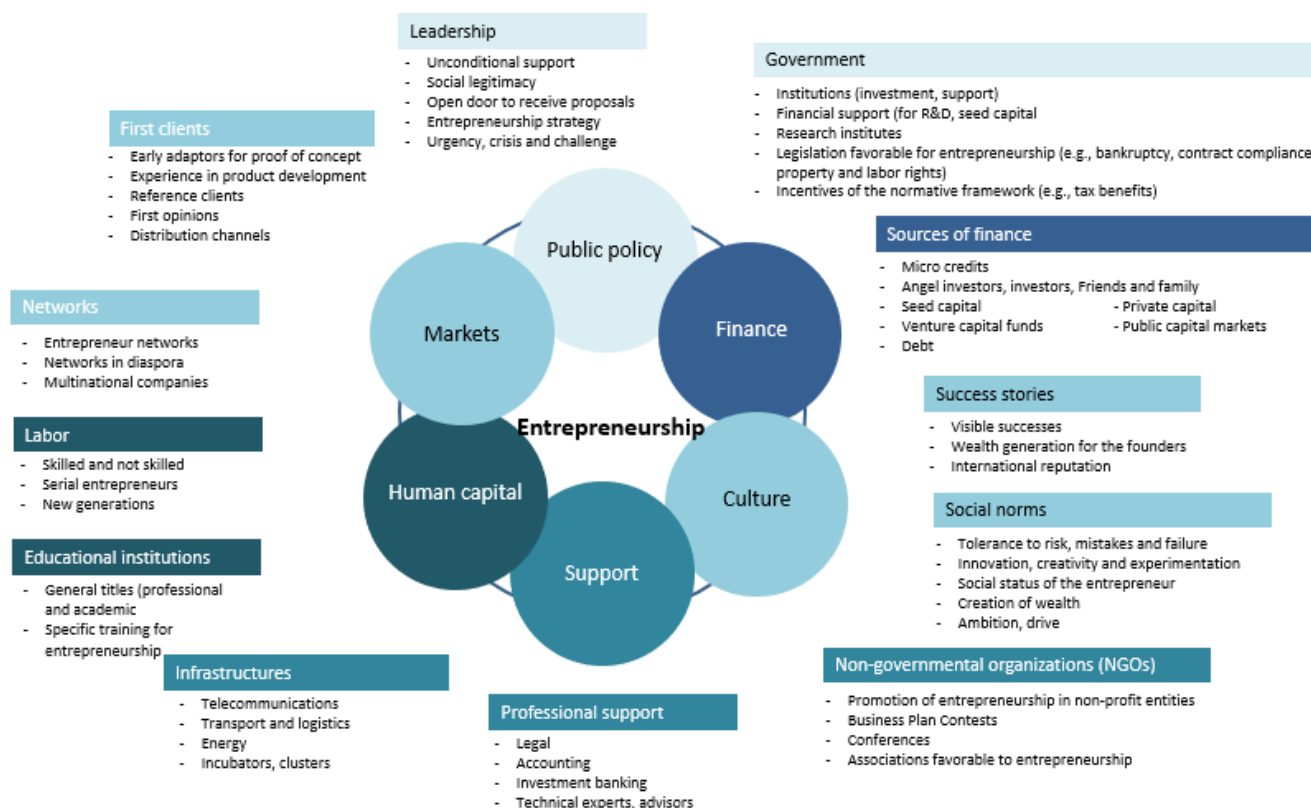




Chart 3: Isenberg model of entrepreneurship ecosystem<sup>24</sup>


## 4.1 Characteristics of startups in energy

In order to determine those elements that are particularly relevant to promote startups in energy within the six entrepreneurship ecosystems described by Isenberg and to analyze the strengths and weaknesses of the entrepreneurship ecosystem in Chile and Germany to promote the development of startups in the energy field it is important to understand the profile of a startup entrepreneur in the energy sector and its characteristics. Below, some particularities are shown that have been identified by the relevant studies in Germany<sup>25</sup> and in 36 qualitative interviews that were held with representatives of companies, incubators and accelerators, universities and public institutions in the entrepreneurship environment in Chile and Germany in the framework of the present study, organizing them according to the fields of the entrepreneurship ecosystem described by Isenberg:

### Public policy

The development of startups in the energy field requires a well-defined and stable policy and normative framework in terms of promoting variable renewable energies and energy efficiency that should give clear signals to the market and, therefore, support the development of this kind of companies, creating business opportunities.

### Culture

<sup>24</sup> Mason, Colin & Brown, Ross (2014): *Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship*, [https://www.researchgate.net/publication/260870819\\_ENTREPRENEURIAL\\_ECOSYSTEMS\\_AND\\_GROWTH\\_ORIENTED\\_ENTREPRENEURSHIP\\_Background\\_paper\\_prepared\\_for\\_the\\_workshop\\_organised\\_by\\_the\\_OECD\\_LEED\\_Programme\\_and\\_the\\_Dutch\\_Ministry\\_of\\_Economic\\_Affairs\\_on](https://www.researchgate.net/publication/260870819_ENTREPRENEURIAL_ECOSYSTEMS_AND_GROWTH_ORIENTED_ENTREPRENEURSHIP_Background_paper_prepared_for_the_workshop_organised_by_the_OECD_LEED_Programme_and_the_Dutch_Ministry_of_Economic_Affairs_on) (reviewed on 05-10-2020), p. 6

<sup>25</sup> Fichter, K. et al. (2014): *Analyse des Unterstützungssystems für grüne Unternehmensgründungen in Deutschland*, [https://www.borderstep.de/wp-content/uploads/2014/11/Fichter-et-al.-Analyse\\_Unterstuetzungssystem\\_guene\\_Unternehmensgruendungen-2014.pdf](https://www.borderstep.de/wp-content/uploads/2014/11/Fichter-et-al.-Analyse_Unterstuetzungssystem_guene_Unternehmensgruendungen-2014.pdf) (reviewed on 10-12-2020), p.12-13

Apart from the elements indicated in Chart 1 as essential to generate an entrepreneurship culture, it is important to understand that an energy entrepreneur has an environmental motivation that can open a cultural gap between entrepreneurs and investors: most entrepreneurs identify themselves with environmental and social sustainability goals. Their business models are not exclusively oriented to economic benefit, but they also seek to generate an added ecological and social value. For most of these entrepreneurs, sustainability criteria are non-negotiable and potential investors must accept this along with the usual indicators such as sales, the benefits and the investment yield.

### **Finance**

In some cases, the cultural differences between the entrepreneurs in the field of energy/cleantech and traditional investors can be significant and may make investment in a startup difficult since investors often have a traditional way of assessing ventures and are rather averse to risks.

Apart from the above, many startups in energy develop high-tech hardware and, therefore, require investment amounts that tend to be higher than, for example, investments in software to develop products and services. In comparison to the development of software without associated hardware, this type of entrepreneurship requires longer pilot cycles and, hence, higher investments, which increases the risk.

### **Human capital**

Generally speaking, an energy entrepreneur has a high educational level and, in most cases, needs highly specialized personnel with specific technological knowledge to create their product/service.

### **Support**

Many energy startups develop high-tech hardware and need a solid infrastructure for R&D (labs, pilot plants, fabrication, etc.).

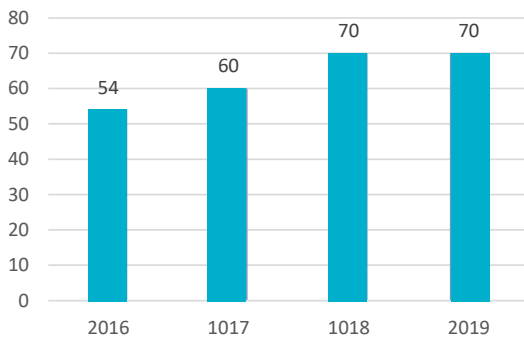
### **Markets**

Startups that introduce innovations in the field of energy and energy efficiency require a market with possible clients with a certain open mind as to taking risks and quick decision, which is facilitated when companies have their headquarters where decisions are made: in the country where the entrepreneurship takes place. Moreover, it has to be considered that innovations in renewable energy can clash with prices and power and benefit structures existing in the companies and institutions of the market and their efforts to maintain the status quo.

In view of the energy entrepreneurs' particular characteristics described, below an analysis is made of entrepreneurship ecosystem in Chile and Germany to understand the type of startups that appear in accordance with the conditions each ecosystem supplies and, based on this, propose lines of action to promote collaboration between Chile and Germany to enhance entrepreneurship in energy and technological transfer between the two countries.

## **4.2 Entrepreneurship ecosystem in Germany**

**Chart 4: Number of startups in German (in thousands), 2016–2019**



The startup ecosystem in Germany shows a positive development in the past years. According to data from the KfW, the number of startups<sup>26</sup> grew continuously between 2016 and 2018 and remained stable in 2019 with 70,000 startups<sup>27</sup>. These positive trends are also present in the increase of venture capital investments in Germany, which more than doubled between 2015 and 2019<sup>28</sup>.

In terms of regional distribution, there is a concentration of startups in North Rhine-Westphalia and Berlin which, together, represent more than one third of the startups<sup>29</sup>. Nonetheless, in a global comparison, Berlin has stayed behind as a metropolis for startups and occupies the 16th place, after having occupied the 10th place in 2019 and 7th in

2017<sup>30</sup>.

The *German Startup Monitor 2020* indicates that sustainability plays an increasingly important role for startups in Germany. 43.4% of startups is classified as belonging to green economy, as compared to 36.65 in 2019<sup>31</sup>. According to current calculations, it can be assumed that there are around 6,000 cleantech startups in Germany, which contribute with their products and services to the protection of the environment, climate and/or resources<sup>32</sup>. The *Green Startup Monitor* reaffirms that cleantech startups play a much more important role in the development and production of technology than startups without ecological focus<sup>33</sup>. Hence, with their high-tech solutions related to climate and the environment they give an important impulse to the energy transition.

However, the events provoked by the COVID-19 pandemic have caused considerable uncertainty and existential challenges in the ecosystem since March 2020. In a survey conducted at the end of March, 91.1% of startups stated that their commercial activities had been affected by the crisis<sup>34</sup>. Companies are particularly concerned about the loss of sales and the collapse of funding from external capital suppliers. In fact, venture capital investments went down by 20% in the first semester of 2020 as compared to the previous year<sup>35</sup>. Investment numbers from angel investors also show a downward trend: almost half of the 33 investors interviewed by *Business Angels Network Germany e.V.* will reduce the number of initial investments due to the pandemic<sup>36</sup>.

<sup>26</sup> This study considered as “startup” companies that were founded no longer than 5 years ago, whose founders work full-time, have a team or founding employees and are oriented to innovation or growth, which means, they conduct research and development activities to take a technological innovation to market maturity or offer at least one market innovation in the whole of Germany.

<sup>27</sup> KfW (2020): *KfW-Startup-Report 2020 Startups in Deutschland stabil bei 70.000 im Jahr 2019 – Auswirkung der Corona-Krise unsicher*, <https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/KfW-Startup-Report/KfW-Startup-Report-2020.pdf> (reviewed on 10-12-2020), p. 1

<sup>28</sup> Dealroom (2020a): *Shortage of later stage venture capital in Germany: more acute due to Corona crisis*, <https://dealroom.co/uploaded/2020/06/Berlin-Capital-FINAL.pdf> (reviewed on 10-12-2020), p.4

<sup>29</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf) (reviewed on 10-12-2020), p.22

<sup>30</sup> Startup Genome (2020): *The Global Startup Ecosystem Report - GSER 2020*, <https://startupgenome.com/reports/gser2020> (reviewed on 10-12-2020), p. 16

<sup>31</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf) (reviewed on 10-12-2020), p. 42

<sup>32</sup> Olteanu, Yasmin & Fichter, Klaus (2020): *Green Startup Monitor 2020*, <https://deusthestartups.org/wp-content/uploads/2020/04/Green-Startup-Monitor-2020.pdf> (reviewed on 10-12-2020), p.13.

<sup>33</sup> ibidem, p. 35

<sup>34</sup> Hirschfeld, Alexander & Gilde, Jannis (2020): *Innovation & Die Corona-Krise*, [https://deusthestartups.org/wp-content/uploads/2020/04/Studie\\_Innovation-und-die-Corona-Krise.pdf](https://deusthestartups.org/wp-content/uploads/2020/04/Studie_Innovation-und-die-Corona-Krise.pdf) (reviewed on 10-12-2020)

<sup>35</sup> Dealroom (2020b): *Q2 shows risk appetite in European tech is back. But not everywhere*, <https://blog.dealroom.co/whats-happening-in-european-venture-capital-q2-2020> (reviewed on 10-12-2020)

<sup>36</sup> BAND (2020): *Business Angels Panel 71: Virus schockt Business Angels*, <https://www.business-angels.de/business-angels-panel-71-virus-schockt-business-angels/> (reviewed on 10-12-2020)

Through the situation for entrepreneurs seemed to calm down from March 2020 onwards, the resurgence of COVID-19 in Germany and Europe from October 2020 draws an even more challenging scenario for startups for the future. At the same time, extraordinary circumstances also catalyze existing trends and give an impulse to digitalization in the economy and the society, which makes the entrepreneurship ecosystem even more relevant.

#### 4.2.1 Public policies

According to the *Global Competitiveness Report 2019* of the *World Economic Forum (WEF)* which classifies 141 countries by competitiveness by means of 12 variables of their economic prosperity, Germany occupies the seventh place. At the same time, the study assigns to Germany the best innovation capacity of the world with a score of 86.8 points out of 100<sup>37</sup>. In this sense, Germany clearly has an innovation-driven economy, which refers to the capacity to develop new innovative products through sophisticated processes<sup>38</sup>. The use of more advanced methods becomes the main source of competitive advantage. Companies are supported by knowledge and strongly invest in skills and advanced technologies. This has led to products and services “*Made in Germany*” being appreciated nowadays in the entire world and recognized because of their high quality.

Germany's outstanding position in innovation goes hand in hand with a policy focused on fomenting research and development (R&D). In this respect, Germany has the fourth highest expenditure in R&D in the world, after the USA, China and Japan<sup>39</sup>. In 2018, public investment in R&D amounted to 17.3 billion euros, compared to 9 billion euros in 2005. This means an increase in investment in R&D of approximately 92% in a period of thirteen years<sup>40</sup>.

The government and the industry jointly invested 104.7 billion euros in R&D, which represent 3.13% of the GDP. For 2025, the government wishes to raise this to 3.5% of the GDP, together with the federated states and the industry. The 2025 High-Technology Strategy supports this goal with a roadmap defining the fields of action and milestones of the research and innovation policy for the coming years<sup>41</sup>.

The number of employees in R&D has continuously increased too and reached a record number in 2017 of over 686,000 people employed in R&D (equivalent to full-time). This all makes Germany today one of the economies most focused on research in the world<sup>42</sup>. In coherence with these data, 100% of those interviewed for the present study consider that Germany gives support to R&D.

<sup>37</sup> WEF (2019): *The Global Competitiveness Report 2019*, [http://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf) (reviewed on 10-12-2020), p. 16

<sup>38</sup> Sternberg, Rolf et al. (2019): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2018/19*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20182019/> (reviewed on 16-12-2020), p. 20

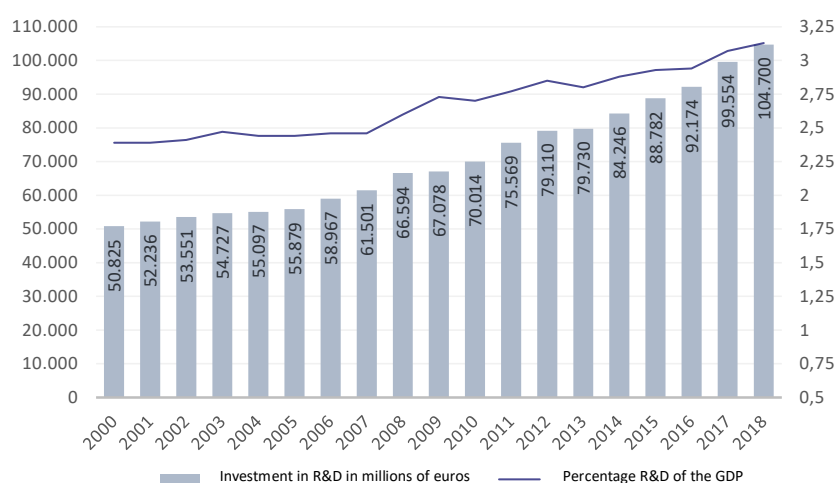
<sup>39</sup> BMBF (2020a): *Daten und Fakten zum deutschen Forschungs- und Innovationssystem. Bundesbericht Forschung und Innovation 2020*, [https://www.bundesbericht-forschung-innovation.de/files/BMBF\\_BuFI-2020\\_Datenband.pdf](https://www.bundesbericht-forschung-innovation.de/files/BMBF_BuFI-2020_Datenband.pdf) (reviewed on 16-12-2020), p. 10

<sup>40</sup> BMBF (2020b): *Bildung und Forschung in Zahlen 2020*, [https://www.bmbf.de/upload\\_filestore/pub/Bildung\\_und\\_Forschung\\_in\\_Zahlen\\_2020.pdf](https://www.bmbf.de/upload_filestore/pub/Bildung_und_Forschung_in_Zahlen_2020.pdf) (reviewed on 16-12-2020), p. 7

<sup>41</sup> BMBF (2018): *Forschung und Innovation für die Menschen. Die Hightech-Strategie 2025*, [https://www.bmbf.de/upload\\_filestore/pub/Forschung\\_und\\_Innovation\\_fuer\\_die\\_Menschen.pdf](https://www.bmbf.de/upload_filestore/pub/Forschung_und_Innovation_fuer_die_Menschen.pdf) (reviewed on 16-12-2020)

<sup>42</sup> BMBF (2020a): *Daten und Fakten zum deutschen Forschungs- und Innovationssystem. Bundesbericht Forschung und Innovation 2020*, [https://www.bundesbericht-forschung-innovation.de/files/BMBF\\_BuFI-2020\\_Datenband.pdf](https://www.bundesbericht-forschung-innovation.de/files/BMBF_BuFI-2020_Datenband.pdf) (reviewed on 31-10-2020), p. 5

**Chart 5: Evolution of investment in R&D in Germany in total (in millions of euros)<sup>43</sup>**



In this context it is surprising that, until recently, Germany was one of the five OECD countries that did not offer tax incentives for R&D. This was a great disadvantage at international level for innovative companies and R&D personnel. Only in May 2019, the federal cabinet decided to implement tax incentives for research and development. The corresponding law came into effect on January 1st, 2020 (Law on subsidies for research)<sup>44</sup>.

The German energy policy shows coherence with its R&D-based innovative profile as described before. Germany emphasizes the importance of future-oriented technologies to achieve the energy transition and its programs are oriented to achieve the German energy policy's fundamental goals outlined in the first chapter: In its seventh Energy Research Program (*Energieforschungsprogramm*)<sup>45</sup> called "Innovations for the Energy Transition" (*Innovationen für die Energiewende*), the German government establishes the directions for financing energy research from 2018 to 2022, following a strategy focused on technology transfer and innovation. Through "real laboratories" (*Reallabore*) new and promising technological solutions are implemented under real market conditions. The experience acquired in the "real laboratories" serves as a yardstick for the later large-scale application technologies. Moreover, a tighter research network will be established at international and European level<sup>46</sup>.

In this scenario, a relevant role is given to the startups:

*[Startups] contribute to the development of new technological solutions, open new markets with innovative products, services and business models [...] and are an important motor for the energy transition. [...] The government has proposed to better deal with startups with new finance formats and increase their participation in all energy-related research spheres<sup>47</sup>.*

In the 2018 coalition agreement the German government defined numerous measures and legal initiatives to improve the general conditions for startups and encourage entrepreneurship. Of the 25 measures in total, 10 have been implemented in the past two years<sup>48</sup>. Among those, the Law on Immigration of Skilled Workers which provides for facilitated employment of skilled foreign personnel, particularly in information technology. Another landmark has been the approval of the Law on Bureaucracy Reduction III. This way founding companies is exempt of the monthly anticipated VAT notification in the next six tax periods, among other benefits<sup>49</sup>.

<sup>43</sup> Own production based on BMBF (2020a): *Daten und Fakten zum deutschen Forschungs- und Innovationssystem. Bundesbericht Forschung und Innovation 2020*, [https://www.bundesbericht-forschung-innovation.de/files/BMBF\\_BuFI-2020\\_Datenband.pdf](https://www.bundesbericht-forschung-innovation.de/files/BMBF_BuFI-2020_Datenband.pdf) (reviewed on 31-10-2020), p. 6

<sup>44</sup> BMBF (2020c): *Förderung in der Forschung*, <https://www.bmbf.de/de/foerderung-in-der-forschung-642.html> (reviewed on 16-12-2020)

<sup>45</sup> Since the end of the seventies, the German government has financed research in energy technology in the framework of Energy Research Programs (*Energieforschungsprogramme*). These programs take strategic political goals of the energy policy and establish the directions for funding research. In the framework of these programs, the ministries call for the presentation of requests for research projects.

<sup>46</sup> BMWi (2018a): *Innovationen für die Energiewende. 7. Energieforschungsprogramm der Bundesregierung*, [https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/7-energieforschungsprogramm-der-bundesregierung.pdf?\\_\\_blob=publicationFile&v=4](https://www.bmwi.de/Redaktion/DE/Publikationen/Energie/7-energieforschungsprogramm-der-bundesregierung.pdf?__blob=publicationFile&v=4) (reviewed on 16-12-2020), p. 4

<sup>47</sup> *ibidem*, p.19.

<sup>48</sup> *getstartet* (2020): *Halbzeit-Bilanz: Wie steht es um die Startup-Politik der GroKo?*, <https://getstarted.de/halbzeit-bilanz-startup-politik/> (reviewed on 16-12-2020)

<sup>49</sup> *ibidem*

The most important national stakeholder of the entrepreneurship policy is the Federal Ministry of Economy and Energy (BMWi), which implemented numerous measures in the past years to promote entrepreneurship and growth of startups in Germany. Some of these measures have been established successfully, such as the High-Technology Entrepreneurship Fund (*High Tech Gründerfonds*) as initial investor and the EXIST program (see dimension of 'finance', Table 3).

Another initiative that had a great impact was the entrepreneurship offensive *GO!* (*Gründungsoffensive*) presented by the Minister of Economy and Energy, Peter Altmaier, in November 2018. The initiative includes ten concrete measures oriented to entrepreneurship thinking and the relevant skills are taught in schools and universities as early as possible. Moreover, the digital advisory services are intended to be extended to create companies, facilitate the creation of serial companies and attract more women to entrepreneurship activity<sup>50</sup>.

As for the weaknesses of the entrepreneurship policy in German, one of the most important demands expressed by the startups is reducing the normative and bureaucratic obstacles<sup>51</sup>. A mountain of administrative procedures to create a company, little flexibility in the directions of state-support programs and a long and complex process for employing foreign workers are only some of the bureaucratic difficulties startups face. However, the government has tried to respond to some of these issues in the past years by creating the Law on Immigration for Skilled Workers and the Law on Bureaucracy Reduction III mentioned earlier. These efforts are reflected in the results of the survey conducted for the present study: 85% (n=20) considers that there is a consistent public strategy to foment the development of science and technology-based ventures and 95% indicates that there is a normative framework that clearly supports renewable energy. Nonetheless, 35% considers that procedures for entrepreneurs (company creation and permits) could be faster and simpler.

Another important demand from startups is special support with respect to business commitment with environment protection and sustainability. For the cleantech startups this is even the most important expectation<sup>52</sup>, which underscores that these startups show specific characteristics requiring special attention, as described at the beginning of this chapter. Some studies have reaffirmed the need to develop specific support programs for cleantech startups<sup>53</sup>.

#### 4.2.2 Finance

"Classic" finance with bank loans plays a rather subordinate role for startups, due to the difficulties to assess the innovative business models and their market potential. Added to this is the greater capital requirement and, often, a lack of guarantees. Finally, high-tech companies often take ten years or longer from the beginning of product development until they become profitable.

The BMWi supplies finance instruments suitable for innovative and technology-based startups. Especially for the so-called "seed" phase it has a quite well-developed support system. Due to Germany's federal structure, there is a broad finance panorama for startups, unparalleled in Europe. Each German federate state has its own development bank. These banks play a central role in the ecosystem for startups and support founders with loans or guarantees for other bank loans. Some of these development banks work together with venture capital funds and offer consultancy services for all the phases in the creation of the company. Thus, 93% (n=16) of the people interviewed for the present study indicate that there are enough public funds for financing technological innovation projects.

<sup>50</sup> BMWi (2018b): *Gründungsoffensive - 10 Punkte für mehr Gründungen*, [https://www.existenzgruender.de/SharedDocs/Downloads/DE/10-Punkte-fuer-mehr-Gruendungen.pdf?\\_\\_blob=publicationFile](https://www.existenzgruender.de/SharedDocs/Downloads/DE/10-Punkte-fuer-mehr-Gruendungen.pdf?__blob=publicationFile) (reviewed on 16-12-2020)

<sup>51</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf) (reviewed on 16-12-2020), p. 59

Olteanu, Yasmin & Fichter, Klaus (2020): *Green Startup Monitor 2020*, <https://deutschestartups.org/wp-content/uploads/2020/04/Green-Startup-Monitor-2020.pdf> (reviewed on 16-12-2020), p. 49.

<sup>52</sup> Olteanu, Yasmin & Fichter, Klaus (2020): *Green Startup Monitor 2020*, <https://deutschestartups.org/wp-content/uploads/2020/04/Green-Startup-Monitor-2020.pdf> (reviewed on 16-12-2020), p. 49.

<sup>53</sup> Fichter et al. (2014): *Analyse des Unterstützungssystems für grüne Unternehmensgründungen in Deutschland*, <https://www.borderstep.de/wp-content/uploads/2014/11/Fichter-et-al.-Analyse-Unterstuetzungssystem-gruene-Unternehmensgruendungen-2014.pdf> (reviewed on 16-12-2020)

On the website [www.förderdatenbank.de](http://www.förderdatenbank.de), the BMWi offers a platform containing the national, federal and European Union finance programs. The portal focuses on financial help to create companies and for small and medium-sized companies. It also gives links between different programs, which are important for the efficient use of state support. Another important platform for entrepreneurs is the website [www.existenzgruender.de](http://www.existenzgruender.de) through which the BMWi supplies information about finance and the administrative processes, learning programs and an expert forum to consultations and other.

However, the financial diversity also leads to a lack of transparency. Even for experts it is difficult to identify the appropriate funding for an entrepreneurship project and many startups do not ask for sufficient information about the finance possibilities with public funds. As a result, each year many funds do not get to be used.

**Table 3: Outstanding state-support programs for startups**

<p><b>High-Technology Entrepreneurship Fund</b> (<i>High-Tech Gründerfonds</i>) Entity: BMWi</p>	<p>The High-Technology Entrepreneurship Fund (HTGF, by its acronym in German) is an investment fund financed by the BMWi, the KfW and 28 private companies currently. It is the most important venture capital fund for technology-based startups and innovative business models. HTGF supplies up to 1 million euros as initial funding. Another 2 million euros are available for the next finance rounds. Apart from finance, HTFG supports founders with technical knowledge and a solid contact network. For more information: <a href="https://www.htgf.de/en/">https://www.htgf.de/en/</a></p>
<p><b>INVEST – Subsidy of venture capital</b> Entity: BMWi</p>	<p>Private investors investing in a company receive a subsidy in the framework of the INVEST support program of up to 20% of the venture capital and is reimbursed free of taxes. It requires an investment of at least 10,000 euros. Subsidies of up to 500,000 euros per year can be requested for the purchase of shares. Within one natural year, shares can be subsidized for an amount of up to 3 million euros per company. In general, the INVEST finance program benefits small companies and new companies as well as investors. For more information <sup>54</sup>: <a href="https://www.bafa.de/DE/Wirtschafts_Mittelstandsfoerderung/Beratung_Finanzierung/Invest/invest_node.html">https://www.bafa.de/DE/Wirtschafts_Mittelstandsfoerderung/Beratung_Finanzierung/Invest/invest_node.html</a></p>
<p><b>EXIST</b> Entity: BMWi</p>	<p>EXIST is a BMWi program aiming at improving the entrepreneurship climate at universities and non-university research institutions and increasing the number of technology-based and knowledge-based startups. Students, graduates and scientists receive financial resources and technical knowledge relevant to create a company in order to convert scientific results into products and/or services suitable for the market, prepare the creation of a company and enter the market. The request must be submitted before initiating a business. For more information: <a href="https://www.exist.de/EN/Home/home_node.html">https://www.exist.de/EN/Home/home_node.html</a></p>

<sup>54</sup> Information available in German only.

<p><b>Climate protection offensive for SMEs</b> (Klimaschutzoffensive für den Mittelstand) Entity: KfW, BMWi</p>	<p>La “Climate protection offensive for SMEs” offers private and municipal small and medium-sized companies with annual sales of up to 500 million euros low-interest loans as well as subsidies for investment in fabrication and use of plants and products that respect the climate with a high climate-protection effect. These include a wide range of measures to reduce CO<sub>2</sub> emissions in the industry, transport, power and heat generation, waste and waste-water management or green IT. KfW will contribute up to 100 million euros per year, initially in a period of three years as of 2020. For more information<sup>55</sup>: <a href="https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/F%C3%B6rderprodukte/Klimaschutzoffensive-f%C3%BCr-den-Mittelstand-(293)/">https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/F%C3%B6rderprodukte/Klimaschutzoffensive-f%C3%BCr-den-Mittelstand-(293)/</a></p>
<p><b>Environment Program</b> (KfW-Umweltprogramm) Entity: KfW</p>	<p>The KfW Environment Program supplies low-interest finance for general environment-protection measures from companies, such as measures for a low carbon-level and resource-efficient economy. For more information<sup>56</sup>: <a href="https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/Finanzierungsangebote/Umweltprogramm-(240-241)/">https://www.kfw.de/inlandsfoerderung/Unternehmen/Energie-Umwelt/Finanzierungsangebote/Umweltprogramm-(240-241)/</a></p>
<p><b>Environment Innovation Program (BMU-Umweltinnovationsprogramm)</b> Entity: BMU</p>	<p>The Federal Ministry of Environment, Nature Protection and Nuclear Security (BMU) supports demonstration projects at large technical scale that show how systems adapt for the first time to cutting-edge technology to reduce environment pollution and how advanced processes and combinations of processes can be applied to avoid and reduce environment pollution. For more information: <a href="https://www.umweltinnovationsprogramm.de/?en=1">https://www.umweltinnovationsprogramm.de/?en=1</a></p>

Another important source of capital for startups are angel investors. These investors generally invest between 50,000 and 150,000 euros. This capital helps in the initial phase of the business, and, at the same time, the startups benefit from the technical knowledge and the contact network of their angel investor. However, for a new business founder it is not easy to find an angel investor because this industry has not been regulated and there is no central register of angel investors. Currently there are no exact numbers on their investment behavior and estimations about the number of active investment angels in Germany and Europe vary considerably. Most angel investors belong to an association. These are members of the BAND association, the “Business Angels Netzwerk Deutschland e.V.”, which has more than 30 members and serves as the first contact for startups ([www.business-angels.de](http://www.business-angels.de)).

Though for most startups initial finance is not a major problem, the lack of adequate funds for the growth phase (including venture capital) is one of the main weaknesses of the German innovation system<sup>57</sup>. Even though venture capital investments in Germany more than doubled from 2015 to 2019<sup>58</sup>, they remain low in international respect. To grow, technology-based companies often require 10 to 50 million euros per finance round, which is a capital that companies of this size have trouble finding with German and/or European investors. As a comparison: total venture capital investments are 300 percent higher in Asia and the United

<sup>55</sup> Information available in German only.

<sup>56</sup> ibidem

<sup>57</sup> Achleitner, Ann-Kristin et al. (2019): *Innovationskraft in Deutschland verbessern: Ökosystem für Wachstumsfinanzierung stärken*, [https://www.eurexrepo.com/resource/blob/1579394/foa7767fa011ea7a0ab8dce2a636eec/data/20190207\\_acatech\\_Studie\\_Wachstumsfinanzierung\\_final.pdf](https://www.eurexrepo.com/resource/blob/1579394/foa7767fa011ea7a0ab8dce2a636eec/data/20190207_acatech_Studie_Wachstumsfinanzierung_final.pdf) (reviewed on 16-12-2020), p. 5

<sup>58</sup> Dealroom (2020a): *Shortage of later stage venture capital in Germany: more acute due to Corona crisis*, <https://dealroom.co/uploaded/2020/06/Berlin-Capital-FINAL.pdf> (reviewed on 16-12-2020), p. 4



States than in Europe (according to 2017 numbers). Precisely in the last growth phases the "venture capital gap" in Europe becomes evident in comparison with Asia and the US. Therefore, for the growth phase of German startups, many investors come from abroad<sup>59</sup>.

Some experts interviewed for this study fear that the lack of venture capital makes startups develop their technologies in Germany to later emigrate outside Europe, especially the US, to carry out their business. In fact, a recent study supports this hypothesis, indicating that a very high percentage (approximately two thirds) of the companies in growth phase co-financed by foreign investors is sold to foreign investors or is traded on the stock market abroad. For companies financed with national funds, this share is only one third<sup>60</sup>.

Recently the European Union (EU) has launched different programs, such as VentureEU and the Artificial Intelligence and Blockchain Investment Fund<sup>61</sup>, to support the venture capital and investment funds, increase the investment amounts, close the gap to access to venture capital and prevent European startups from being forced to move to the United States or Asia to look for investors.

As for the cleantech startups it is worth mentioning that finance with venture capital through angel investors is even more complex as compared to startups that dedicate themselves to non-ecological topics. This difference is shown, above all, in very innovative startups: while 31% of very innovative non-ecological startups have received finance through angel investors and 23% through venture capital, very innovative cleantech startups have received only 18% and 9% respectively. According to *Berset 2015* the reason could be the investors' limited experience in ecological topics as well as a higher risk attribution due to, for example, an unstable normative framework<sup>62</sup>. Hence, it can be concluded that private investors and venture capital companies are not fully exploiting the economic and ecological potential of the cleantech startups.<sup>63</sup> Moreover, these results reaffirm that cleantech startups face greater challenges to receive financial resources, as outlined at the beginning of this chapter, so funds addressed to cleantech startups require strengthening. In this respect it is worth mentioning the program "Green Startup Sonderprogramm" of the German Federal Environment Foundation (*Deutsche Bundesstiftung Umwelt, DBU*) launched in 2019. The program addresses startups that combine innovative solutions for the environment and sustainability with a focus on digitalization. The maximum duration of the finance is 24 months and has a maximum amount of 125,000 euros (more information: <https://www.dbu.de/2535.html>).

Moreover, characteristic for the entrepreneurship ecosystem in Germany is the high percentage of young entrepreneurs investing their own savings in creating a startup and/or receiving financial support from friends or relatives (see chart 4). According to the annual report "Deutscher Startup Monitor" 80% of the 1946 startups interviewed indicated to have invested their savings in their new venture<sup>64</sup>. Added to this is the great discrepancy between preferred finance sources and those effectively used. The report draws the conclusion that access to external capital is still one of the main challenges for the startups in the German ecosystem<sup>65</sup>.

<sup>59</sup> Achleitner, Ann-Kristin et al. (2019): *Innovationskraft in Deutschland verbessern: Ökosystem für Wachstumsfinanzierung stärken*, [https://www.eurexrepo.com/resource/blob/1579394/foa7767fa011ea7a0ab8dce2a636eec/data/20190207\\_acatech\\_Studie\\_Wachstumsfinanzierung\\_fina.pdf](https://www.eurexrepo.com/resource/blob/1579394/foa7767fa011ea7a0ab8dce2a636eec/data/20190207_acatech_Studie_Wachstumsfinanzierung_fina.pdf) (reviewed on 16-12-2020), p. 5

<sup>60</sup> Braun, Reiner et al. (2019): *Foreign Venture Capital Supply in Europe: Consequences on Ventures' Exit Locations and Entrepreneurial Migration*, [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=3415370](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3415370) (reviewed on 11-12-2020)

<sup>61</sup> VentureEU; [VentureEU - the European Union venture capital mega-fund | Horizon 2020 \(europa.eu\)](https://www.europa.eu/press-communications/infographic/infographic-ventureeu) (reviewed on 28-12-2020); Fondo de Inversión en Inteligencia Artificial y Blockchain: [EU Artificial Intelligence and Blockchain investment fund to invest 100 million euros in startups in 2020 | Shaping Europe's digital future \(europa.eu\)](https://www.europa.eu/press-communications/infographic/infographic-ventureeu) (reviewed on 28-12-2020)

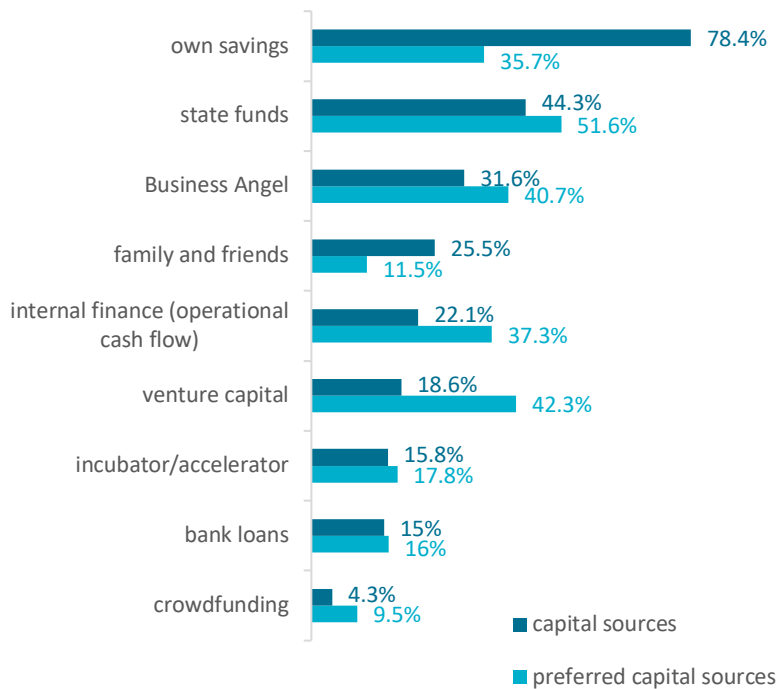
<sup>62</sup> Bergset, Linda (2015): *The Rationality and Irrationality of Financing Green Startups*, *Administrative Sciences*, 5(4), p.260–285

<sup>63</sup> Olteanu, Yasmin & Fichter, Klaus (2020): *Green Startup Monitor 2020*, <https://deutschestartups.org/wp-content/uploads/2020/04/Green-Startup-Monitor-2020.pdf> (reviewed on 16-12-2020), p. 40

<sup>64</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf) (reviewed on 11-12-2020), p. 46

<sup>65</sup> ibidem

**Chart 6: Sources of finance used versus preferred sources of finance<sup>66</sup>**



\*preliminary numbers

After the COVID-19 pandemic crisis, in April 2020 the German government launched a help package to support startups. With an amount of 2 billion euros the BMWi, the Federal Ministry of Finance and the KfW seek to strengthen finance for startups through two pillars: The first pillar strengthens venture capital funds to guarantee new finance rounds for startups. These funds are supplied by the KfW. The second pillar considers funds managed by the federate states for startups and SMEs without access to pillar one. However, there are weaknesses in applying the help package. Until November 2020 only 50 million euros have benefitted the startups. Only 20% of the requests seems to be successful. Of these approved requests, only half is signed finally by the fund managers. At the same time, a disbalance shows in the sector and regional concentration of

the beneficiary startups<sup>67</sup>.

<sup>66</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf) (reviewed on 11-12-2020), p. 46

<sup>67</sup> Álvarez, Sonja (2020): *Zwei-Milliarden-Hilfspaket für Startups zeigt Mängel in der Umsetzung*, *WirtschaftsWoche*, <https://www.wiwo.de/politik/deutschland/corona-hilfen-zwei-milliarden-hilfspaket-fuer-startups-zeigt-maengel-in-der-umsetzung/26607476.html> (reviewed on 11-12-2020)

### Infobox 1: Experiences of entrepreneurship in energy: The Biofabrik Technologies GmbH case<sup>68</sup>

#### Products and services sold by Biofabrik Technologies GmbH:

Biofabrik is a startup that was founded in 2011 in the city of Dresden and has developed a technology to, in a decentralized way, convert plastic waste into valuable recycled oils which, depending on the application, can be used directly in situ as a source of energy or as a raw material for recycled plastic. Each “WASTX Plastic” plant processes up to 1,000 kg of plastic waste per day and module; a standard container fits up to 5 modules. Moreover, the technology generates its own electricity, which makes it entirely self-sufficient. For the founder of the startup, Oliver Riedel, Biofabrik is his second venture. With the creation of the platform “Lebensmittel.de” for purchasing food, the young entrepreneur already has a success case, experience and, above all, financial resources thanks to the successful sale of the company. The idea of Biofabrik was the result of a trip to Cambodia where Oliver was impressed by the plastics dumpsters he saw there. For more than 8 years, a small team of engineers, computer engineers, biologists and other scientists worked on the development of a mobile technological solution.

The long process of developing and perfecting the technology resulted in different solutions that Biofabrik offers today:

- WASTX Plastic: Plastic waste converted into tradable synthetic oil and energy.
- WASTX Oil: Liquid waste (used oil, used diesel, heating oil, kerosene and marine oil waste) are recycled, in a decentralized way, to be reintroduced into the raw material cycle.
- Greenrefinery: To obtain vegetal amino acids from grass.

#### Motivation of the founder:

Biofabrik wishes to contribute to plastic waste not being a critical environment problem but a valuable resource. Moreover, it wants to become the main think tank for environment problems and invest in research of new environment technologies. The strong ideology that drives the work stands out.

#### Current situation:

In 2020 Biofabrik came with its technological solution in serial production. Plants were opened in Saudi Arabia, Nigeria, the United Kingdom and a large-scale plant was installed with a daily capacity of up to 200 tons of plastic waste as a pilot model in the Saxion region in Germany. Currently the startup is focused on internationalization and the creation of an international network of distributors for maintenance and local regulations.

#### Finance:

Thanks to the successful sale of his first business, the founder of Biofabrik had own capital for his new venture. According to the information supplied, without these own funds it would have been difficult to overcome the development phase which lasted more than eight years. The startup refused to collaborate with investors because independence in his business and decisions was more important to him.

#### Main barriers:

**Finance:** Though Germany and Europe offer public funds for entrepreneurship, they mainly focus on the seed phase of a startup. In this sense, Biofabrik could not recur to these funds once it had advanced with the development of the technology. The startup considers this a great disadvantage because the transition of a technology in development to a technology ready for the market is where an impulse is needed as well as starting finance.

<sup>68</sup> Interview with Fröse, COO of Biofabrik Technologies GmbH on 16.02.2021

**Regulatory barriers:** Obtaining the necessary permits to start plant operation is a great challenge that can take up to six months, which makes it difficult for the business to progress.

**Human capital:** The startup talks about the difficulty to obtain suitable skilled personnel. Many times, specialists stay in the big multinational companies because of the attractive salary and the low business risk.

**Fundamental elements for entrepreneurship:**

Finance, culture, contact network

### 4.2.3 Support

The support system in Germany consists of several levels, where interaction of the different stakeholders at national, regional and local level defines the entrepreneurship ecosystem of a startup. The support panorama for startups in Germany is characterized by the appearance and development of different support formats which differentiate themselves more and more and grow in number. Nonetheless, this diversity of the support system also makes it difficult to competently deal with the individual offers. Until now, there is no uniform understanding of the beneficiaries, stakeholders and specific goals of the offers and instruments.

In 2018 a study of the Institute for Innovation and Technology identified **1,132 support systems** in total<sup>69</sup>:

- **309 Entrepreneurship and Technology Centers<sup>70</sup> for the development of regional entrepreneurship:** The Entrepreneurship and Technology Centers are building complexes where technology-oriented startups settle in "their own" rooms but in a community with other companies of the same region and oriented to innovation. The needs for infrastructure and support to develop new products and services are key for the innovative cleantech startups. The Entrepreneurship and Technology Centers play an important role and, generally, contribute by offering flexible space according to the needs of each startup, quick consultancy in financial and legal issues, good opportunities for a possible tight cooperation with scientific and research institutions as well as associations, chambers, etc. Subsidized rent and shared resources contribute to supplying a favorable environment for the startups to innovate and grow. This way regional innovation and growth policy seeks to improve the framework conditions for the startups. Apart from the economic advantages of these centers, the possibility of quick and easy knowledge transfer and integration in "networks" are especially important to the companies.
- **141 awards and contests for entrepreneurs initiated by the government, the federated states and other stakeholders:** Contests for entrepreneurs (*Gründerwettbewerbe*) have become as a popular instrument among startups, as confirm the experts interviewed for this study. The main goal of these instances is to make a reputation and gain recognition in the market. Almost one third of all contests are organized by companies (31.9%). Other main initiators are the federated states (21.3%) and universities (13.5%)<sup>71</sup>. As part of the "StartUp4Climate" project, financed by the BMWi, for the first time in 2015 a national award was given to the creation of ecological companies, the *StartGreen Award*. Since then, the contest has been performed annually and is for people interested in creating a company,

<sup>69</sup> Zinke, Guido et al. (2018): *Trends in der Unterstützungslandschaft von Startups – Inkubatoren, Akzeleratoren und andere*, [https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/trends-in-der-unterstuetzungslandschaft-von-startups.pdf?\\_\\_blob=publicationFile&v=8m](https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/trends-in-der-unterstuetzungslandschaft-von-startups.pdf?__blob=publicationFile&v=8m) (reviewed on 11-12-2020)

<sup>70</sup>The Federal Association of German Centers of Innovation, Technology and Entrepreneurship (Bundesverband Deutscher Innovations-, Technologie- und Gründerzentren) represents, as a central organization, the interests of the Entrepreneurship and Technology Centers and the related startups. Moreover, it has developed its own audit procedure to apply uniform quality standards to the centers.

<sup>71</sup> Zinke, Guido et al. (2018): *Trends in der Unterstützungslandschaft von Startups – Inkubatoren, Akzeleratoren und andere*, [https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/trends-in-der-unterstuetzungslandschaft-von-startups.pdf?\\_\\_blob=publicationFile&v=8](https://www.bmwi.de/Redaktion/DE/Publikationen/Studien/trends-in-der-unterstuetzungslandschaft-von-startups.pdf?__blob=publicationFile&v=8) (reviewed on 16-12-2020), p. 91

founders with sustainable projects and young ecological companies (for more information: <https://www.borderstep.org/projects/startgreen-award/>).

- **1268 coworking spaces<sup>72</sup> and 33 “maker labs”<sup>73</sup>**: Coworking spaces and the so-called “*maker labs*”<sup>73</sup> are places for “creative exchange” to give all interested people access to modern and advanced technologies that are normally only available for a small circle of people. At the same time, they are spaces to do networking. Most of the *maker labs* are part of local universities.
- **121 accelerators and 56 incubators**: German accelerators cover a very wide gamma of contents and are accessible to startups from different sectors and target markets. However, the supplier structure is less diverse: eight of every ten accelerators are operated by companies, followed at a great distance by offers of federated states, universities and the government. There is a trend of suppliers to concentrate on relevant issues of the future such as digital transformation and 4.0 industry. Unlike the incubators, their main goal is to accelerate commercialization of new companies based on a business model that works. An excellent accelerator in green energy is EIT Climate-KIC, which since 2010 has supported over 1,000 startups in this sector. It is the largest public-private association in Europe fighting climate change through innovation. EIT Climate-KIC is a community including 380 organizations in 25 companies. Through its offices in Munich and Berlin, the *EIT Climate-KIC DACH Accelerator-Program* impulses the development of sustainable solutions for climate protection with its programs and its community of innovative companies, researchers, startups and students (for more information: <https://dach.climate-kic.org/en/who-we-are/climate-kic-in-germany-austria-switzerland/>).

The incubators are public or private initiatives which offer services to founders that are in a very early stage of their initial idea. The 56 incubators do not only offer support for startups in the form of physical space (facilities and rooms) and minimum finance, but also contribute human capital and knowledge to transform the startups' promising ideas into prototypes and define adequate business models. For this purpose, the incubators accompany the project for a long time and receive, in some cases, a higher share than, for example, accelerators. Incubators contribute significantly to the professionalization of the founders or the founding teams.

- **340 additional instruments**: Apart from the instruments mentioned, the study identifies 340 additional instruments including angel investor associations (38), venture capital investors (51), company builders<sup>74</sup> (26), crowdfunding platforms (24), foundations (19) and networking instruments such as trade shows and information platforms.

This analysis shows the large number and variety of support instruments the German ecosystem offers the startups. 85% of the experts interviewed for the present study indicated that in Germany there are mentors with technical experience and 95% said that there is a good offer of incubators, hubs and accelerators with international networks. Moreover, 90% asserts that there is a good infrastructure to perform R&D pilot projects.

These data can be complemented with the results of the *Deutscher Startup Monitor* (DSM) where proximity to universities and contact networks with other startups are aspects that are better valued by the startups as for the entrepreneurship ecosystem in Germany<sup>75</sup>. The results indicate that, even though the founders are integrated into a broad network of startups, it is necessary to keep promoting the dialogue between them and the established stakeholders. Access to capital and investments (38.5%) and the availability of accessible office

<sup>72</sup> Between 2018 and 2020 the number of coworking spaces was multiplied by four, according to a study from the German Federal Association of Coworking Spaces (Bundesverband Coworking Spaces Deutschland e. V.) of 2020: Bundesverband Coworking Spaces Deutschland: *Zahl der Coworking Spaces hat sich vervierfacht*, <https://www.bundesverband-coworking.de/2020/06/zahl-der-coworking-spaces-hat-sich-vervierfacht/> (reviewed on 11-12-2020)

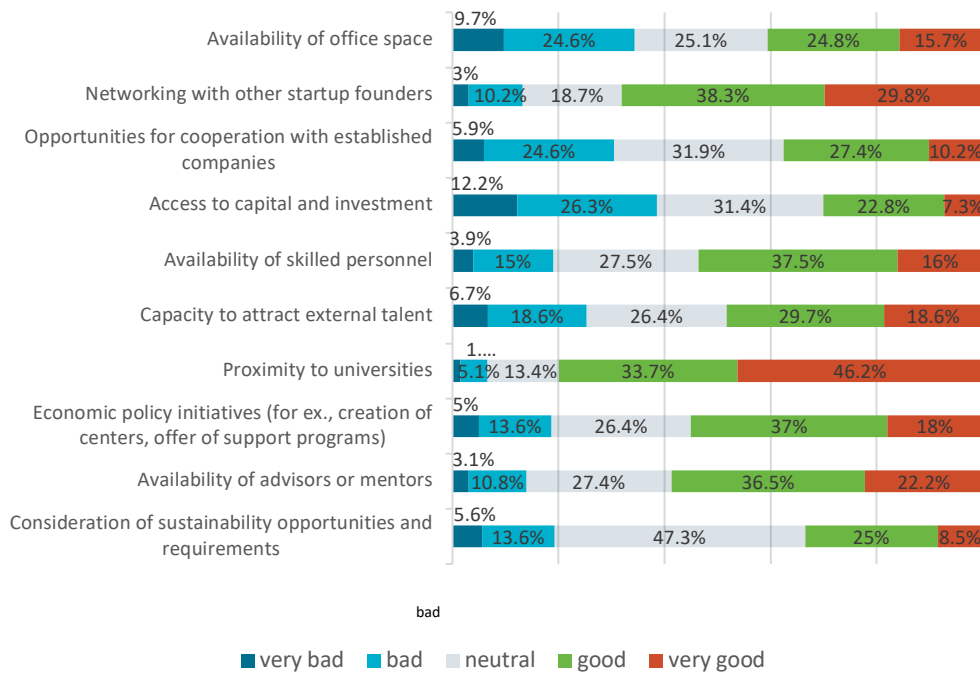
<sup>73</sup> Sometimes also called “FabLabs”.

<sup>74</sup> Company builders have a very similar function to that of accelerators and incubators. The company builders maintain tight collaboration with the startup and accompany it for 2-5 years. They contribute financial resources and expertise and often form a team of professionals to accompany the startup throughout the entire creation and growth process. Therefore, its right to intervene in the business is quite big.

<sup>75</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf) (reviewed on 16-12-2020), p.52-53

spaces (34.3%) are dimensions that the startups interviewed in the DSM<sup>76</sup> qualify more frequently as (very) poor.

Chart 7: Specific assessment of the ecosystem for entrepreneurship (2020)<sup>77</sup>



<sup>76</sup> ibidem, p.52.

<sup>77</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf), (reviewed on 22-12-2020), p. 53

## Infobox 2: Experiences of entrepreneurship in energy: The EnergyCortex GmbH case<sup>78</sup>

### Products and services sold by EnergyCortex:

The startup EnergyCortex, with office in Aquisgrán, was founded in 2018 by Mr. Bastian Baumgart and Christian Gerloff and offers a software solution as a web-based service to digitally assess energy consumption of the industrial clients and detect and automatically delete faulty data. As a result, the client can achieve important savings which could reach up to 15% of the energy costs and 85% of the manual processes.

### Motivation of the founder:

Before founding EnergyCortex, Bastian Baumgart worked for almost ten years at Trianel GmbH, a municipal service cooperation company to guarantee decentralized and nearby power supply to citizens and clients. The motivation to create his own company came from Baumgart's wish to develop and apply his own ideas and innovative solutions freely as well as supply digital tools to the industry and commerce.

### Current situation:

The pandemic makes EnergyCortex face great challenges: Its potential clients have changed their business priorities and because it has not incorporated new clients, EnergyCortex is facing cash flow problems. Moreover, trade shows have ceased to be an important instrument to capture new clients. Public funds and research programs are an important financial support tool, especially in this era, without which it would not exist anymore today, according to the founder.

### Finance:

EnergyCortex is a company derived from the University RWTH of Aquisgrán and has financed itself with public funds and research projects. In the beginning, it won the EXIST grant and later it resorted to other national and regional public funds. In this sense, the startup did not take the classic route via investors, but mainly used the public finance programs offered. With the company Freudenberg & Co. KG, EnergyCortex also managed to obtain a reputed strategic partner to support the startup and its product. Moreover, participating in contests became a marketing tool. EnergyCortex, for example, won the 2018 startup contest “*Digital Innovations*”.

### Main barriers:

The startup considers that the complex bureaucratic requirements and the conditions associated with finance programs are slow and sometimes contradictory and therefore pose significant barriers for the startup. The financial demands, the high interest rates and warranties are also conditions imposed by banks which require new companies to be greatly willing to take risks and which are sometimes difficult to meet. Additionally, research projects and, particularly, the high scientific standards associated to them, tend to be linked to difficult conditions to understand and meet for companies. In this case, mostly universities and research institutions themselves approach the startups and involve them in their projects. Nonetheless, Energy Cortex indicates the important role of support instances, such as business development agencies, to give consultancy to startups in terms of finance, suitable support programs and administrative issues.

### Fundamental elements for entrepreneurship:

Support system (contact network, advisory), public funds and tight collaboration with universities/research institutions.

## 4.2.4 Market

<sup>78</sup> Interview with Bastian Baumgart, founder and general manager of EnergyCortex GmbH, on 09.09.2020

The capacity of large companies to innovate is more and more related to their capacity to cooperate with startups. Frequently, startups develop new products or complementary services together with the established companies to satisfy the needs of the clients. In general, established companies are willing to commit to new technologies, products and services. In this sense, the *Global Entrepreneurship Monitor 2020* draws the conclusion that the German economy is characterized by being open to new technologies<sup>79</sup>.

This is reflected in the significant financial support companies give to R&D. The business sector represents two thirds of R&D expenditure in Germany. These funds are used for the companies' own R&D activities as well as joint R&D projects with partners from the industry and science<sup>80</sup>.

Nonetheless, there still are some obstacles in cooperation between startups and established companies. Almost a third of the startups in Germany considers that cooperation opportunities with companies are scarce, another third have a neutral attitude. However, more than one third indicates that there are good opportunities for cooperation, so there is no clear trend in this field (see also chart 5)<sup>81</sup>. Anyhow, a considerable number of startups has the perception that many companies are not sufficiently concerned with growth and development of the smallest partners. Therefore, large companies need to be more open to "open innovation" and learn to work side by side and under conditions of equality with the startups<sup>82</sup>.

Moreover, many startups have to face the so-called "valley of death" which refers to the interval between the startup receiving its initial capital and when it starts to generate turnover. The "valley of death" is due to different factors: The purchase of innovative products brings about uncertainty about its optimum functionality and durability. Startups do not have many references nor the same credit capacity as established companies, which makes collaboration in which the startup assumes the role of supplier difficult. The *Green Startup Monitor* highlights this challenge for startups that dedicate themselves to sustainability and environment protection<sup>83</sup>.

94% of the experts who participated in the survey conducted for this study consider that the existence of large and medium-sized companies with an innovative culture and that can be the first clients is (very) important to support the startups of the energy sector. However, 50% indicate that there would not be enough companies with these characteristics.

These results are in contrast with the conclusions of the *Global Entrepreneurship Monitor* and other studies that indicate the general willingness of medium-sized companies to cooperate with new suppliers<sup>84 85</sup>. One interpretation of this discrepancy in data could be that there are fewer opportunities for collaboration for cleantech startups or that at present there are no efficient mechanisms to join startups with companies interested in investing in innovative solutions.

According to the *Green Startup Monitor*, cleantech startups (n=243) pursue the following goals when entering into cooperation with an established company<sup>86</sup>:

1) 56% pursues the goal of complementing their technical knowledge;

<sup>79</sup> Sternberg, Rolf et al. (2020): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2019/2020*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20192020/>, p. 55.

<sup>80</sup> BMBF (2020): *Daten und Fakten zum deutschen Forschungs- und Innovationssystem. Bundesbericht Forschung und Innovation 2020*, [https://www.bmbf.de/upload\\_filestore/pub/Bufi\\_2020\\_Datenband.pdf](https://www.bmbf.de/upload_filestore/pub/Bufi_2020_Datenband.pdf), (reviewed on 16-12-2020), p. 9

<sup>81</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf), (reviewed on 16-12-2020), p. 52

<sup>82</sup> Accenture (2015): *Mehr Kooperationen wagen: Großunternehmen setzen auf Startups*, <https://www.accenture.com/at-de/company-news-release-dare-cooperation-focus-startups> (reviewed on 16-12-2020)

<sup>83</sup> Olteanu, Yasmin & Fichter, Klaus (2020): *Green Startup Monitor 2020*, <https://deutsche startups.org/wp-content/uploads/2020/04/Green-Startup-Monitor-2020.pdf> (reviewed on 16-12-2020), p. 55.

<sup>84</sup> Sternberg, Rolf et al. (2019): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2018/19*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20182019/> (reviewed on 16-12-2020), p. 55

<sup>85</sup> RKW Kompetenzzentrum (2018): *Mittelstand meets Startup - Potenziale der Zusammenarbeit*, <https://www.gruenderlexikon.de/news/content/media/doc/2018/05/20180529144031.pdf> (reviewed on 16-12-2020).

<sup>86</sup> Olteanu, Yasmin & Fichter, Klaus (2020): *Green Startup Monitor 2020*, <https://deutsche startups.org/wp-content/uploads/2020/04/Green-Startup-Monitor-2020.pdf> (reviewed on 16-12-2020), p. 43.



- 2) Cooperation offers new sales channels (51%) and client groups (41%);
- 3) For 34% the use of technical infrastructure is important.

Additionally, many cleantech startups seek to increase their financial resources. However, for the investment potential it is worth indicating that only a few German companies have invested important amounts in startups, among which some large corporations relevant for cleantech startups such as BASF, Bosch, Siemens, Evonik, Innogy and BMW. Another important investor and corporate accelerator for startups in the energy sector is E.ON:agile, which supplies up to ten projects per semester. Anyhow, large budgets over 100 million euros are still an exception. German companies tend to concentrate on research and development of internal products meant to improve the main business<sup>87 88</sup>.

#### 4.2.5 Culture

"Culture" generally refers to a system of share values, beliefs and standards of a society. Moreover, there is the expectation that members act in accordance with these common values and beliefs. A favorable and dynamic venture particularly includes a positive perception of innovative technologies, the willingness to take risks and the capacity to tolerate failure<sup>89</sup>.

Several studies indicate that entrepreneurship culture in Germany is characterized by a lack of taking risks and little tolerance of failure<sup>90 91 92</sup>. Founders who were unsuccessful with their venture are likely to be labeled as "failed" and have great difficulties to obtain capital in a future entrepreneurship project, while in other countries the experience acquired is valued and there is trust that an insolvent founder can be more successful in the second attempt because of what he learned<sup>93</sup>. The fear associated with creating a company is mainly caused by the consequences of a possible failure, such as high financial costs, which also affect private goods, personal deception and possible legal consequences and judicial procedures<sup>94</sup>.

The experts interviewed for this study confirm this. 90% indicate that there is no positive valuation of failure in entrepreneurship and 95% asserts that Germany lacks a culture that encourages to take risks (see chart 6).

However, there are many other factors that influence the entrepreneurship culture and the decision to create a company. To strengthen the entrepreneurship culture, measures are to be developed that show the opportunities of business activity to broad sectors of the population and, thus, wake a greater desire to enterprise<sup>95</sup>. Visibility of successful entrepreneurship cases can be an important instrument. 80% of the experts interviewed for this study consider that there are numerous technology and/or energy-based success cases. Entrepreneurship awards and contests contribute to their acknowledgement (see also the support dimension). The experts also agree that there is a positive valuation of ventures that emphasize sustainability (85%).

<sup>87</sup> Capital (2020): *Warum deutsche Konzerne in Startups investieren sollten*, <https://www.capital.de/wirtschaft-politik/warum-deutsche-konzerne-in-startups-investieren-sollten> (reviewed on 16-12-2020)

<sup>88</sup> RKW Kompetenzzentrum (2018): *Mittelstand meets Startup - Potenziale der Zusammenarbeit*, <https://www.gruenderlexikon.de/news/content/media/doc/2018/05/20180529144031.pdf> (reviewed on 16-12-2020)

<sup>89</sup> Sternberg, Rolf et al. (2020): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2019/2020*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20192020/> (reviewed on 16-12-2020), p. 52

<sup>90</sup> Technische Universität München (2019): *Die Rolle von Startups im Innovationssystem – Eine qualitativ-empirische Untersuchung*, [https://www.e-fi.de/fileadmin/Innovationsstudien\\_2019/StuDIS\\_12\\_2019.pdf](https://www.e-fi.de/fileadmin/Innovationsstudien_2019/StuDIS_12_2019.pdf) (reviewed on 16-12-2020)

<sup>91</sup> Röhl, Klaus-Heiner (2016): *Unternehmensgründungen: Mehr innovative Startups durch einen Kulturwandel für Entrepreneurship?*, IW Policy Paper, No. 2/2016, <https://www.econstor.eu/bitstream/10419/127448/1/847446247.pdf> (reviewed on 16-12-2020)

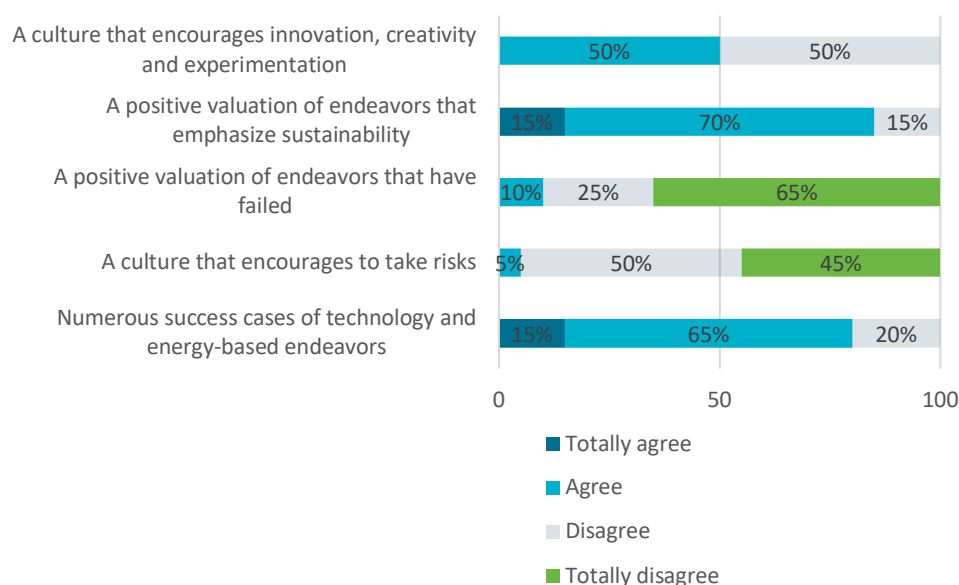
<sup>92</sup> Metzger, Georg (2019): *Gründungsstandort Deutschland: Angst vor dem Scheitern mit besserer ökonomischer Grundausbildung kontern*, KfW Research, Fokus Volkswirtschaft nr. 242, <https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-Fokus-Volkswirtschaft/Fokus-2019/Fokus-Nr.-242-Februar-2019-Gr%C3%BCndungsstandort-D-Angst-vor-dem-Scheitern.pdf> (reviewed on 16-12-2020).

<sup>93</sup> OECD (2013): *Entrepreneurship at a Glance 2013*, [https://www.oecd-ilibrary.org/docserver/entrepreneur\\_aag-2013-26-en.pdf?expires=1607232160&id=id&accname=guest&checksum=B4A31617443DE2CE0Co5D687CBo84CF6](https://www.oecd-ilibrary.org/docserver/entrepreneur_aag-2013-26-en.pdf?expires=1607232160&id=id&accname=guest&checksum=B4A31617443DE2CE0Co5D687CBo84CF6), reviewed on 16-12-2020). (reviewed on 16-12-2020)

<sup>94</sup> Metzger, Georg (2019): *Gründungsstandort Deutschland: Angst vor dem Scheitern mit besserer ökonomischer Grundausbildung kontern*, KfW Research, Fokus Volkswirtschaft nr. 242, <https://www.kfw.de/PDF/Download-Center/Konzernthemen/Research/PDF-Dokumente-Fokus-Volkswirtschaft/Fokus-2019/Fokus-Nr.-242-Februar-2019-Gr%C3%BCndungsstandort-D-Angst-vor-dem-Scheitern.pdf> (reviewed on 16-12-2020)

<sup>95</sup> Piegeler, Monika & Röhl, Klaus-Heiner (2015): *Gründungsförderung in Deutschland – Ein Aktionsplan gegen sinkende Gründerzahlen*, IW Policy Paper Nr. 17/2015, <https://www.econstor.eu/bitstream/10419/111686/1/828819823.pdf> (reviewed on 16-12-2020)

**Chart 8: Survey about entrepreneurship culture in Germany.**  
**In our country there is... (n=19)<sup>96</sup>**



Economic policy in German has taken up the task to promote the entrepreneurship culture. An example of this is the “Gründerwoche Deutschland” (entrepreneurship week), which invites hundreds of local and regional collaborators to attend conferences, workshops and the like about entrepreneurship. The “Gründerwoche” is part of the "Global Entrepreneurship Week", which nowadays is held in over 120 countries. However, these measures have a limited scope because they only reach those who are interested in enterprising<sup>97</sup>.

Therefore, it is appropriate to think of activities with a long-term perspective, such as the development of "entrepreneurship education" at schools and universities to start teaching knowledge and business thinking early. In this context, economy is being incorporated as a school subject more and more, which is considered an important milestone<sup>98</sup>. Moreover, it is recommended to strengthen innovation capacity by new education concepts that promote competencies to question existing solutions and develop new value propositions and business models, as well as a study plan to teach all university students basic digital skills<sup>99</sup>. A case of good practice is the national program “JUNIOR” of the BMWi that has been in place for 25 years and introduces students to entrepreneurship spirit. The idea is for students to develop an idea of business and create a student company in their school. Every year the best projects of the federated states are identified, and the best student company is given a national award.

Education in entrepreneurship can strengthen the personal perception about one's own capacity to enterprise. In 2019, 46% of the German population indicated that they had enough skills and experience to start a business (2018: 38.3%)<sup>100 101</sup>. A little more than 57% indicated that they had the creativity and capacity to turn ideas into

<sup>96</sup> Own preparation.

<sup>97</sup> Röhl, Klaus-Heiner (2016): *Unternehmensgründungen: Mehr innovative Startups durch einen Kulturwandel für Entrepreneurship?*, IW Policy Paper, nr. 2/2016, <https://www.econstor.eu/bitstream/10419/127448/1/847446247.pdf>, p. 28 (reviewed on 16-12-2020).

<sup>98</sup> Sternberg, Rolf et al. (2019): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2018/19*, file:///C:/Users/dkirschner/Downloads/20190417\_LF\_GEM\_online%20(2).pdf, p.72 (reviewed on 16-12-2020).

<sup>99</sup> Sternberg, Rolf et al. (2020): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2019/2020*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20192020>, (reviewed on 16-12-2020), p. 78

<sup>100</sup> Sternberg, Rolf et al. (2020): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2019/2020*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20192020> (reviewed on 16-12-2020), p. 40

<sup>101</sup> Sternberg, Rolf et al. (2019): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2018/19*, file:///C:/Users/dkirschner/Downloads/20190417\_LF\_GEM\_online%20(2).pdf, (reviewed on 16-12-2020), p. 34

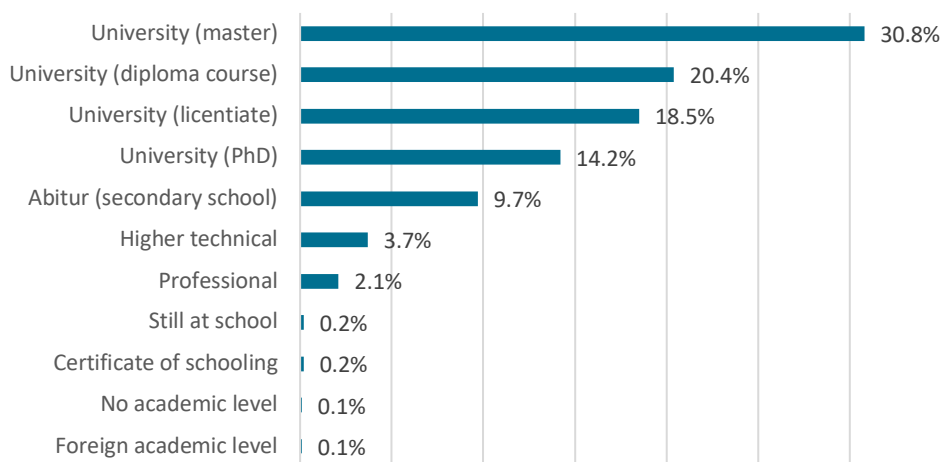
economic value. These attributes are more present in the population than technological knowledge. 26% of the interviewees rate their digital skills positively<sup>102</sup>.

In summary, it can be said that the culture still is a weak point in the entrepreneurship ecosystem in Germany.

#### 4.2.6 Human capital

The cleantech startups need a specific entrepreneur profile because of the high degree of innovation and technological orientation. Above all, the level of education is a relevant factor that must be taken into account and that cannot be compared to the profile of a conventional entrepreneur. Although a correlation between the level of education and entrepreneurship in Germany<sup>103</sup> cannot be verified, the results vary greatly if only the scenario of startups is analyzed: four out of five founders of a startup have an academic degree in Germany (83.9%), 14.2% have a PhD (see also graph 7)<sup>104</sup>. This difference is important to note and, in turn, requires specific consideration when analyzing the dimension of human capital within the entrepreneurship ecosystem for cleantech startups. In addition, it should be noted that startups created by people with higher education generally have a more relevant economic weight, are more financially sound, more successful and technologically more demanding. In this context, Germany stands out for its availability of skilled labor: 100% (n=19) of the respondents in this study indicate that Germany has a skilled workforce for technological innovation and for the promotion of entrepreneurship in the energy sector. At the same time, hiring highly specialized personnel also entails higher expenses, which highlights once again that cleantech startups are faced with a more complex financial situation. Today, hiring people in IT is a particular challenge for all startups<sup>105</sup>.

Chart 9: Highest academic level (2020)<sup>106</sup>



<sup>102</sup> Sternberg, Rolf et al. (2020): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2019/2020*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20192020> (reviewed on 16-12-2020), p.63-65

<sup>103</sup> ibidem, p.26.

<sup>104</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf) (reviewed on 16-12-2020), p. 33

<sup>105</sup> Olteanu, Yasmin & Fichter, Klaus (2018): *Green Startup Monitor 2018*, <https://www.borderstep.de/wp-content/uploads/2019/03/GreenStartupMonitor2018.pdf> (reviewed on 16-12-2020), p. 27

<sup>106</sup> Bundesverband Deutsche Startups e.V. (2020): *Deutscher Startup Monitor. Innovation statt Krise*, [https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm\\_2020.pdf](https://deutscherstartupmonitor.de/wp-content/uploads/2020/09/dsm_2020.pdf), p.34

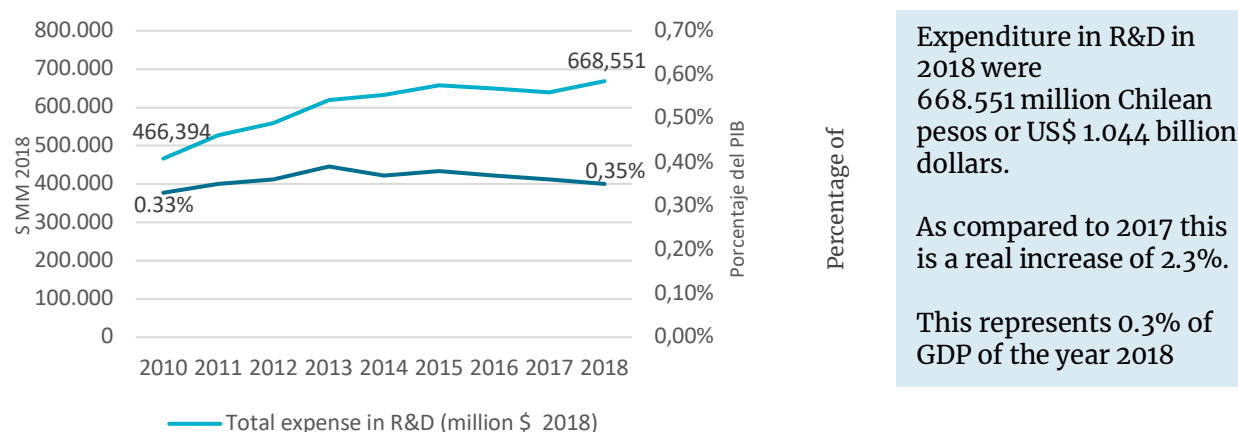
## 4.3 The entrepreneurship ecosystem in Chile

### 4.3.1 Public policy

According to the World Bank ranking, Chile belongs to the category of high-income countries with a GDP per capita at nominal prices of US\$14,896 in 2019<sup>107</sup>. The latest *Global Competitiveness Report 2019*<sup>108</sup> published by the *World Economic Forum* (WEF), which measures the competitiveness of countries, gives Chile the 33rd place among 137 countries that are part of the study, thus being the most competitive country in Latin America. On the other hand, this report places the Chilean economy in a state of transition between stage 2 of economic development, which is an 'efficiency-driven' economy, driven by improvements in the efficiency of production processes where, nonetheless, most of the technology is imported from developed countries and stage 3, which is an 'innovation-driven' economy, driven by innovation, sophisticated production processes and the ability to generate its own technology. However, when analyzing in detail Chile's performance in the different pillars of the index, the innovation indicator stands out, which is the lowest of all the pillars. In the innovation pillar, Chile ranks 52nd out of 137 countries with a score of 28.6 points out of 100 in its innovation capacity, revealing the gap Chile faces to become an 'innovation-driven' economy. This gap has also been increasing, if we consider that in 2003 Chile came to occupy the 28th place in the competitiveness ranking but that during the following years it was falling in that ranking<sup>109</sup>.

As for expenditure in R&D, we see that, in Chile, despite the fact that Law 20,570 was enacted in 2012 which establishes a tax incentive for private investment in research and development (R&D), this expenditure is still low, reaching only 0.35% of GDP in 2018, as shown in chart 7 extracted from the presentation of the Ministry of Science, Technology, Knowledge and Innovation (MICITEC) about the results of the 2020 R&D Survey<sup>110</sup>. This is a much smaller percentage, as it corresponds to what, according to the World Bank, is spent in countries classified as "low income" (those with per capita income below 1,036 dollars)<sup>111</sup>.

**Chart 10: Evolution of expenditure in R&D and the percentage GDP of 2010–2018, percentage and millions USD 2018** <sup>112</sup>



<sup>107</sup> World Bank (2020): *Chile*, <https://data.worldbank.org/country/chile> (reviewed on 10-12-2020)

<sup>108</sup> WEF (2019): *The Global Competitiveness Report 2019*, [http://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf) (reviewed on 10-12-2020), p. 13

<sup>109</sup> World Economic Forum (2004): *Global Competitiveness Report*, <https://www.almendron.com/blog/wp-content/images/2016/11/GLOBAL-COMPETITIVENESS-REPORT-2003-2004.pdf> (reviewed on 10-12-2020)

<sup>110</sup> Ministerio de Ciencia, Tecnología, Conocimiento e Innovación (2020): *Encuesta de I+D: Resultados año de referencia 2018 y mejoras a futuro*, [https://www.minciencia.gob.cl/sites/default/files/webinar\\_resultados\\_id\\_20200507.pdf](https://www.minciencia.gob.cl/sites/default/files/webinar_resultados_id_20200507.pdf) (reviewed on 10-12-2020)

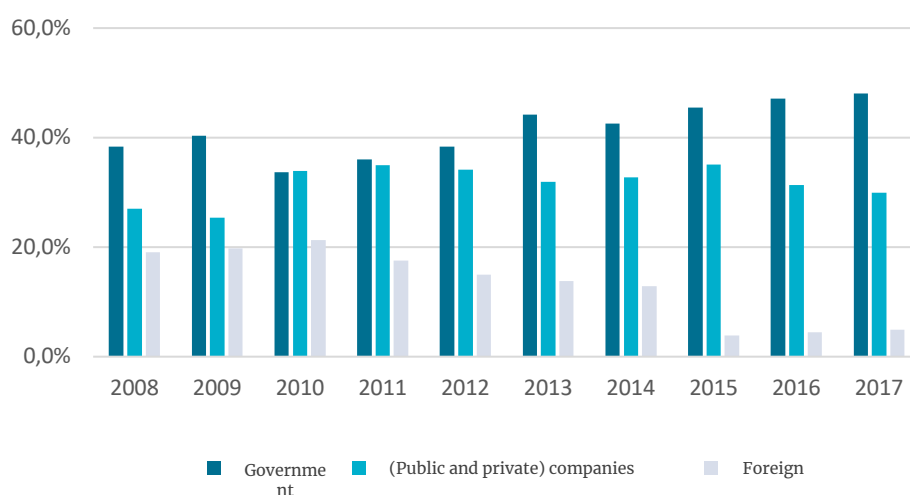
<sup>111</sup> The World Bank: *Research and Development Expenditure (% of GDP)*, <https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS> (reviewed on 10-12-2020)

<sup>112</sup> Ministerio de Ciencia, Tecnología, Conocimiento e Innovación (2020): *Encuesta de I+D: Resultados año de referencia 2018 y mejoras a futuro*, [https://www.minciencia.gob.cl/sites/default/files/webinar\\_resultados\\_id\\_20200507.pdf](https://www.minciencia.gob.cl/sites/default/files/webinar_resultados_id_20200507.pdf) (reviewed on 23-12-2020).

In recent decades, Chilean governments have promoted innovation and the valorization of knowledge by creating an Innovation Council for Competitiveness, as well as new funds for research and MICITEC in 2018. Recently, the Ministry of Science launched a competition to strengthen the development of institutional capacities for innovation based on research and development in higher education, under which 12 university projects are financed throughout the country<sup>113</sup>.

Since the beginning of the decade, about 50% of finance has come from the state (government), a value that increased slightly from 2014 to 2017. The relative importance of private enterprise, on the other hand, grew only in 2011 and 2012 and then dropped in 2017 by more than 10%, while foreign resources also fell considerably, as shown in Chart 9.

**Chart 11: Expenditure in R&D in % according to finance origin <sup>114</sup>**



In the survey of 22 experts (n=22) of the Chilean entrepreneurship ecosystem, in the political dimension it is revealed that a large majority of 84% consider that the most important element to promote entrepreneurship in energy is the existence of a uniform and consistent public strategy to promote the development of new ventures in this field, however, 64% of the people consulted consider that in Chile there is no such thing.

<sup>113</sup> Ministerio de Ciencia, Tecnología, Conocimiento e Innovación (2020): *InES adjudica fondos a 12 proyectos para que las universidades desarrollen innovación basada en I+D*, <https://www.minciencia.gob.cl/noticias/ines-adjudica-fondos-12-proyectos-para-que-las-universidades-desarrollen-innovacion-basada-en-id> (reviewed on 10-12-2020)

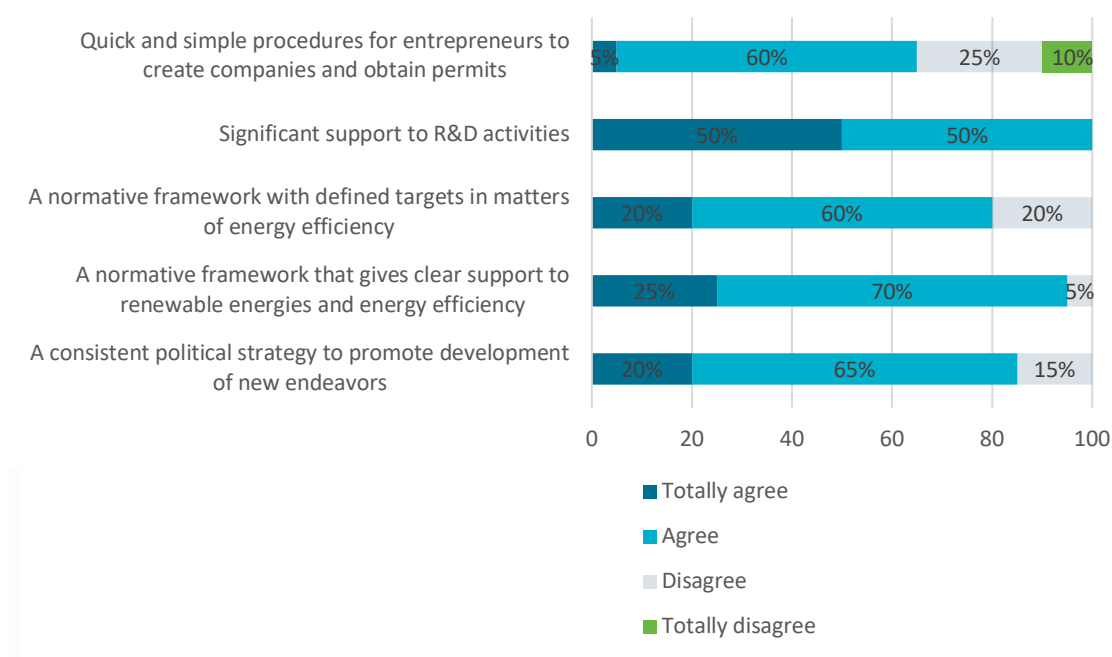
<sup>114</sup> Own preparation based on data published in the Red Iberoamericana de Indicadores de Ciencia y Tecnología (RICYT): *Gasto en I+D por sector de financiamiento*, en: [http://app.ricyt.org/ui/v3/bycountry.html?country=CL&subfamily=CTI\\_IMD&start\\_year=2009&end\\_year=2018](http://app.ricyt.org/ui/v3/bycountry.html?country=CL&subfamily=CTI_IMD&start_year=2009&end_year=2018) (reviewed on 24-12-2020).

**Table 4: Policy:** What importance do you give to each of the following elements to promote entrepreneurship in energy in Chile from the public policy field? 1 = more important; 4 = less important

	1	2	3	4	Total
A consistent political strategy to promote development of new ventures.	42.11%	42.11%	15.79%	0.00%	19
A normative framework that gives clear support to renewable energies and energy efficiency.	40.00%	25.00%	25.00%	10.00%	20
Significant support to R&D activities.	13.64%	22.73%	40.91%	22.73%	22
Quick and simple procedures for entrepreneurs to create companies and obtain permits.	4.55%	13.64%	18.18%	63.64%	22

### Existence of guidelines to develop innovation ventures and projects in energy.

In our country there are...



In the personal interviews held, we sought to identify the reasons that lead to the perception that was reflected in the results of the survey that there is no consistent public strategy, and it was identified that, in part, this is related to the fact that the Corporation for the Promotion of Production (CORFO), an institution under the Ministry of Economy, Promotion y Tourism, in charge of "improving competitiveness and productive diversification of the country, through the promotion of investment, innovation and entrepreneurship, and strengthening human capital and technological capacities"<sup>115</sup> as well as the InnovaChile Committee that seeks to turn Chile into a country driven by innovation, have gone through several restructurings in recent years. The latest institutional redesign dates from 2018 in which the offer of entrepreneurship and innovation programs was redesigned from 38 instruments to offer a set of 15 instruments, in addition to the R&D tax incentive and Startup Chile, accelerator of the Chilean government that promotes global technological

<sup>115</sup> Ministerio de Economía, Fomento y Turismo Informe de Gestión de CORFO (2019): *Corporación de Fomento de la Producción: Balance de Gestión Integral Año 2018*, <https://www.economia.gob.cl/wp-content/uploads/2019/03/3.-CORFO.pdf> (reviewed on 16-12-2020), p. 16

ventures<sup>116</sup>, and in the case of the InnovaChile Committee, an institutional redesign was carried out that also reduced the number of instruments, among other things<sup>117</sup>.

The support instruments that CORFO offers today, after the latest institutional restructuring, combine a range of instruments typical of an "efficiency-driven" economy, with different promotion instruments aimed at pushing the desired transition towards an "innovation-driven" economy:

In line with an economy based on efficiency, CORFO presents an offer of promotion instruments focused on facilitating trade flows and improving integration into global value chains through territorial<sup>118</sup> and strategic<sup>119</sup> programs, as well as trade cooperation programs between countries such as the collaboration program between Chile and Germany "Fit for Partnership" (supported by the BMWi)<sup>120</sup> aiming at improving the competitiveness of companies. At the same time, CORFO and the InnovaChile Committee offer promotion programs aimed at improving innovation capacity through public-private partnerships, human capital development and the promotion of entrepreneurship. According to the information collected in the interviews with the experts, a shortcoming detected in relation to the promotion of entrepreneurship is that the supports are concentrated mainly in the initial stage through early financing funds and programs such as Startup Chile, however, financing oriented towards the growth stage is scarce, where the challenges and amounts required are greater especially when we analyze technology-based startups.

Through the Technological Capabilities Management<sup>121</sup>, efforts are made to put together an infrastructure that facilitates collaboration between science, business and the State, seeking to strengthen the capacities of marketing and intellectual property management in the R&D+i ecosystem, to transfer new technologies to the national and international industry, in addition to promoting associative R&D+i programs. For this, it strives to develop the necessary infrastructure with laboratories and technological infrastructure within the framework of the Strategic Technological Programs.

In this context, the Management of Technological Capacities has promoted various initiatives to provide specific support to issues related to the energy transition: It held a tender for the Institute of Clean Technologies with the aim of creating a Technological Institute with physical capacities and human capital to develop research and development activities, technology transfer and innovation, specialized technological and technical assistance, technological diffusion or generation of research and information in support of regulation and public policies, in the areas of solar energy, low-emission mining and advanced lithium and other mineral materials. The resources for the financing of this Institute come from a contract that CORFO maintains with the company SQM for the extraction of lithium in the Salar de Atacama and that contemplates the financing of R&D activities<sup>122</sup>. Recently this tender was awarded to the Associated Universities Inc. (AUI) consortium.<sup>123</sup>

Along the same lines, the consortium led by the Universidad de Chile was recently awarded a tender for the implementation of a Center for the Development of Electromobility which will be aimed at contributing to accelerating the processes of adopting electromobility, through a focus on the problems, requirements and

<sup>116</sup> Startup Chile: <https://www.CORFO.cl/sites/cpp/convocatorias-startup-chile> (reviewed on 16-12-2020)

<sup>117</sup> Ministerio de Economía, Fomento y Turismo Informe de Gestión de CORFO (2019): *Corporación de Fomento de la Producción: Balance de Gestión Integral Año 2018*, <https://www.economia.gob.cl/wp-content/uploads/2019/03/3.-CORFO.pdf> (reviewed on 16-12-2020)

<sup>118</sup> The Strategic Programs (PE) seek to contribute to improving competitiveness of a sector and/or enabling platform by solving gaps and/or coordination failures between public and private agents.

<sup>119</sup> Integrated Territorial Program (PTI): is a territorial economic development proposal approaching the region from its production vocation and value chains. It aims at and focuses on competitively scaling these up and the impact on regional/local economies. Their design is based on the capacity to manage public and private resource leverage to implement a portfolio of investment initiatives for the promotion of production and enabling conditions.

<sup>120</sup> *Fit for Partnership* is a Training and Business Generation Program supporting a group of SMEs, microentrepreneurs and startups to concrete business deals with German companies. This program receives the support from the German Ministry of Economy and Energy (BMWi): [https://www.CORFO.cl/sites/cpp/convocatorias/programa\\_fit\\_for\\_partnership\\_with\\_germany\\_2020](https://www.CORFO.cl/sites/cpp/convocatorias/programa_fit_for_partnership_with_germany_2020)

<sup>121</sup> The Technological Capacity Management (GCT) facilitates and promotes business, scientific, government and civil society collaboration to deal with the great challenges of technological development.

<sup>122</sup> <https://investchile.gob.cl/CORFO-calls-specialized-lithium-producers-to-invest-in-chile-with-stable-supply-and-at-a-preferential-price/>

<sup>123</sup> CORFO: *CORFO adjudica Instituto de Tecnologías Limpias a Consorcio liderado por AUI, Asociación fundada por prestigiosas universidades*, en: [https://www.CORFO.cl/sites/Satellite?c=C\\_NoticiaNacional&cid=1476727520687&d=Touch&pagename=CORFOPortalPublico%2FC\\_NoticiaNacional%2FCORFODetalleNoticiaNacionalWeb](https://www.CORFO.cl/sites/Satellite?c=C_NoticiaNacional&cid=1476727520687&d=Touch&pagename=CORFOPortalPublico%2FC_NoticiaNacional%2FCORFODetalleNoticiaNacionalWeb) (reviewed on 23-02-2021)

particular solutions for its development and implementation. The financing for the implementation of this center comes from the resources granted to CORFO by the company Albemarle<sup>124</sup>.

This management also led the tender of two technological consortia that through R&D+i processes seek to develop solutions to use hydrogen as fuel in mining vehicles<sup>125</sup>.

Finally, through the Investment and Financing Management, CORFO strives to support the obtaining of financing through credit facilities and access to financing, in addition to promoting venture capital through specialized programs in this area. Venture capital outlays increased by almost 120% between January and December over the previous year. During 2018 CORFO disbursed 489 million UF<sup>126</sup> and in 2017 388 million UF (CORFO report). In addition, it strives to increase venture capital to facilitate innovation processes by promoting the creation of venture capital funds<sup>127</sup>.

When analyzing more specific supports in line with the sustainable energy development policy, the Investment and Financing Management has launched some Green Economy Programs, among which the CORFO-KfW Solar Program for the development of Concentrated Solar Energy (CSP) (Solar Credit for CSP projects) and the Green Credit that was launched in October 2018 to finance investments of projects for generation and storage of renewable energies, including self-supply projects, energy efficiency (EE) and environmental improvement measures in production processes<sup>128</sup>.

As a second most important element, the interviewed experts highlighted the existence of a regulatory framework that provides clear support for renewable energies and energy efficiency, which 65% of the experts considered very important or important. In relation to renewable energies, 77% considered that there is a clear framework and 55% that there is energy efficiency (see Table 4).

Regarding the energy policy in Chile, with the publication of the Energy 2050 Agenda, a clear planning has been formulated that initiated a public policy in this regard to transform the energy sector with clear goals to incorporate renewable energies and energy efficiency, among other things.<sup>129</sup> However, this was only published in 2015, so that, during the last years, these long-term goals have been translated into short and medium-term goals through the "Roadmaps" of each government and supported by the development of a favorable regulatory framework. In addition, with the commitment made by Chile in 2019 ahead of COP25 to achieve carbon neutrality by 2050<sup>130</sup> which the Decarbonization Plan presented that same year, the transition to a sustainable energy sector received a boost that even led to advance the fulfillment of certain goals. In addition, this was supported by Law No. 20,936, which amended the General Law on Electrical Services, article 83 of which embodied the obligation of the Ministry of Energy to develop a long-term energy planning process every five years for the different energy scenarios for expanding generation and consumption, in a horizon of at least thirty years, so that these scenarios are considered in the planning of power transmission systems carried out by the National Energy Commission (CNE), as indicated by the same Law<sup>131</sup>. With this, at the level of energy policy, not only is there a clear objective that facilitates accelerating the regulatory framework for a rapid incorporation of renewable energies in the matrix and promotion of energy efficiency (Energy Efficiency Law), but also is this accompanied by a planning process that facilitates identifying the crucial strategic areas to be developed to achieve the objectives of the energy transition.

<sup>124</sup> <https://www.induambiente.com/chile-tendra-su-primer-centro-para-el-desarrollo-de-la-electromovilidad>

<sup>125</sup> Revista Electricidad: *Dos consorcios probarán en Chile inédita tecnología: construirán motores a hidrógeno para la industria minera*, en: <https://www.revistaei.cl/2018/03/05/dos-consorcios-probaran-chile-inedita-tecnologia-construiran-motores-hidrogeno-la-industria-minera/#> (reviewed on 30-12-2020)

<sup>126</sup> MUF means Miles de Unidades de Fomento (Thousands of Unidades de Fomento). The Unidad de Fomento (UF) is a financial unit adjustable according to inflation.

<sup>127</sup> Ministerio de Economía, Fomento y Turismo Informe de Gestión de CORFO (2019): *Corporación de Fomento de la Producción: Balance de Gestión Integral Año 2018*, <https://www.economia.gob.cl/wp-content/uploads/2019/03/3.-CORFO.pdf> (reviewed on 16-12-2020), p.44

<sup>128</sup> Ministerio de Economía, Fomento y Turismo Informe de Gestión de CORFO (2019): *Corporación de Fomento de la Producción: Balance de Gestión Integral Año 2018*, <https://www.economia.gob.cl/wp-content/uploads/2019/03/3.-CORFO.pdf> (reviewed on 16-12-2020), p.44

<sup>129</sup> Ministerio de Energía (2015): *Energía 2050 Política Energética de Chile*, en: [https://energia.gob.cl/sites/default/files/energia\\_2050\\_-\\_politica\\_energetica\\_de\\_chile.pdf](https://energia.gob.cl/sites/default/files/energia_2050_-_politica_energetica_de_chile.pdf) (reviewed on 10-12-2020)

<sup>130</sup> Emol (2019): *Chile y su meta de ser "carbono neutral" en 2050: El ambicioso camino de los otros países que también se propusieron* <https://www.emol.com/noticias/Economia/2019/06/18/951626/Chile-y-su-meta-de-ser-carbono-neutral-El-ambicioso-camino-de-los-otros-paises-que-tambien-se-propusieron-serlo.html> (reviewed on 10-12-2020)

<sup>131</sup> Biblioteca del Congreso Nacional de Chile (2017): *Ley 20.936*, <https://www.bcn.cl/leychile/navegar?idNorma=1092695> (reviewed on 10-12-2020)



**Infobox 2: Experiences of entrepreneurship in energy: The case of the SolarBosch project<sup>132</sup>****Innovative proposal of SolarBosch:**

The company Enerbosch, dedicated to the construction of mini hydraulic power plants, in 2017 formed a team to lead the SolarBosch project. With this project they sought to develop a small-scale power solar concentrator that was of rapid construction, taking advantage of the high solar radiation in Chile and thinking about the PMGD market. For this, they wanted to test two innovations: Use air as a heat carrier fluid that reaches a higher temperature than molten salts and use copper slag to isolate the pond from the storage system.

**Motivation of the founding partners:**

Being able to do something that has an impact and using Chile's comparative advantages in terms of natural resources for renewable energy generation.

**Finance and support raised for the R&D project:**

In 2017, they applied for a CORFO Validation and Packaging fund that provided funding of up to 200,000,000 CLP. In 2018 they were awarded a technology contract with the Universidad de Chile and obtained an advisory with the DLR (German Aerospace Center) that was financed by the GIZ.

**Barriers in the process:**

With the finance obtained, the team managed to develop about 90% of the engineering and the most important components. However, due to the particularity of the technology that needed to concentrate many heliostats in a single point, to make a minimum viable product the amount required close to US\$ 1 million was very high. They applied to a high-tech CORFO fund that awards \$400 million and even though the project was technically approved, they were not awarded the fund because CORFO did not have a good track record of the company, given that the submission process of the first CORFO project that was awarded was very problematic.

Parallel to the CORFO application, the SolarBosch team had started looking for investors. They had several conversations with the venture capital fund Endurance, however, as the project was very risky and they were not awarded the CORFO fund, Endurance gave up investing in SolarBosch.

**Lessons and problems identified:**

The following lessons from the process of developing an R&D project were highlighted: On the one hand, they consider that it is very necessary to consider in the budget a person to handle the details of project submission with CORFO to avoid problems associated with financial submission. In the same way, this advice would be essential in the process of preparing the initial budget, because budgeting an innovation project based on an idea, is presented as something extremely difficult. On the other hand, definitely in this type of project, it is essential to start immediately with the effort to raise capital. For this, it is essential to have a good network of contacts that can make the link with investors abroad, since venture capital investment funds in Chile are rather conservative and it is unlikely to be able to raise the capital for this type of projects in Chile.

A problem described by SolarBosch is related to the fact that, according to its assessment, the counterpart in CORFO in charge of innovation projects, on the one hand, does not have greater knowledge about the energy sector and, furthermore, there is little flexibility in relation to the content changes that may occur in the case of an innovation project based on a series of hypotheses that may change as the project develops. That is why SolarBosch believes that it would be essential to have a counterpart that understands the energy issue as was the case of the CORFO Solar Committee.

**Current situation:**

When the CORFO fund was not awarded and the capital was not raised, the team abandoned the R&D process due to lack of funding to move forward.

<sup>132</sup> Interview with Andrés Bosch, SolarBosch chief of projects, on 04-09-2020

### 4.3.2 Support

According to the assessments of the experts interviewed in the framework of the 2019 Chilean National Report of Chile carried out by the Global Entrepreneurship Monitor (GEM) (report analyzing the general conditions of entrepreneurship, not only those focused on the development of startups), Chile has a very good physical infrastructure to undertake, that is, for entrepreneurs it is easy to access roads to mobilize and transport goods, in addition to having in almost the entire territory, communications and basic services such as water, electricity, gas, telephone and internet. In this dimension Chile occupies the 6th place among the 54 countries considered in the ranking<sup>133</sup>.

In the interviews conducted for this study with 26 representatives of the Chilean entrepreneurship ecosystem, the experts also concluded that Chile has a good offer of professional services that can provide support of legal, accounting and financial advice to the entrepreneur.

According to the working document "Ecosystem of i+e: incubators and accelerators" developed by Patricio Moya Muñoz under the wing of Open Beauchef, the Center for Entrepreneurship and Innovation of the Universidad de Chile, at national level CORFO recognizes 17 different incubators that can access funds to support entrepreneurship, of which 11 have some degree of connection with universities. The total number of companies or startups supported by all incubators in Chile in 2016 was at least 1,061 (considering companies already created and those that are still part of the portfolio of each organization). On the other hand, approximately 11.61 million USD were raised from private funds (many incubators do not provide this information, while others do not distinguish between public and private capital raised). The presence of seven accelerators was established, of which three have some kind of relationship with university institutions. In general, the amount of finance provided by the accelerators ranges from 10 million pesos to 60 million pesos and more than 1,200 enterprises have been supported. The services they offer are physical workspaces, mentoring networks, access to national and international networks and alliances, support in obtaining private capital, etc. It should be noted that in this group is Startup Chile, the business accelerator with state funds, which has a portfolio of ventures valued at 1.35 billion dollars by 2016<sup>134</sup>.

In relation to the national offer of incubators, accelerators and hubs with international networks as well as mentors with experience in energy issues, 60% of the experts who responded to the survey sent to identify quantitative indicators, indicated that in Chile there are mentors with technical experience and 64% believed that there is a good supply of incubators, hubs and accelerators with international networks. However, in the individual interviews with the entrepreneurs, three out of four indicated that they lacked mentors with experience in the energy business, in addition to being able to count on successful entrepreneurs with skills in the field that could support them with their experience in the sector<sup>135</sup>. In relation to incubators and accelerators, five were interviewed, of which two did not have an international network to facilitate their entrepreneurs' access to other markets, international contacts and access to finance opportunities abroad<sup>136</sup>.

In the framework of the individual interviews, three representatives of energy companies (Engie, COPEC and Enel) participated and found that, in the energy field today in Chile, the efforts of large companies to allocate corporate funds to set up incubators for managing their companies (company building) are rather limited, but some corporate venture capital funds have been created, an investment tool in which companies build a specific area to invest in startups (more details in dimension "financing")<sup>137</sup>: Engie, with Engie Factory at the time, built a startup incubator and accelerator, however, it was restructured and today it functions as a venture capital fund that invests in startups in the sector, but no longer provides the support of an incubator and

<sup>133</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 67

<sup>134</sup> Moya Muñoz, Patricio (2016): *Ecosistema de i+e: incubadoras y aceleradoras*, <https://www.openbeauchef.cl/wp-content/uploads/2016/12/Ecosistema-de-i-e-incubadoras-y-aceleradoras.pdf> (reviewed on 10-12-2020)

<sup>135</sup> Interviews with Daniel Santander, CEO y Fundador de *Wenu Work* el 11-08-2020; Andrés Bosch, Fundador de *Solarbosch* el 04-09-2020 y Pedro Pablo Silva, Gerente de Desarrollo y Fundador de *Efizity*, el 24-09-2020

<sup>136</sup> Interviews with Alejandra Parra, Environment Executive at *Magical Startups* on 31-07-2020; Sebastián Fernández Prat, Portfolio Analyst at *Chile Global Ventures* on 31-07-2020; Felipe Ñancupil, Acceleration Leader at *OpenBeauchef*; Javiera Aranceda, Corporate Network Executive at *Startup Chile* on 31-07-2020 and Gonzalo Yun, Manager *Endeavor Atacama* on 17-08-2020

<sup>137</sup> Interviews with Andrés Baehr, Investment Director Corporate Venture Capital at *Engie Factory* on 04-08-2020; Hernán Acuña, Manager *Enel Innovation Hub Chile* on 06-08-2020 and Maximiliano Valdés, New Energies Leader at *Wind Ventures de Copec* on 07-10-2020

accelerator<sup>138</sup>, the same does COPEC with its venture capital fund Wind Ventures<sup>139</sup>. However, Copec does provide incubator-type support through the Copec UC Foundation, which in 2014 inaugurated the UC Anacleto Angelini Innovation Center, a space open to all companies and enterprises, which encourages the creation of strategic alliances between public and private entities dedicated to research and development and disseminates scientific and technological advances in the area of natural resources. Annually, it holds the Regular R&D+i Contest, the R&D+i Contest for Young Researchers, and the Contest for Higher Education Students: 'Apply your idea', providing technical, commercial and financial support to various initiatives<sup>140</sup>. Enel, on the other hand, performs more of a scouting or exploration activity, in which it searches for possible innovative solutions in the market based on the company's internal needs.

The survey sought to identify, among others, the support elements required more specifically in the field of energy entrepreneurship. The experts who answered the survey highlighted as central elements: having a good infrastructure to carry out R&D and piloting activities, as well as an infrastructure for manufacturing.

**Table 5: Support:** What importance do you give to each of the following support elements to promote entrepreneurship in energy in Chile? 1 = more important; 4 = less important

	1	2	3	4	Total
Infrastructure to perform R&D+i activities and pilots	73.68%	26.32%	0.00%	0.00%	19
Manufacturing infrastructure	15.79%	42.11%	26.32%	15.79%	19
Incubators, accelerators, hubs, etc. with international networks	10.00%	25.00%	45.00%	20.00%	20
Mentors with technical experience	4.55%	4.55%	31.82%	59.09%	20

However, both elements were evaluated with an insufficient degree of existence in the country: In the case of infrastructure for R&D, 68% of the respondents considered that they totally disagreed or disagreed with the existence of an infrastructure in Chile facilitating energy entrepreneurship. As for manufacturing infrastructure, 96% of respondents strongly disagree or disagree with the existence of the infrastructure needed for manufacturing processes.

As described at the top in the "public policy" dimension of entrepreneurship ecosystem and energy in Chile, several of CORFO's funds and competitions as well as the Ministry of Science are aimed precisely at strengthening the infrastructure for R&D.

Another relevant element to analyze in the context of "supports" and that in literature on development of entrepreneurship ecosystems is mentioned as a fundamental element, is that at the center of a business ecosystem there is usually at least one, and usually several, 'large established companies', with important management functions (e.g., the head office or the division/subsidiary office) and that carry out research and development and production activities. These companies generally manage a high level of technology. Their role in the development of an entrepreneurship ecosystem, especially a technology-based entrepreneurship ecosystem, as is the case in the energy sector, is very significant: Firstly, they are 'talent magnets', who recruit a large number of skilled workers. Secondly, they provide business training to their employees and enable them to move up in the company hierarchy. Thirdly, they are a source of new business, as some of the staff retire to set up their own businesses. Fourthly, large companies located in more isolated, peripheral territories or territories lacking infrastructure play an important role in developing regional ecosystems, boost the pool of ecosystem management talents and offer business opportunities to local companies<sup>141</sup>.

<sup>138</sup> Website of Engie Factory: <https://engiefactory.com/>

<sup>139</sup> Website of Wind Ventures: <https://www.windventures.vc/>

<sup>140</sup> Website of Copec: <https://www.empresascopec.cl/innovacion/>

<sup>141</sup> Mason, Colin & Brown, Ross (2014): *Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship*,

[https://www.researchgate.net/publication/260870819\\_ENTREPRENEURIAL\\_ECOSYSTEMS\\_AND\\_GROWTH\\_ORIENTED\\_ENTREPRENEURSHIP](https://www.researchgate.net/publication/260870819_ENTREPRENEURIAL_ECOSYSTEMS_AND_GROWTH_ORIENTED_ENTREPRENEURSHIP)

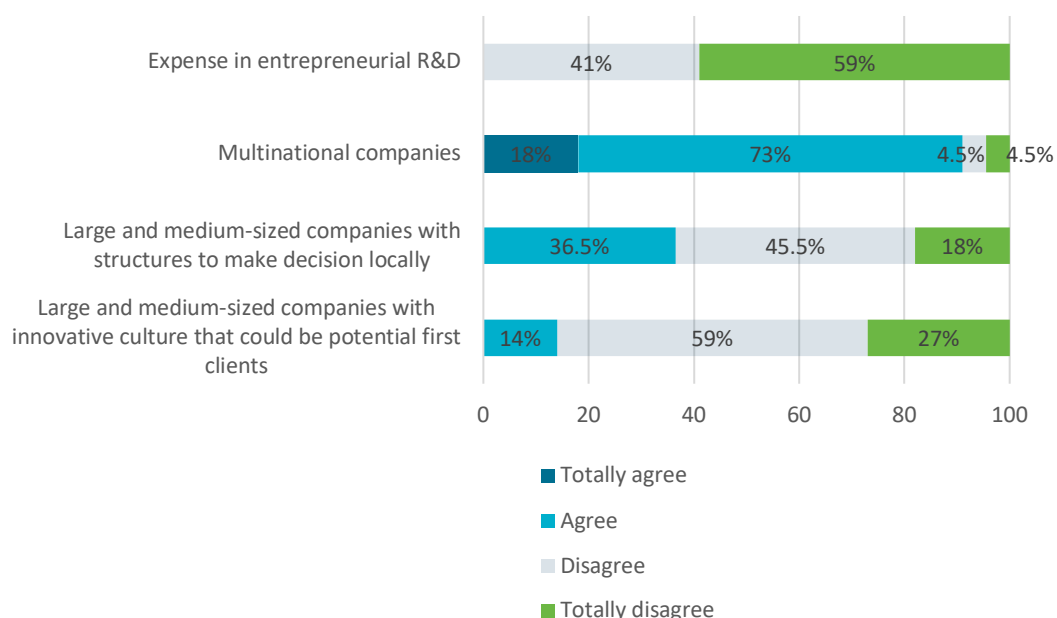
In Chile, the main economic sectors, which are very often located in more isolated or peripheral places, such as the mining and the agri-food industry, have functioned as a motor for the development of SMEs that are providers of technologies and services to the industry. These industries play an important role in the development of an entrepreneurship ecosystem. Especially mining has an interesting potential, due to the highly skilled personnel it attracts. In this context, different actors linked to the mining industry seek to facilitate technological innovation and therefore also technology-based ventures, in order to transform mining into a more proactive actor in terms of technological innovation. Since the end of 2018, in the Region of Antofagasta and with the support of CORFO, a network of mining pilotage centers has been implemented to promote and strengthen technological development for this sector in Chile, through pilot programs that allow the diagnosis of products under controlled conditions, reducing the risk of early adoption of technology and the cost of failure associated with a possible negative effect on industrial-scale productivity<sup>142</sup>.

### 4.3.3 Markets

One of the main obstacles identified in the "markets" dimension for energy entrepreneurship is the lack of innovative culture of companies in the country, which hinders the piloting processes of innovative technologies and services, as well as their sale.

As is also reflected in the results of the expert survey, the corporate culture, like that of the financial sector in Chile, demonstrates a risk aversion that is detrimental to incorporating innovations, especially if they also consider an intervention in production processes.

**Chart 12: Survey about the entrepreneurship market in Chile.**  
In our country there are... (n=22)<sup>143</sup>



[Background paper prepared for the workshop organised by the OECD LEED Programme and the Dutch Ministry of Economic Affairs on](#) (reviewed on 05-10-2020), p. 9

<sup>142</sup> Minería Chilena (2018): *CNP y Ciptemin: Nacen dos centros de pilotaje minero*, <https://www.mch.cl/reportajes/cnp-ciptemin-nacen-dos-centros-pilotaje-minero/> (reviewed on 10-12-2020)

<sup>143</sup> Own preparation.

The importance of large companies established as an actor for the promotion of entrepreneurship is given by a series of variables, of which Colin Mason and Ross Brown in their study "Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship" highlight three:

- a) Being a potential investor for ventures through corporate venture capital funds or an allocated budget to support ventures with technologies and services of interest to the company.
- b) Being the first customer for proofs of concept and open the international market by having headquarters in other countries.
- c) Attracting a large number of skilled workers who at some point may leave the company to start a business (it is also analyzed in dimension "Supports")<sup>144</sup>.

In the case of the Chilean market, the role of established large companies is even more important since, in view of the small size of the national market (17 million inhabitants), the development of B2B (business to business) solutions becomes very important.

In relation to the first variable (potential investor), in the energy sector, there are currently companies such as Engie, Colbún, Copec and Enel, among others, that have opted for corporate venture capital as a tool to invest in startups and thereby innovate in their portfolio of technologies and services related to the energy transition (Engie Factory, Copec Wind Ventures)<sup>145</sup>, the development of internal processes to be able to identify corporate innovation needs and go out in search of possible solutions in the market to provide support in terms of infrastructure and access to customers (ENEL)<sup>146</sup> or forthrightly the acquisition and integration of companies that complement the offer of products and services of the company (Colbún<sup>147</sup>). However, when analyzing the investments that have been realized (Efizity, IntiTech<sup>148</sup>), these were carried out at a more advanced stage of their development as companies (scale-ups).

As for the second variable (potential customers for proofs of concept and facilitating access to other markets), entrepreneurs in Chile face the obstacle of a rather conservative corporate culture as shown by the results of the survey of experts as well as the interviews conducted with entrepreneurs in the energy sector. In mining there are other factors that hinder the relationship with entrepreneurs: On the one hand, to be able to access a mining company to perform proofs of concept with that potential client, startups must have a series of certifications that they hardly have at that stage of business creation. This is something being strived to bring down with the piloting centers that are being promoted under CORFO wings. In addition, in the interviews conducted with entrepreneurs, another obstacle indicated was that, in many production companies, managers are reluctant to make changes in processes, either to incorporate a new technology, change a technology or intervene the process in some other way, because of the risk that this implies. In addition to this, they indicated that in mining there is a large turnover of managers in the management areas, so purchase decision processes are very often interrupted and the people in charge are likely to avoid decisions that could affect their own performance. In multinational companies, this is added to important decisions regarding technology acquisitions usually made at headquarters located outside Chile<sup>149</sup>.

Finally, to date, there is still a very small number of successful entrepreneurs in the energy sector in Chile, so there is no significant network of serial entrepreneurs in the sector who could function as investors, mentors and open international markets that they already managed to conquer with previous ventures or where they were currently located.

<sup>144</sup> Mason, Colin & Brown, Ross (2014): *Entrepreneurial Ecosystems and Growth Oriented Entrepreneurship*, [https://www.researchgate.net/publication/260870819\\_ENTREPRENEURIAL\\_ECOSYSTEMS\\_AND\\_GROWTH\\_ORIENTED\\_ENTREPRENEURSHIP\\_Background\\_paper\\_prepared\\_for\\_the\\_workshop\\_organised\\_by\\_the\\_OECD\\_LEED\\_Programme\\_and\\_the\\_Dutch\\_Ministry\\_of\\_Economic\\_Affairs\\_on](https://www.researchgate.net/publication/260870819_ENTREPRENEURIAL_ECOSYSTEMS_AND_GROWTH_ORIENTED_ENTREPRENEURSHIP_Background_paper_prepared_for_the_workshop_organised_by_the_OECD_LEED_Programme_and_the_Dutch_Ministry_of_Economic_Affairs_on) (reviewed on 05-10-2020), p. 10

<sup>145</sup> Website of Engie Factory: <https://engiefactory.com/> and website of Wind Ventures: <https://www.windventures.vc/>

<sup>146</sup> Website of Enel Innovation Hub: <https://www.enel.cl/en/sustainability/innovacion/innovation-hub.html>

<sup>147</sup> Trade Digital News (2020): *Colbún adquiere Efizity en busca de potenciar su oferta*, <https://trade-news.cl/2020/09/07/colbun-adquiere-efizity-en-busca-de-potenciar-su-oferta/> (reviewed on 05-10-2020)

<sup>148</sup> Lex Latin (2019): *La startup chilena Inti-Tech recibe inyección de capital*, <https://lexlatin.com/noticias/startup-chilena-inti-tech-recibe-inyeccion-capital> (reviewed on 05-10-2020)

<sup>149</sup> Interviews with Daniel Santander, CEO and founder of *Wenu Work* on 11-08-2020; Andrés Bosch, Founder of *Solarbosch* on 04-09-2020 and Pedro Pablo Silva, Development Manager and founder of *Efizity*, on 24-09-2020

**Infobox 3: Experiences of entrepreneurship in energy: The Solcor case<sup>150</sup>****Products and services sold by Solcor:**

Solcor is a company formed in 2014 by two Belgian entrepreneurs, who began to establish themselves in Chile with the aim of offering photovoltaic solutions under the Net Billing Law with an ESCO (Energy Service Company) model. Today, it is already a holding company that employs about 80 people. The Solcor group is composed of the following companies: a distribution company of several equipment brands of photovoltaic installations that imports materials and sells them to the market of small installers, the initial company "Solcor" that develops and installs projects under the law of Net Billing and PMGD, the company Delta Activos dedicated to the services of Operation and Maintenance of plants, they have an investment fund called S-Invest and, finally, the company Nikola that is dedicated to smaller installations in houses.

**Motivation of the founding partners:**

Contributing to sustainable development.

**Current situation:**

The companies of the Solcor group continue to grow strongly and are beginning to integrate new business areas, such as electromobility.

**Key to maintain a company and make it grow:**

A key that Solcor highlights was to have innovated in the business model proposed to customers in Chile, arriving with a value proposition that considered being able to offer solutions according to the ESCO model, that is, in investing in photovoltaic projects. For this, they used their network of contacts in Belgium by creating their own investment fund that facilitated the process of obtaining capital for the projects and also initially gave them flexibility to be able to carry out business, in a flexible and fast manner.

The other key that they highlight is to carry out a work of excellence so that all customers are satisfied and recommend the company. In this respect, the network of contacts they were able to generate under CORFO's wing was fundamental, managing to reach out through CORFO's contacts to potential customers through regional farmers' associations.

Finally, for the growth process it was essential to identify business opportunities that allowed them to vertically integrate much of the value chain of a photovoltaic project. In relation to human capital in Chile, its good quality stands out.

**Barriers:**

When they started with the company, the Net Billing Law had just been passed and the processing process was very difficult as it was not yet digitalized and customers mistrusted energy distributors. However, these barriers are no longer relevant.

They recognize that, for other companies, which do not have access to a good network of contacts similar to the one they had built in Belgium, finance is a stumbling point and hinders the development of the business.

**Advice:**

Understand which link in the value chain you position yourself at and keep expenses to a minimum. Do the job well with good-quality facilities and good post-sales service.

<sup>150</sup> Interview with Alexander Decock, founder of Solcor, on 18-02-2021

#### 4.3.4 Finance

For a startup in Chile, finance through bank loans is not feasible due to the lack of seniority as a company. Specifically in the case of energy entrepreneurship, many times they are ventures with technological innovations (hardware), so for the development of their innovation they require high amounts of finance added to the long periods of development of the final product, which often means results in terms of amortization or payback are not seen before the fifth year. In addition, currently even in more advanced stages of the development of their business, companies with technological innovations or business models in the energy field face bank executives lacking knowledge to evaluate their projects.

However, in 2017, Banco Estado began to develop financial products to support the achievement of the country's generation goals with renewable energies, launching the first credit for renewable energy projects for SMEs<sup>151</sup> <sup>152</sup>. Currently, it has added other credit offers such as the Green Credit to finance thermal insulation projects, solar energy and air conditioning and efficient ventilation for natural entities<sup>153</sup>. Along the same lines, Banco Santander has launched "Santander Verde" announcing a mortgage loan at a preferential rate for sustainable housing<sup>154</sup>. Added to this is CORFO's Green Credit, with which companies can finance long-term loans granted by financial bank or non-bank intermediaries to companies requiring finance for their NCRE generation or storage projects, energy efficiency and environmental improvements in production processes such as, for example, the reuse of waste and recycling.

Although this type of credit is not focused on companies in the startup phase, they have an important benefit for energy ventures by supporting the development of the energy efficiency and renewable energy market, which increases the demand for products and services developed by entrepreneurs.<sup>155</sup>

According to the data published in the GEM 2019, the dimension of 'financial support' is the worst evaluated of the dimensions of the entrepreneurship ecosystem in Chile by the experts surveyed for the GEM<sup>156</sup>. There is a consensus about there being sufficient supply of public subsidies especially for the stages of early financing articulated mainly through CORFO (see analysis of dimension "Policy"), however, the lack of private finance opportunities to support the processes of business growth is identified as a great shortcoming.

<sup>151</sup> ACESOL (2017): *Banco Estado lanza oficialmente su crédito de ENRC a pymes con tasa especial*, <https://acesol.cl/noticias/item/1265-banco-estado-lanza-oficialmente-su-cr%C3%A9dito-de-enrc-a-pymes-con-tasa-especial.html> (reviewed on 05-10-2020)

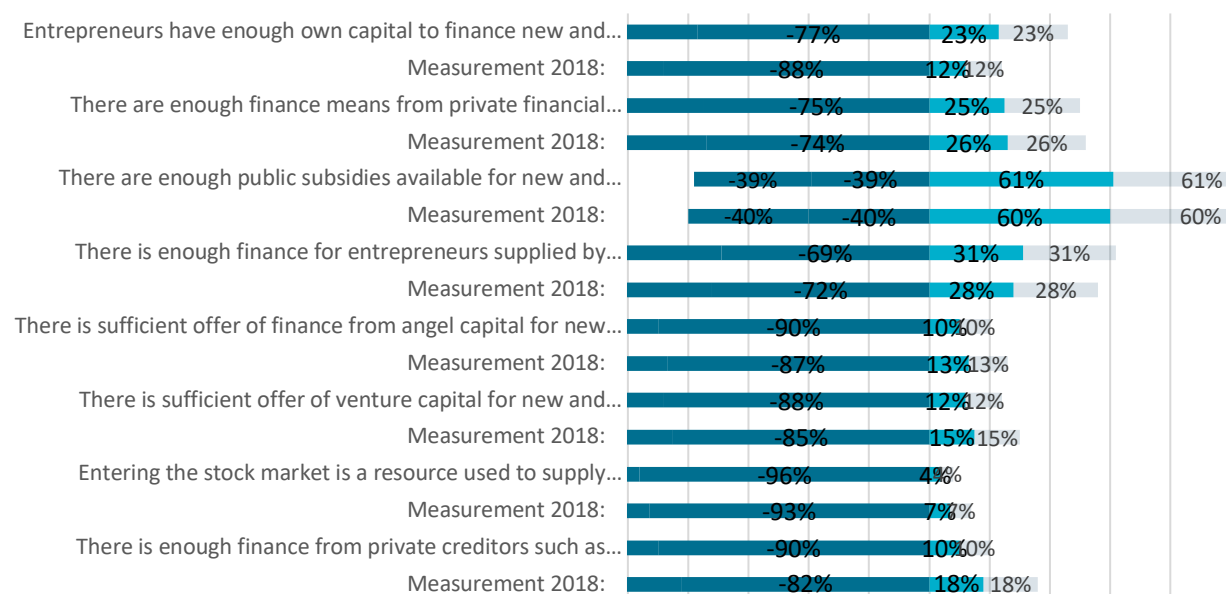
<sup>152</sup> BancoEstado (2017): *Financiamiento Proyectos Eficiencia Energética*, <https://www.bancoestado.cl/imagenes/pequenas-empresas/productos/financiamiento/proyectos-eficiencia-energetica.asp> (reviewed on 05-10-2020)

<sup>153</sup> BancoEstado (2017): *Nuevo crédito verde*, <https://www.bancoestado.cl/imagenes/campanas/credito-verde/index.asp> (reviewed on 05-10-2020)

<sup>154</sup> Bio Bio Chile (2020): *Santander lanza inédito crédito hipotecario para viviendas sustentables y con tasa preferencial*, <https://www.biobiochile.cl/especial/aqui-tierra/noticias/2020/11/19/santander-lanza-inedito-credito-hipotecario-para-viviendas-sustentables-y-con-tasa-preferencial.shtml> (reviewed on 05-10-2020)

<sup>155</sup> Ministerio del Medio Ambiente: "Verdazo": *BancoEstado presenta estrategia verde con histórica tasa de 1,79% en créditos hipotecarios para proyectos sustentables*; <https://mma.gob.cl/verdazo-bancoestado-presenta-estrategia-verde-con-historica-tasa-de-179-en-creditos-hipotecarios-para-proyectos-sustentables/> (reviewed on 25-02-2021)

<sup>156</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 58

Chart 13: Financial support – Chile <sup>157</sup>


When analyzing the reduced national expenditure in R&D (see dimension "Public Policy") which in 2018 was 1,044 million dollars and comparing the amounts available in the framework of the innovation contest in CORFO, where, in general, for the development of innovation prototypes or for validation and packaging of innovations there are between 25 and 200 million CLP per project<sup>158 159</sup>, with the amounts available in innovation competitions in Germany or in Europe<sup>160</sup>, access to adequate financing for the amounts required by startups developing hardware is still limited.

As for venture capital, around 50 venture capital funds currently operate in Chile<sup>161</sup>. From the answers received in the interviews conducted for this study, it was concluded that they have a rather conservative culture, so the name "venture capital" is not necessarily representative of the type of investments CORFO makes<sup>162</sup> through the Investment and Financing Management aiming at boosting the venture capital industry through programs focused on creating venture capital funds and other investment funds, granting loans at a very low rate to promote the development of venture capital investment funds, focused on Chilean companies that are in the early stages of development and present a potential for growth and innovation in technology-related sectors<sup>163</sup>.

<sup>157</sup>Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 66.

<sup>158</sup> CORFO (2017): *Validación y Empaquetamiento de Innovaciones - i+D Empresarial para sectores estratégicos*, [https://www.CORFO.cl/sites/cpp/convocatorias/inv-2017\\_validacion\\_y\\_empaquetamiento\\_de\\_innovaciones\\_-\\_i%20i%20d\\_em?resolvetemplatefordevice=true](https://www.CORFO.cl/sites/cpp/convocatorias/inv-2017_validacion_y_empaquetamiento_de_innovaciones_-_i%20i%20d_em?resolvetemplatefordevice=true) (reviewed on 10-12-2020)

<sup>159</sup> CORFO (2020): *Crea y Valida*, [https://www.CORFO.cl/sites/cpp/convocatorias/crea\\_y\\_valida;jsessionid=oHQfHod7HDAQ9R2017sWKwBoW\\_HZYM1Ku\\_mp\\_TEEpIoJYb3WQRc!99420333!-1920157562](https://www.CORFO.cl/sites/cpp/convocatorias/crea_y_valida;jsessionid=oHQfHod7HDAQ9R2017sWKwBoW_HZYM1Ku_mp_TEEpIoJYb3WQRc!99420333!-1920157562) (reviewed on 10-12-2020)

<sup>160</sup>Fondo de Innovación Unión Europea: <https://ec.europa.eu/inea/en/innovation-fund>

<sup>161</sup> Corporación de Fomento de la Producción (CORFO) (2018): *Informe Público de Capital de Riesgo*, p. 5

<sup>162</sup> Interviews with, among others, Eduardo Bitrán, academician of the Universidad Adolfo Ibáñez and vice-president of CORFO from 2014 to 2018, on 04.09.2020, Daniel Santander, CEO and founder of [Wenu Work](#) on 11-08-2020; Andrés Bosch, founder of [Solarbosch](#) on 04-09-2020 and Pedro Pablo Silva, Development manager and founder of [Efizity](#), el 24-09-2020

<sup>163</sup> CORFO (2020): *Inversión y Financiamiento*, [https://www.CORFO.cl/sites/Satellite?c=C\\_LineaDeApoyo&cid=1456407918101&d=Touch&pagename=CORFOPortalPublico%2FC\\_LineaDeApoyo%2FCORFOLineaDeApoyoInteriorGIFWebLayout](https://www.CORFO.cl/sites/Satellite?c=C_LineaDeApoyo&cid=1456407918101&d=Touch&pagename=CORFOPortalPublico%2FC_LineaDeApoyo%2FCORFOLineaDeApoyoInteriorGIFWebLayout) (reviewed on 10-12-2020)



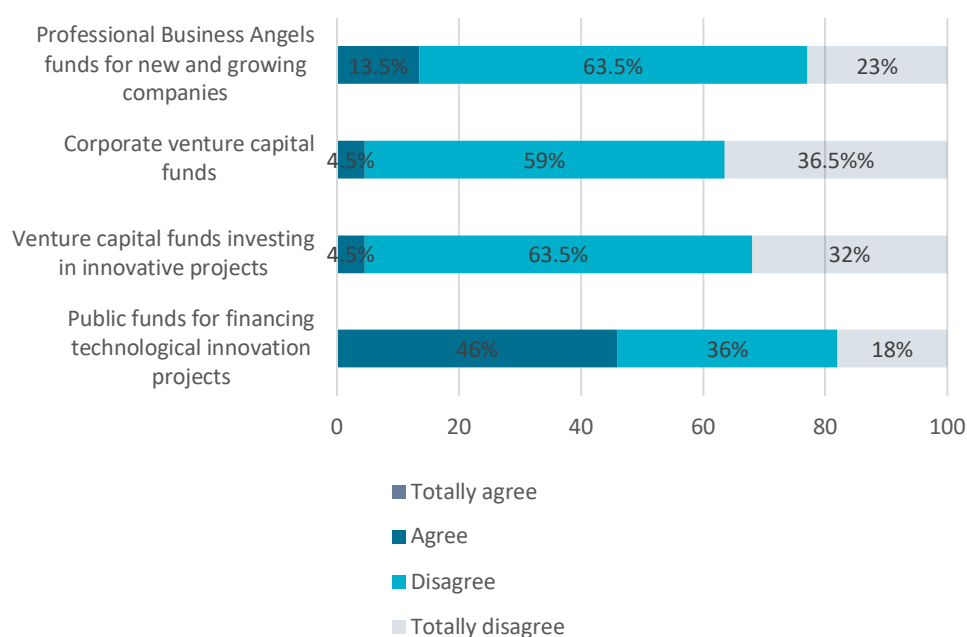
Table 6: CORFO Venture Capital Programs<sup>164</sup>

EARLY-STAGE FUND		DEVELOPMENT AND GROWTH FUND	
GOAL		GOAL	
The Program is intended to encourage the creation of investment funds that allow the financing and development of Chilean small and medium-sized enterprises that are in the early stages and present a potential for growth and innovation.		The Program is intended to encourage the creation of investment funds that allow the financing and development of Chilean small and medium-sized enterprises with high growth potential, and that are in stages of expansion.	
CHARACTERISTICS		CHARACTERISTICS	
CORFO credit line	Minimum size of UF 50,000 and maximum UF 350,000	CORFO credit line	Minimum size of UF 100,000 and maximum UF 550,000
Debt-capital ratio	Up to 2:1 with a potential premium of up to 3:1	Debt-capital ratio	Up to 1:1 with a potential premium of up to 1.5:1
Optional increase or reduction	Credit line can be increased or reduced by 25%	Optional increase or reduction	Credit line can be increased or reduced by 25%
Maximum potential of the fund	US\$ 40 million approximately	Maximum potential of the fund	US\$ 80 million approximately
Interest rate	BCU <sup>a</sup> at 10 years (-2,55%) (UF <sup>b</sup> + 2%) contingent	Interest rate	BCU <sup>a</sup> at 10 years (-2,55%) (UF <sup>b</sup> + 2%) contingent
Beneficiaries	Companies with maximum initial equity of UF 50,000	Beneficiaries	Companies with maximum initial equity of UF 200,000
Potential CORFO budget to assign	US\$ 80 million (approximately 6 funds)	Potential CORFO budget to assign	US\$ 120 million (approximately 4 funds)
TARGET COMPANIES		TARGET COMPANIES	
Companies with commercial, technological or process uncertainty but with high growth potential.		Companies where commercial and technological uncertainty has been relatively solved and which, given their future development, show potential to expand.	

<sup>164</sup> Graphics from the information brochure about the [Programa de Capital de Riesgo de CORFO](#)

However, despite this, the experts interviewed this study reveal exactly the same perception described in the GEM 2019: The vast majority strongly disagree or disagree with the existence in Chile of sufficient venture capital funds to invest in innovative projects, angel investors for new and growing companies, and corporate venture capital funds (see chart 12).

**Chart 14: Survey about finance for entrepreneurship in Chile.**  
In our country there are...<sup>165</sup>



However, recently there has been a significant increase in corporate venturing instruments, in the form of company building, an instrument in which companies develop an area with the aim of attracting entrepreneurial talent and founding their own startups and corporate venture capital (CVC), an investment tool in which companies develop a specific area to invest in startups. In the energy field, examples of CVC are Copec, which in 2019 created a fund with the name Wind Ventures to invest in technologies and services that help the company to play an important role in decarbonization, decentralization and digitalization of the energy market, as well as new trends in mobility technologies. To date, it has invested in nine startups in different countries, including Chile, in energy storage, energy efficiency and electric vehicle charging with an investment range usually between US\$1 million and US\$10 million<sup>166</sup>.

Another example of CVC is Engie, which, with Engie Factory maintains a venture capital fund to invest in startups with technologies and services of interest. This is how, together with Alaya Capital Partners and Albi Investments, they invested in the Chilean startup Inti Tech, whose founder was also interviewed for this study<sup>167</sup>.

<sup>165</sup> Own preparation.

<sup>166</sup> El Mercurio (28-12-2020): Crece interés de grandes empresas por invertir en startups y varias ya levantan sus propios fondos:

<https://www.windgarage.cl/noticias/crece-interes-de-grandes-empresas-por-invertir-en-startups-y-varias-ya-levantan-sus-propios-fondos-el-mercurio/> (reviewed on 30-12-2020)

<sup>167</sup> <https://lavca.org/2019/11/19/engie-factory-alaya-capital-partners-and-albi-investments-leads-investment-in-inti-tech/>

**Infobox 4: Experiences of entrepreneurship in energy: The case of C&E Consulting and Energy<sup>168</sup>****Products and services sold by C&E:**

C&E is a company that was born in 2012 and specializes in the development of NCRE projects, taking energy projects to the construction stage, connecting project developers and investors, in addition to consulting necessary services before the construction stage, ranging from the financial area, environmental and legal processing. In 2014, C&E created an innovation area in response to a reduced availability of financing for energy projects due to low energy prices. The area focuses on developing new technological products for energy, agriculture and mining taking into consideration circular economy principles, looking to create spin-offs that can commercialize these products. They are currently focused on developing by-products associated with rice husk, which is currently a difficult waste generated in rice production. They contemplate:

- Implementing a biomass plant "La Gloria" for 45,000 ton/year of rice husk that would generate 3.4MW.
- Creating SIP panels with rice husk as insulation material.
- Using ashes from burning rice husk to produce and aerogel and conditioner for farming soils.
- Using ashes from burning rice husk to develop silicon to be used in photovoltaic panels and lithium batteries.

**Motivation of the founding partners:**

Promoting technological innovations based on the energy revaluation of industrial and household waste to develop more efficient, sustainable and economic by-products that contribute to the development of a circular economy.

**Current situation:**

They have product developments at the prototype level of small-scale laboratory and need to raise funding to pilot each product and get to industrialize the solutions.

The biomass project "La Gloria" has obtained finance, the construction of the boilers has already begun and it is expected to enter into operation in March 2022.

**Finance:**

C&E has extensive experience in raising capital and has managed to sustain its operations and developments as follows: Own financing from other commercial activities of the company, CORFO subsidies for R&D (Prototyping), Japanese government subsidy for carbon credits for the biomass plant "La Gloria", raising capital with private investors and obtaining bank credit.

**Main barriers:**

They consider difficult and scarce access to financing as the main barrier for the development of startups in energy. In relation to subsidies, they consider that CORFO has funds available for the prototype development stages, however, the subsidies available are relatively few, so the probability of being awarded these funds is low. Nonetheless, for the stages after prototyping, that is, piloting and then industrializing the solution, there are no subsidies, but only the option of a pro-investment guarantee to request bank financing. C&E's experience with Banco Estado, however, was that, despite the CORFO guarantee for the investment necessary for the biomass plant "La Gloria", the Bank requested a guarantee because the CORFO guarantee is not enforceable by all the fine print. C&E finally got a Chilean investor who made its guarantees available, however, Banco Estado again rejected the loan due to the executives not being able to assess the risk well. Today, C&E obtained a loan with Banco Santander with the CORFO guarantee, but in any case, this bank also requested a guarantee that was finally managed by the investors C&E attracted. For the "La Gloria" project, C&E also obtained a grant from the Japanese government managed through the suppliers of some of the technology needed for the plant.

<sup>168</sup> Interview with Guido Riega, founder of C&E, on 11-02-2021

From its experience in obtaining capital with venture capital funds, C&E highlights their aversion to risk, because they are not willing to finance projects in the piloting phase and that, if they do, their contracts are very predatory and demand a disproportionate percentage of participation in the company and seek to have very high returns.

**Fundamental elements for entrepreneurship:**

The contact network.

### 4.3.5 Culture

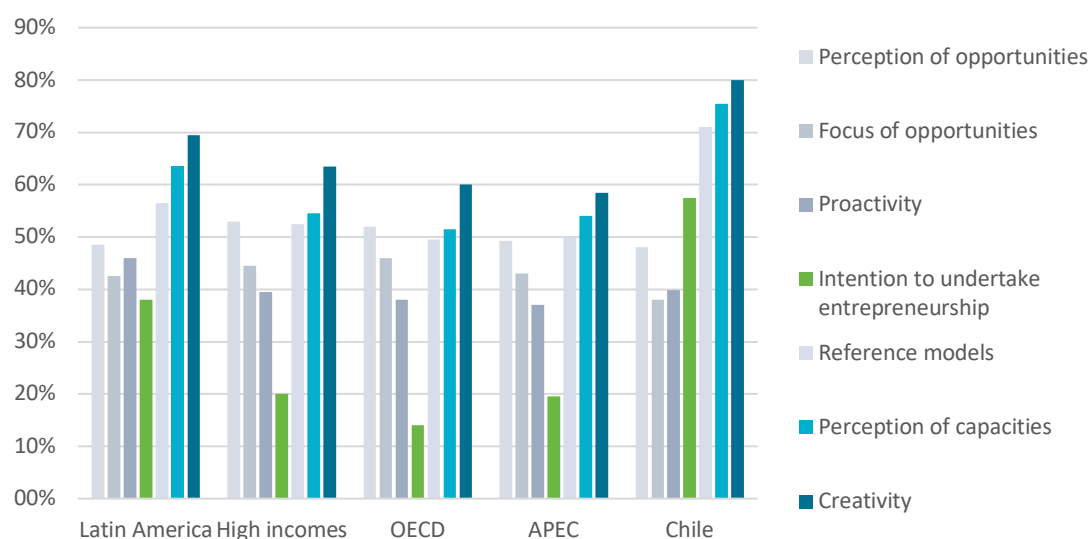
The word culture embraces all the values, manifestations of social habits, work practices, professional and business organizations of a society. The entrepreneurial culture is one that motivates new or old entrepreneurs and innovators to join the economy through their own business. The decision to start a new business is the product of attitudes, perceptions and intentions, established within a social, cultural and political context that could support or limit that decision. To be successful, the entrepreneur must rely on a wide range of stakeholders, including investors and employees, suppliers and customers, as well as the support of family and friends.<sup>169</sup>

When analyzing the data collected by the GEM 2019, within the Latin American context, Chile stands out in terms of entrepreneurial culture: 58% of the Chilean non-entrepreneurial population has expressed its intention to carry out an entrepreneurial initiative in the next three years, a trend that has been steadily increasing during the studies within the framework of the GEM and that may be related to the favorable perception of the attributes to entrepreneurship such as creativity (80%), the skills and knowledge needed to undertake entrepreneurship (76%), and having reference models of people who have recently done so (71%)<sup>170</sup>.

<sup>169</sup> Proaño, Luis Fernando (2014): *La Cultura del Emprendimiento y su Formación*; Universidad Católica de Santiago de Guayaquil, Ecuador (reviewed on 20-12-2020)

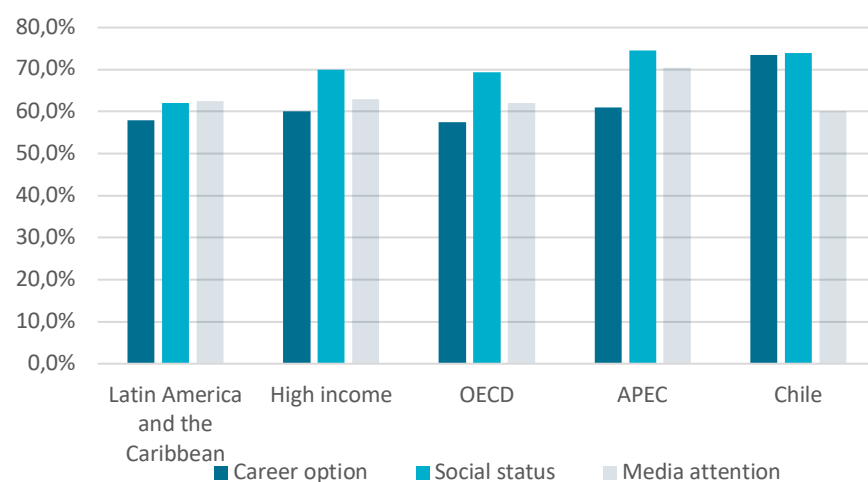
<sup>170</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 25

**Chart 15: Valuation of the individual attributes to enterprise - international comparison<sup>171</sup>**



A high percentage of the Chilean population affirms that entrepreneurship is an attractive career option (74%) and that successful Chilean entrepreneurs enjoy a high social status (75%)<sup>172</sup>.

**Chart 16: Social valuation towards entrepreneurship - international comparison<sup>173</sup>**



However, below, we will analyze some variables that become relevant especially in view of the cultural elements necessary for the development of startups<sup>174</sup> which, within the spectrum of entrepreneurship, have the differentiating characteristics described above, and which highlight the aspects that still have to be promoted to better prepare the bases for developing innovative and hardware ventures:

<sup>171</sup> ibidem, p.25

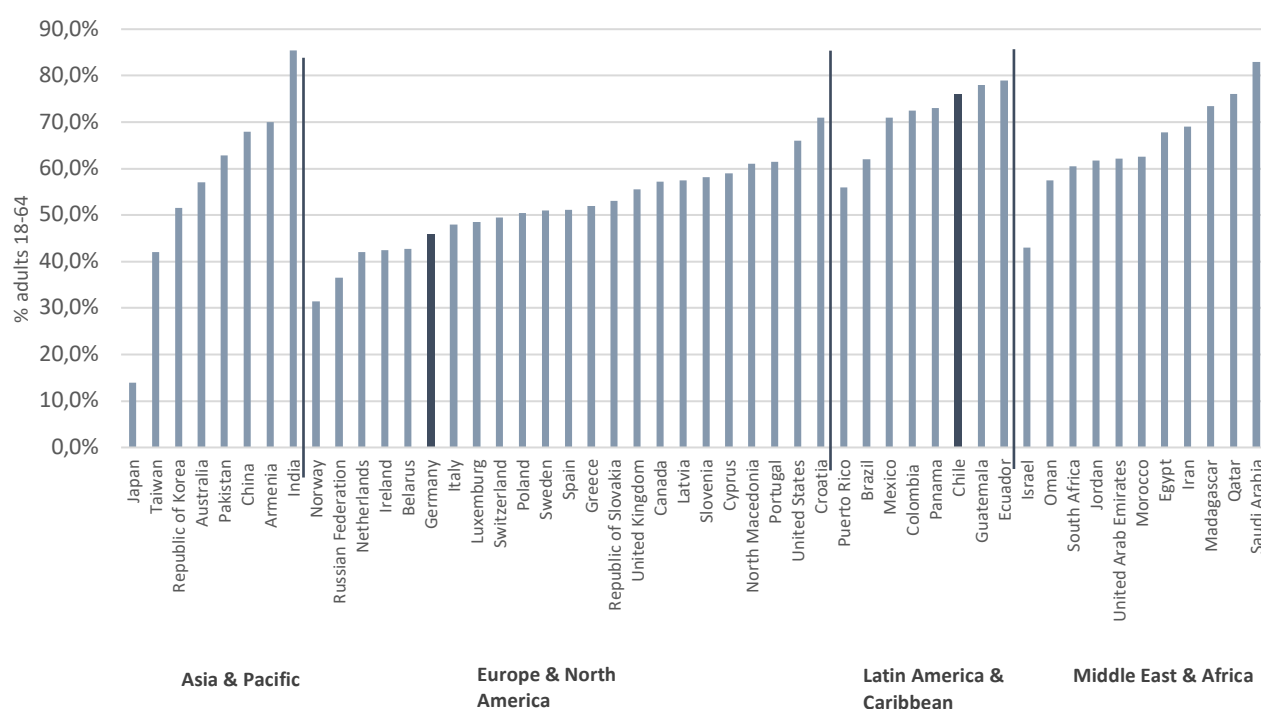
<sup>172</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 26

<sup>173</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 24

<sup>174</sup> Note: For purposes of the analysis of the present study, a startup is defined as follows: a young, innovative company with an important growth potential, see page 13

On the one hand, despite these favorable trends in the Chilean entrepreneurship ecosystem development, where the perception of the ability to start a business is high, where three quarters of adults consider that they have the knowledge, skills and experience to start a business (see chart 15), the materialization of these entrepreneurial intentions depends on multiple conditions, where a determining condition is the fear of failure that continues to act as a cultural limitation to entrepreneurship, given that almost six out of ten people who see good business opportunities agree that they are deterred by fear of failure (see chart 16)<sup>175</sup>. Because innovative technology-based entrepreneurship, such as energy entrepreneurship, carries a high risk of failure, this cultural condition negatively affects the development of this type of ventures.

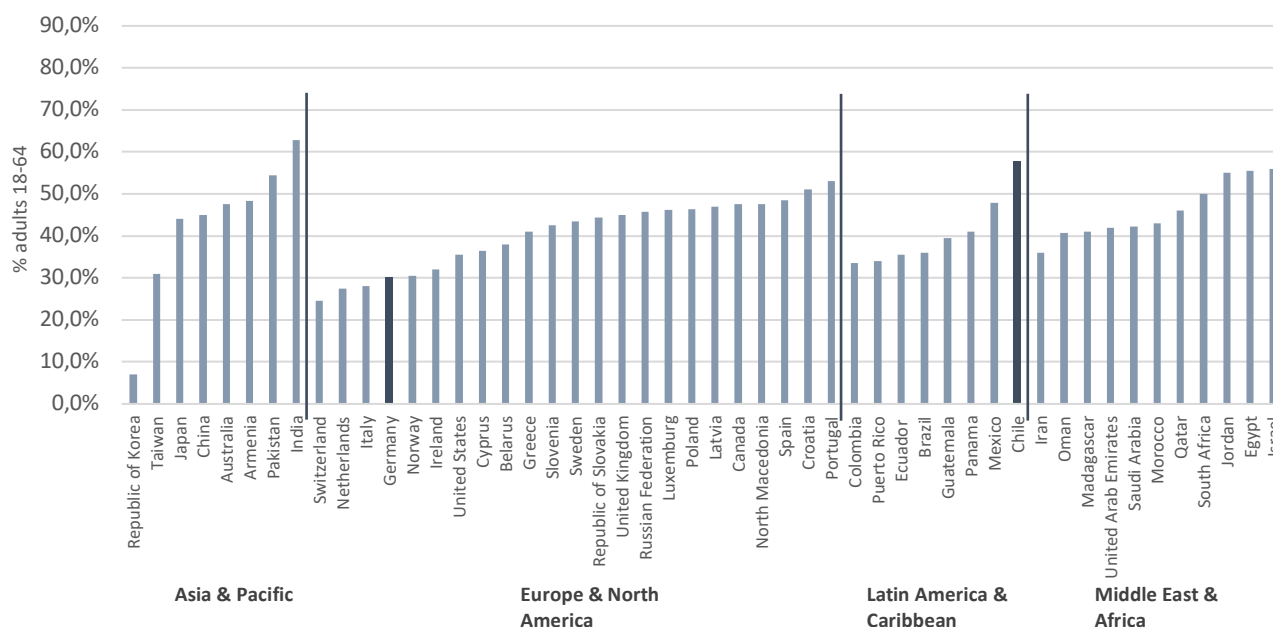
**Chart 17: You personally have the knowledge, the skills and the experience to start a new business (% adults)<sup>176</sup>**



<sup>175</sup> Niels Bosma, Stephen Hill, Aileen Ionescu-Somers, Donna Kelley, Jonathan Levie, Anna Tarnawa, and the Global Entrepreneurship Research Association (2020): *Global Entrepreneurship Monitor 2019/2020*, p.36

<sup>176</sup> Niels Bosma, Stephen Hill, Aileen Ionescu-Somers, Donna Kelley, Jonathan Levie, Anna Tarnawa, and the Global Entrepreneurship Research Association (2020): *Global Entrepreneurship Monitor 2019/2020*, p.32

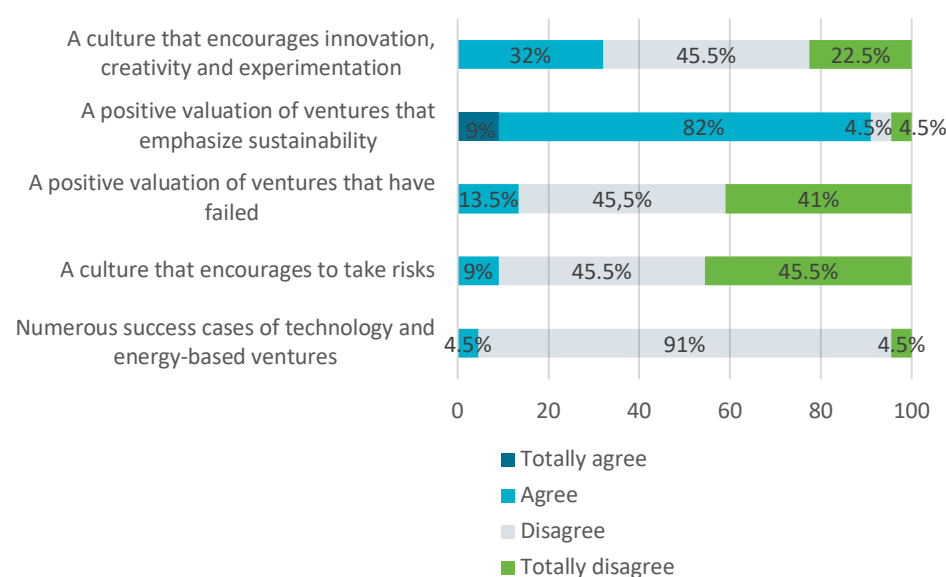
**Chart 18: There are good opportunities, but you would not start a business for fear of failing (% adults)<sup>177</sup>**



In line with these results, in the framework of the survey of national experts, 86% indicated that they do not agree that in Chile there is a culture that positively values the failure of entrepreneurship. Breaking down the fear of failure and installing a culture that values failure positively is a major challenge to make it easier for people to recognize opportunities, they also feel empowered to act accordingly.

**Chart 19: Survey about entrepreneurship culture in Chile.**

**In our country there is... (n=22)<sup>178</sup>**



<sup>177</sup> Niels Bosma, Stephen Hill, Aileen Ionescu-Somers, Donna Kelley, Jonathan Levie, Anna Tarnawa, and the Global Entrepreneurship Research Association (2020): *Global Entrepreneurship Monitor 2019/2020*, p.33

<sup>178</sup> Own preparation.

Through respective studies from Germany<sup>179</sup> and in 36 qualitative interviews that were conducted with representatives of companies, incubators and accelerators, universities and public institutions in the Chilean and German entrepreneurship environment, it was determined that energy entrepreneurs are usually people with an environmental motivation that goes beyond the business itself, their profile is rather technical with a high educational degree and a capacity for innovation.

In Chile, the main reason for entrepreneurs to undertake is the scarcity of employment (69% of startup entrepreneurs and 76% of established entrepreneurs)<sup>180</sup>, while a significant percentage of established entrepreneurs and entrepreneurs only have a school education (between 35% in the case of emerging entrepreneurs and 51% of established entrepreneurs). In the segment of emerging entrepreneurs, however, it is important to note that there is a significant increase in people with a university education (33%) versus the segment of established entrepreneurs (21%) (see chart 20)<sup>181</sup>. This shows that in the university segment there are still limitations for entrepreneurship. In the interviews held with representatives of incubators under university wing and entrepreneurs who participated in university incubators<sup>182</sup>, it was found that universities have been implementing more transversal contents related to entrepreneurship in the curriculums, apart from creating a range of services and infrastructure to support entrepreneurs to agument the number of university entrepreneurs. This becomes very relevant for promoting energy entrepreneurship because an innovative enterprise classified as a startup is usually led by people with a higher educational degree.<sup>183</sup>

The degree of innovation in entrepreneurship in Chile is currently low according to the GEM. In terms of product innovation, 66% of emerging entrepreneurs, 71% of new entrepreneurs, and 75% of established entrepreneurs have said they have not developed any type of innovation in product or services, while, in relation to process innovation, 66% of emerging entrepreneurs, 68% of new entrepreneurs, and 71% of established entrepreneurs have said they have not developed any type of innovation in processes<sup>184</sup>.

<sup>179</sup> Fichter, K. et al. (2014): *Analyse des Unterstützungssystems für grüne Unternehmensgründungen in Deutschland*, [https://www.borderstep.de/wp-content/uploads/2014/11/Fichter-et-al.-Analyse\\_Unterstuetzungssystem\\_gruene\\_Unternehmensgruendungen-2014.pdf](https://www.borderstep.de/wp-content/uploads/2014/11/Fichter-et-al.-Analyse_Unterstuetzungssystem_gruene_Unternehmensgruendungen-2014.pdf) (reviewed on 10-12-2020), p.12-13

<sup>180</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 35

<sup>181</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 38

<sup>182</sup> Interviews with Felipe Ñancupil, Líder Aceleración en [OpenBeauchef](#); Daniel Santander, CEO y Fundador de [Wenu Work](#) el 11-08-2020; Camilo Contreras, CEO y Fundador de [Inti Tech](#) el 11-08-2020; Pedro Pablo Silva, Gerente de Desarrollo y Fundador de [Efizity](#) el 24-09-2020

<sup>183</sup> Wadwa, V. et al. (2008): *Education and Tech Entrepreneurship*, Kauffman The Foundation of Entrepreneurship, p.2

<sup>184</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 49



Chart 20: Innovation in products<sup>185</sup>

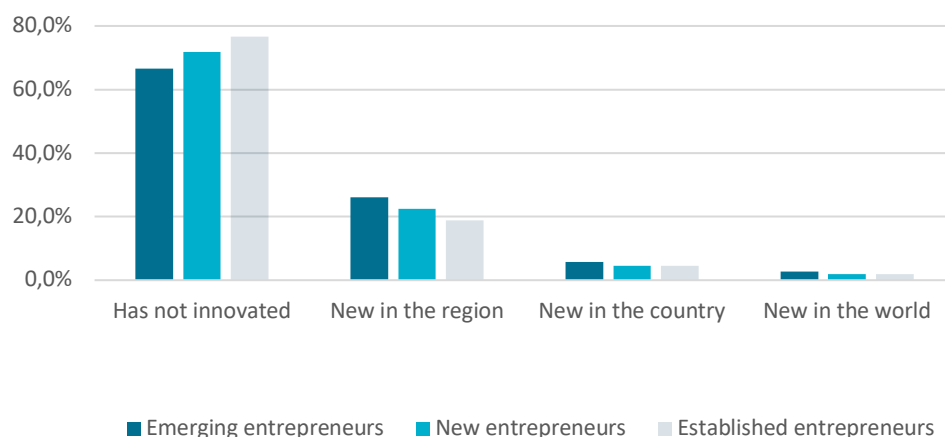
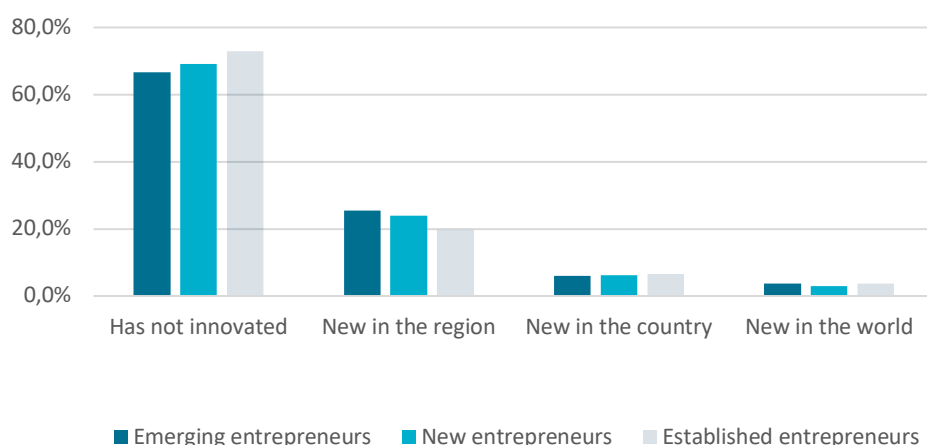


Chart 21: Innovation in processes<sup>186</sup>



However, those entrepreneurs in the initial and established stage who have innovated in processes have done so thinking about their domestic market (local and national) and less than 2% have done so considering an international market<sup>187</sup>.

This contrasts with the perception of innovative potential as a personal attribute that arises within the framework of the Global GEM 2019, where in Chile about 60% of the people interviewed indicated that other people consider them to be innovative, while in Germany only about 50% of the people gave this answer<sup>188</sup>.

In line with the low expenditure in R&D described in the "Public Policy" dimension, together with the rather traditional and little innovative culture of companies in the country's main economic sectors and the risk aversion of investors, the results of the survey held in this study show that a culture encouraging innovation

<sup>185</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 49

<sup>186</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 49

<sup>187</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p. 50

<sup>188</sup> Niels Bosma, Stephen Hill, Aileen Ionescu-Somers, Donna Kelley, Jonathan Levie, Anna Tarnawa and the Global Entrepreneurship Research Association (2020): *Global Entrepreneurship Monitor 2019/2020*, p.34

needs to be installed as well as creativity and experimentation (68% indicate that it does not exist enough in Chile) and over 90% agree that there is no culture that encourages taking risks, which is why most startups today cannot be classified as startups<sup>189</sup>.

As a result of this, experts also agree that there is still a lack of success stories for technology-based / energy-based ventures (95.46%).

### Infobox 5: Experience of entrepreneurship in energy: The Phineal case<sup>190</sup>

#### Company summary:

Phineal is a company founded in 2013 that develops technological products and services in the fields of electrical engineering and renewable energies, developing public and private projects. Phineal has 3 business areas and for each one it has created companies that operate autonomously:

**phiNet:** A solar radiation and energy measurement platform, which aims to reduce the costs of these services for small and medium-scale solar power plants. In 2016, when solar energy came to have a very low price, already comparable with the price of energy from the power grid, they understood how to give it added value and they developed platforms for the energy blockchain, being Transelec one of their first customers for whom they developed the Pulse platform, which guarantees the traceability of energy, certifying and verifying in real time the origin of the energy generated from renewable sources. From then on, they have worked on blockchain solutions.

**CENTRAL Spa:** This company was born in 2015 making solar installations under the Distributed Generation Law, having installed to date more than 50 projects.

**Solar Robotics:** This is a company that was created to develop products for electromobility with the vision that every machine that has a motor, can be transformed into an electric machine. To date, with Solar Robotics they have still been investing, because it is a company dedicated to R&D.

#### Motivation of the founding partners:

The founder of Phineal is a founding partner of the first Solar Race of electric cars in Latin America and worked, from 2010, for 4 years at Fundación Chile when solar energy was not yet massified in the country. Hence his concern to undertake in this field, aiming to contribute to technological development to generate added value in distributed power systems and generation plants with renewable energies, and with Phineal he began installing measuring equipment for the first photovoltaic projects that were developed. They are currently engaged in the development of IoT devices for measuring different phenomena in the renewable energy generation industry and the application of blockchain and artificial intelligence.

#### Current situation:

Phineal's three business units are currently in operation, with phiNet having sustained a steady growth due to the development of blockchain and artificial intelligence platforms, and they are pioneers in this field in Chile. For this reason, they have been invited to several international conferences, also thanks to the dissemination provided by the CORFO Solar Committee and other international institutions such as IRENA and GIZ in Mexico.

<sup>189</sup> Note: For purposes of the analysis of the present study, a startup is defined as follows: a young, innovative company with an important growth potential, see page 13

<sup>190</sup> Interview with Eduardo Soto, founder of Phineal, on 18-02-2021

**Finance:**

Phineal's main sources of financing so far have been equity from the profits generated with the sales of services and products in electrical engineering for medium and large-scale projects in addition to other services derived from phiNet and Central. It has also received the support of co-financing from CORFO for R&D, as a technological prospecting fund, co-financing for a technological contract with the Universidad Federico Santa María to develop an industrial prototype of a lithium battery, in addition to a co-financing from CORFO for supplying the contracted services to the center of excellence in advanced manufacturing Leitat (Catalan center of excellence brought to Chile by CORFO), which helped them remaster a phiNet product without requiring participation in intellectual property. Activities that stand out include participation in public goods activities through collaboration with Universities in the Ayllú Solar and ValpoSolar projects, as well as in public tenders of the Ministry of Energy and the World Bank for the development of pilot energy and blockchain projects.

**Main barriers:**

*Financing:* Access to public and private financing in Chile still presents several barriers. In the case of public financing, the founder of Phineal points out, on the one hand, that very often when it comes to public tenders or funds related to R&D, SMEs compete with universities, which is an asymmetric competition because they compete with very large units that also receive funding from the Ministry of Education and therefore have lower costs, and they have their own infrastructure, beyond the fact that they may not have been carrying out developments in the area in question.

In the case of financing through CORFO funds, it has had the experience that very innovative projects because the executives in charge of evaluation the projects lack technical expertise. In the case of bank financing, in addition to the barrier of technical expertise, there is the barrier that they are conservative entities and do not grant loans if the company fails to present all the guarantees requested, which for a newer company is an important barrier.

In relation to venture capital funds, the founder of Phineal highlights a barrier that is related to the network of contacts, since accessing these funds is difficult without knowing the people who facilitate access. However, there is interest from the VC to invest and they are seeing tangible possibilities to take advantage of the association of companies like Transelec for business development in different areas.

**Culture:** The founder of Phineal points out that Chile shows a lack of a culture conducive to entrepreneurship and that values failure positively. In addition, the "old minds", according to him, who still control especially the sources of financing and many important positions in large companies, inhibit the development of innovation and manufacturing processes in Chile, because they do not believe in the capacity for local development and, therefore, do not place any bet on developments made in Chile.

A cultural aspect the founder of Phineal also pointed out, is that by raising capital abroad, Chilean startups play against the fact that Latinos are not considered very honest. This changes as companies have in-country sales and local partners which helps build trust and overcome this barrier.

**Human capital:** In Chile there is highly qualified human capital for innovation and manufacturing processes, however, there is a lot of human capital flight to other places with more developed R&D ecosystems and where human resources are also better paid.

**Markets:** There is a lack of a more massive culture of innovation at the level of large companies, which makes it easier for startups to find the first customers for innovative developments, as was the case with Transelec for Phineal: Transelec opted for the development of the Pulse platform, assumed the risk of failure, but was an early adopter that facilitated Phineal to move forward with the development of blockchain platforms.

### Recommendations and lessons

The founder of Phineal highlights that in the process of entrepreneurship for him it has been essential to have a good external accounting service and the service of a lawyer who has supported him in the contractual processes with has helped him to inspire seriousness with clients. In addition, he emphasizes the importance of building a good contact network at international level to be able to access sources of financing abroad more easily.

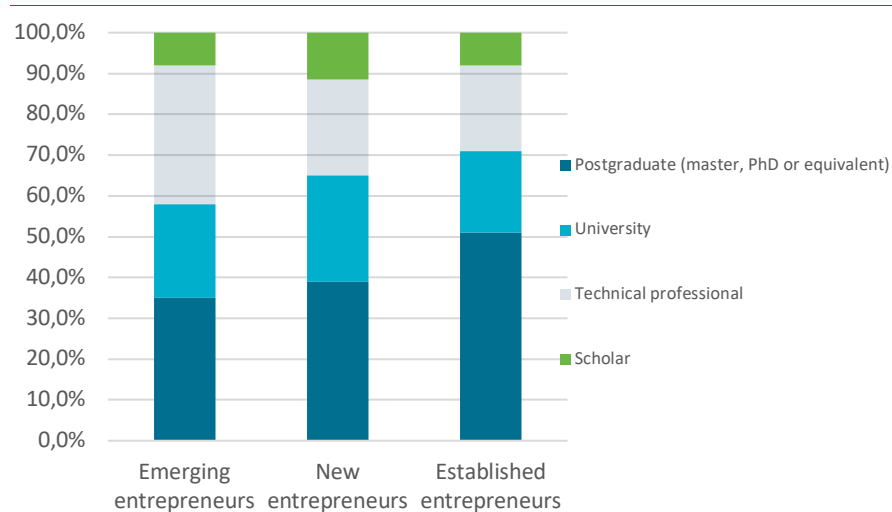
In general, it is essential for him to improve the venture capital ecosystem for Chilean entrepreneurs to facilitate access to an international venture capital network.

### 4.3.6 Human capital

To analyze this dimension of the Chilean entrepreneurship ecosystem in view of its maturity to promote energy entrepreneurship, several of the elements analyzed in the other dimensions must be considered. According to the information collected through respective studies in Germany<sup>191</sup> and in 36 qualitative interviews that were conducted with representatives of companies, incubators and accelerators, universities and public institutions in the entrepreneurship environment of Chile and Germany, the profile of entrepreneurs in energy is characterized by a high educational level and faces the challenge of often requiring highly specialized personnel with specific technological knowledge to develop their product/service, which for a startup is difficult to pay for.

As we have already mentioned in the dimension of culture, in Chile still many entrepreneurs only have secondary school education (between 35% in the case of emerging entrepreneurs and 51% of established entrepreneurs), however, when adding those emerging entrepreneurs with university and postgraduate education, we can conclude that more than 40% of emerging entrepreneurs today are in that category.

**Chart 22: Distribution entrepreneurship activity according to educational level - Chile<sup>192</sup>**



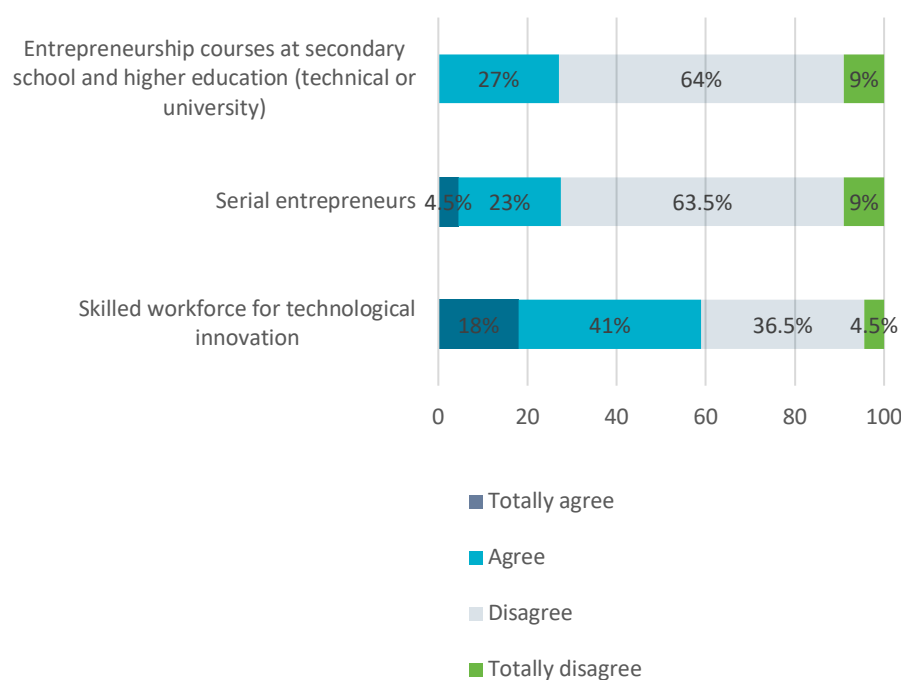
<sup>191</sup> Fichter, K. et al. (2014): *Analyse des Unterstützungssystems für grüne Unternehmensgründungen in Deutschland*, [https://www.borderstep.de/wp-content/uploads/2014/11/Fichter-et-al.-Analyse\\_Unterstützungssystem\\_gruene\\_Unternehmensgründungen-2014.pdf](https://www.borderstep.de/wp-content/uploads/2014/11/Fichter-et-al.-Analyse_Unterstützungssystem_gruene_Unternehmensgründungen-2014.pdf) (reviewed on 10-12-2020), p.12-13

<sup>192</sup> Guerrero, Maribel & Serey, Tomás (2020): *Global Entrepreneurship Monitor - Reporte Nacional de Chile 2019*, Universidad del Desarrollo, <https://negocios.udd.cl/gemchile/reportes/reportes-nacionales/> (reviewed on 10-12-2020), p.38

This reflects a change in the trend of graduates from higher education institutions for whom the option of a entrepreneurship is increasingly presented as a career alternative.

In the survey of experts, almost 60% of them indicated that they consider Chile has a skilled workforce for technological innovation and for promoting energy entrepreneurship; having a skilled workforce they consider to be the most important element.

**Chart 23: Survey about the availability of human capital for entrepreneurship in Chile. In our country there are...**<sup>193</sup>



However, as described in the "Culture" dimension, the degree of innovation of entrepreneurship in Chile currently remains low. This is due to multiple factors, which are related to the factors analyzed in the other dimensions: lack of an innovation culture nationwide and at the corporate level, which really takes advantage of and enhances this human capital, reflected also in the low R&D expenditure in Chile in relation to its classification as a 'high-income' country, an infrastructure that is just in the process of being implemented to perform technological developments and piloting, financing according to the capital requirements of innovative ventures, the difficulty for entrepreneurs to hire highly qualified human capital. In addition, in the field of technology, other countries have long occupied the role in the global economy of developing technology, so for a Chilean entrepreneur importing technology is always an attractive option. This was also the case with Efizity: In the interview with Pedro Pablo Silva, Development Manager, the energy efficiency solutions implemented by Efizity were imported technologies, developed abroad<sup>194</sup>.

In this sense, it is essential to change the corporate culture in relation to innovation: in Chile there are seven international R&D centers, which contributed to the country's scientific development through the Program of Attraction of Centers of International Excellence promoted by CORFO since 2010, in addition to another 50 national research centers funded by the National Agency for Research and Development (ANID), entity in charge of the Millennium Science Initiative. These centers provide highly qualified human capital, with the training and experience to face new problems that have not been solved before, in addition to having an

<sup>193</sup> Own preparation.

<sup>194</sup> Interview with Pedro Pablo Silva, Development manager and founder of [Efizity](#) el 24-09-2020

international support network<sup>195</sup>. However, in Chile the fact that an R&D culture is not sufficiently developed at the corporate level leads to a large part of the State financing this type of activity, leading to a deficiency in the system from the perspective of transfer, dialogue and collaboration between industry and R&D entities ensuring developments are subsequently inserted into the market.

### Infobox 6: Experiences of entrepreneurship in energy: The Efizity case<sup>196</sup>

#### Products and services sold by Efizity:

Efizity was founded in 2010 by four partners who had known each other since university with the initial goal of providing consulting services on issues of energy efficiency in construction. They quickly expanded their range of services to the industrial sector for which they partnered with another consulting firm in the area and were awarded an IDB project. In addition, they began to import and adapt technology for the measurement, analysis and management of energy consumption. Its value proposition today is focused on being a partner that aims to support its customers in solving their energy challenges. In this respect, they have been expanding to offer various solutions, among which the Energy Platform, a platform for energy transactions between free customers and energy providers. In addition, they are exploring new business areas related to electromobility and energy storage, among others. Today, Efizity employs 70 people.

#### Finance:

Thanks to its good network of contacts, the incorporation of a capitalist partner and the fact that most of its developments have been software, those that require smaller amounts of investment made a large part of their developments with their own capital, loans from the capitalist partner and in some cases, requesting loans from banking institutions for working capital.

In 2020 they were acquired by Colbún. Efizity accepted Colbún's offer because this would allow it to have greater possibilities to be more competitive and offer a greater range of energy solutions to its customers, including those with larger amounts of investment in technology (electromobility, storage, etc.).

Colbún's motivation to invest in Efizity is given by the changes in the energy market, where it is no longer enough to offer customers the cheapest energy, but a complete solution for which it is essential to innovate. However, innovating in a large and established company is difficult because of a corporate culture that punishes mistakes a lot. Smaller companies, on the other hand, often understand and assume that making mistakes is part of learning and therefore achieve a higher rate of innovation. In the case of Efizity, eight of the seventy employees work in new business development.

#### Appreciations of the elements of the entrepreneurship ecosystem:

Financing remains a stumbling block as banks do not lend to startups and without a good network of contacts, it is difficult to access capital.

The qualification of human capital has advanced during the last years, because, at the university level, for example, the topics of energy efficiency and renewable energies have been included in the curriculums of the respective careers, as well as the methodologies for entrepreneurship. In this sense, today the market has increasingly better prepared capital.

<sup>195</sup> Diario Financiero of 20.08.2020: *Ecosistema Científico Local: La Red que impacta en el Desarrollo País*, [A9R226F.tmp.pdf](#) (reviewed on 16-12-2020)

<sup>196</sup> Interview with Pedro Pablo Silva, Development manager and founder of Efizity, on 24-09-2020

**Infobox 7: The energy entrepreneurship ecosystem in brief: Essential data on Germany and Chile**

	Germany	Chile
<b>Public policy</b>	Number 7 among 141 countries in the <i>Global Competitiveness Report</i>	Number 33 among 141 countries in the <i>Global Competitiveness Report</i>
	“Innovation-driven” economy	“Efficiency-driven” economy
	Policy focused on promoting Research and Development (R&D)	
	3,13% of GDP 2019 => 3,5% to 2025	0,35 % of GDP for 2018
	2/3 comes from private company	State finances almost 50%
	Fourth highest total expenditure in R&D in the world	Low expenditure in R&D
	Well-defined normative framework for promoting NCRE and EE	Well-defined normative framework for promoting NCRE and, to a lesser extent, EE
	Public policy strategy for promoting new ventures: majority agrees	Public policy strategy for promoting new ventures: majority disagrees
	Relevant stakeholder for BMWi promotion programs	Relevant stakeholder for CORFO promotion programs
	Seventh Energy Research Program ( <i>Energieforschungsprogramm</i> ) called "Innovations for Energy Transition" (Innovationen für die Energiewende): Real Labs	
		Electromobility Center
		Investment and Finance Management: CORFO-KfW Solar Program for development of Concentrated Solar Energy (CSP) and the Green Credit
<b>Finance</b>	BMW i supplies financial instruments for innovative and technology-oriented startups but in the early phases	CORFO supplies instruments for initial phases

	<p>Comparatively the answers to the survey show that there is more availability of private funding in Germany, through Business Angels, corporate venture capital (2/3 of expenditure on R&amp;D) and Venture Capital Funds</p>	<p>GEM Chile: 'financial support' is the worst assessed of all dimensions of the entrepreneurship ecosystem</p> <p>Interviewed experts 'disagree' that Chile has enough venture capital funds that invest in innovative projects, Business Angels for new and growing companies and corporate venture capital funds</p>
	<p>Last growth phases where the "venture capital gap" in Europe becomes clear as compared to Asia and the United States.</p>	<p>CORFO through Investment and Finance Management seeks to drive the Venture Capital industry =&gt; 50 venture capital funds have been created</p>
	<p>European Union (EU) has launched different programs, such as VentureEU and the Artificial Intelligence and Blockchain Investment Fund to support venture capital funds and investment funds to increase the investment funds</p>	
	<p>31% of non-ecological very innovative startups have received funding through Business Angels and 23% through venture capital, this is only 18% and 9% in very innovative cleantech startups</p>	
	<p>Corporate Venturing is more common</p>	<p>Increase in corporate venturing instruments, as company building and corporate venture capital (CVC)</p>
	<p>"Green Startup Sonderprogramm" of the German Federal Environment Foundation (Deutsche Bundesstiftung Umwelt, DBU)</p>	
<b>Support</b>	<p>Solid infrastructure for R&amp;D, incubators and accelerators</p>	<p>Good offer of incubators, some under the wing of universities</p> <p>R&amp;D infrastructure is assessed as deficient</p>
	<p>Mentors with technical experience in energy</p>	<p>Mentors have technical experience but lack experience in energy</p>
	<p>Good relationship between academia and the entrepreneurship ecosystem</p>	<p>Incubators under the wing of universities contribute to increasing contact between the entrepreneurship ecosystem and the academia: Copec: Centro de Innovación UC Anacleto Angelini</p>
<b>Markets</b>	<p>B2B facilitated by Corporate Venturing, however, large budgets over 100 million euros remain an exception</p>	<p>B2B per market size and finance availability</p>



	In general: established companies open to innovation and to collaborating with startups	Companies averse to risk
	Collaboration opportunities are fewer for cleantech startups	Increase in availability of corporate venture capital in the energy sector
<b>Culture</b>	Entrepreneurship culture is little developed, which is still a weak point in the entrepreneurship ecosystem in Germany	Entrepreneurship culture, but many people venture because of necessity
<b>Human capital</b>	Four out of five founders of a startup have an academic degree in Germany (83.9%) and 14.2% have a PhD	Nowadays more than 40% of emerging entrepreneurs have a university degree and/or master or PhD
	Germany stands out in terms of its availability of skilled labor	60% of the experts said to consider that Chile has skilled labor for technological innovation
	Contracting highly specialized personnel brings about higher costs, which underlines once and again that cleantech startups face a more complex financial situation	
	High degree of innovation: Only 4.4% of entrepreneurs who founded their company in the past 3.5 years consider that their product or service has no novelty value	Low level of innovation in ventures due to multiple factors associated with other dimensions
	One out of each ten ventures is assigned to high or medium-technology sectors	

## 5 Technologies for Energy Transition in Chile: Business Needs and Opportunities

The ambitious goals of the energy transition can only be achieved by implementing a mix of different technologies, services and business models. As described above, the role of startups in this context is of the utmost importance since, together with the mature technologies that are already being commercialized, new technological developments, services and business models are required to close the technological gaps.<sup>197</sup> Below are the different technological areas that are becoming important to achieve the energy transition in Chile and the associated challenges to be able to take advantage of the potential of each area.

### 5.1 Renewable energies

#### Biomass

Of the renewable energies used by Chile, a large part is biomass. 80% of this is used in industrial processes and 20% in the heating of houses in the south of the country in the form of firewood and pellets. In total, 90% of homes in the south use firewood or pellets for heating. The use of firewood is still very common and causes major air pollution problems in several southern cities and is generally responsible for 87% of fine particulate matter emissions (MP 2.5).<sup>198</sup>

In recent years, the Ministry of Environment launched several decontamination plans and the Heater Replacement Program, which included subsidies for a replacement of appliances, which use firewood for heating in homes in the south. In 85% of cases, the replacement was for devices using pellets.<sup>199</sup> Overall, pellet production in Chile increased considerably in recent years with a growth of almost 180% in 2018 and 20% in 2019.

Table 7: Pellet production volumes in ton/year<sup>200</sup>

Region	2017	2018	2019
Maule	3,600	5,700	7,470
Biobío	53,000	70,000	88,010
Araucanía	12,630	25,390	26,740
TOTAL	36,230	101,090	122,220

<sup>197</sup>

[https://www.energieforschung.de/lw\\_resource/datapool/systemfiles/elements/files/70013C70EE963F41E0539A695E8680ED/current/document/TFE\\_Politikbericht\\_komplett.pdf](https://www.energieforschung.de/lw_resource/datapool/systemfiles/elements/files/70013C70EE963F41E0539A695E8680ED/current/document/TFE_Politikbericht_komplett.pdf), S. 14

<sup>198</sup> Nueva Minería y Energía (2020): Biomasa en Chile: ¿Avanzando hacia su validación?, en: <https://www.nuevamineria.com/revista/biomasa-en-chile-avanzando-hacia-su-validacion/>

<sup>199</sup> Nueva Minería y Energía (2020): Biomasa en Chile: ¿Avanzando hacia su validación?, en: <https://www.nuevamineria.com/revista/biomasa-en-chile-avanzando-hacia-su-validacion/>

<sup>200</sup> Instituto Forestal (2020): *Cifras importantes: Industria de pellet en Chile*, en: <https://www.infor.cl/index.php/noticias/568-infor-desarrolla-estudio-que-posiciona-a-la-region-del-biobio-como-principal-productor-de-pellet-en-chile>



At the same time, Chile focuses its efforts on the implementation of district heating networks, where biomass will also play an important role. In the city of Temuco, the planned district heating system will probably use biomass as an energy source.<sup>201</sup> There is also a potential for cogeneration systems for heating systems.<sup>202</sup>

Similarly, the use of "Waste-to-energy" plants would be a possible source for district heating, which could solve the problem of landfills in several southern regions. Currently, in Chile there are no waste-to-energy plants, however, a feasibility study was done in Santiago and the company Asgreen is going to build a pilot plant in the city of Curicó.<sup>203 204</sup>

The challenges for the use of biomass in pellet form are the safety of raw material quality and dependence on sawmills.

### Geothermal energy and heat pumps

The use of geothermal sources of low enthalpy heat and cold with heat pumps is not very common in Chile yet. The few low-enthalpy projects were mainly implemented in the commercial context in greenhouses, offices, schools and hot springs.<sup>205</sup> In total, there is 20 MW of installed capacity for direct use of geothermal energy, although there is a potential for direct use between 2,200 and 3,500 MW in Chile.<sup>206</sup>

Last year, the government entered a bill into the Chamber of Deputies, which wants to facilitate exploration of geothermal potential with the obligation to register exploration projects instead of the current concession system.<sup>207</sup> The main barrier is the risk of exploration and the lack of a geothermal industry in Chile with service providers. The technology also has to compete with other energy sources, especially solar thermal panels, biomass and natural gas.<sup>208</sup> However, there will be better potential for exploration after the adoption of the law.

### Photovoltaic energy

In its power generation matrix, Chile already has more than 3,257 MW of installed photovoltaic energy capacity, with high growth in recent years. In addition, in its long-term energy planning, the Ministry of Energy has an installed capacity of over 20,000 MW by 2050.

An important measure to achieve that number, apart from a lower cost of solar panels, is to increase the efficiency of such panels. In Chile, new technologies – such as bifacial panels or technology that orients the panels towards the sun<sup>209</sup> – are already being developed and/or tested in several research institutions such as the Solar Energy Research Center (SERC) of the Universidad de Chile, the GIZ Energy Program in Chile, the Fraunhofer Chile Center and in multinational companies such as the Innovation Center of the company Acciona. Likewise, the public-private initiative Atamostec is developing bifacial modules with an additional gain of 11%. The initiative involves, among other stakeholders, the Research Center ICS Konstanz in Germany, Fraunhofer Chile, the National Energy Institute (Inés) in France and the Chilean company Colbún.<sup>210</sup> In addition, another interesting field where new developments are needed are technologies that allow better use

<sup>201</sup> Biobiochile (2020): Temuco contará con gran proyecto de calefacción distrital alimentado por biomasa, en:

<https://www.biobiochile.cl/noticias/nacional/region-de-la-araucania/2020/02/03/temuco-contara-con-gran-proyecto-de-calefaccion-distrital-alimentado-por-biomasa.shtml>

<sup>202</sup> Revista Electricidad (2019): Biomasa: potencial al alza, en: <https://www.revistaeci.cl/reportajes/biomasa-potencial-al-alza/#>

<sup>203</sup> País Circular (2019): Intendencia inicia segunda etapa de análisis para determinar gestión y emplazamiento de planta de Waste to Energy en Santiago, en: <https://www.paiscircular.cl/ciudad/waste-to-energy-santiago/>

<sup>204</sup> Diario Financiero (2020): Asgreen construirá planta piloto en Curicó para generar energía con desechos de manzanas y aceitunas en 2021, en: <https://asgreen.cl/wp-content/uploads/2020/08/asgreendf.jpeg>

<sup>205</sup> CEGA (2020): Usos de la geotermia en Chile, en: <http://www.cega-uchile.cl/informacion-de-interes/usos-de-la-geotermia-en-chile/>

<sup>206</sup> Colegio de Ingenieros de Chile (2019): Desarrollo de la Geotermia en Chile: Masificación de la Geotermia de Alta y Baja Entalpia, en: [http://doc.ingenieros.cl/presentacion\\_torres.pdf](http://doc.ingenieros.cl/presentacion_torres.pdf)

<sup>207</sup> Cámara de diputadas y diputados (2019): Gobierno ingresó proyecto que perfecciona Ley de Geotermia, en: [https://www.camara.cl/prensa/sala\\_de\\_prensa\\_detalle.aspx?prmId=136734](https://www.camara.cl/prensa/sala_de_prensa_detalle.aspx?prmId=136734)

<sup>208</sup> Colegio de Ingenieros de Chile (2019): Desarrollo de la Geotermia en Chile: Masificación de la Geotermia de Alta y Baja Entalpia, en: [http://doc.ingenieros.cl/presentacion\\_torres.pdf](http://doc.ingenieros.cl/presentacion_torres.pdf) p. 17-19

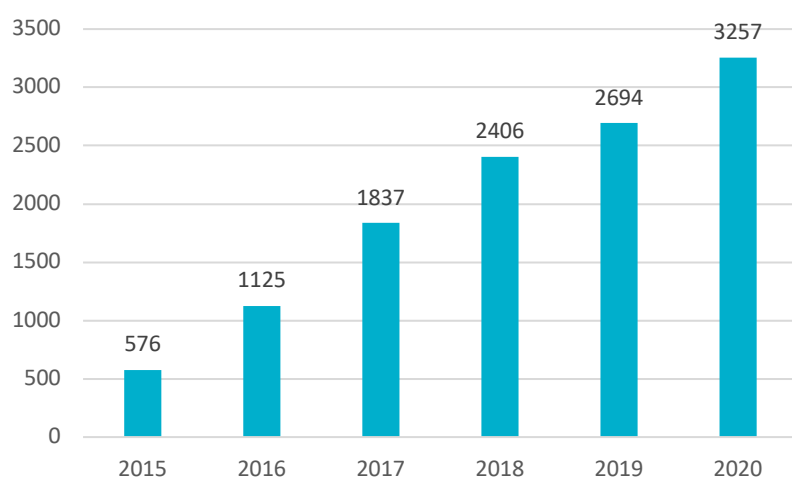
<sup>209</sup> La Tercera (2020): Energía solar: el centro de innovación que prueba nuevas tecnologías en el desierto de Atacama, en: <https://www.latercera.com/laboratoriodecontenidos/noticia/energia-solar-el-centro-de-innovacion-que-prueba-nuevas-tecnologias-en-el-desierto-de-atacama/SM66TVDQSF2RJA5O6Q6UCFIE/>

<sup>210</sup> PV Magazine (2020): Un panel bifacial "made in Chile", en: <https://www.pv-magazine-latam.com/2020/04/24/un-panel-bifacial-made-in-chile/>

to be made of space to achieve the integration of photovoltaic panels in buildings, in agricultural activities and on water with floating solar panels, according to Constanza Muñoz of Fraunhofer Chile.<sup>211</sup> These technologies are already being investigated internationally. In Chile, moreover, in the photovoltaic field, developments and, therefore, startups with technologies to face local problems such as the dirt of the panels, for example, can be of great interest. It is in this context that the successful Chilean startup Inti-Tech emerged, whose founder was also interviewed and surveyed in the framework of this study, with the development of a solar panel cleaning robot in 2019.<sup>212</sup>

Moreover, the adaptation of the solar panels themselves to Chilean conditions, for example, in the Atacama Desert with its high ultraviolet radiation has a potential for the future, according to SERC Chile. That includes the use of new materials and improvement in heat dissipation.<sup>213</sup>

**Chart 24: Evolution of photovoltaic installed capacity in operation, in MW**



According to CORFO's Solar Committee, another technology with potential for the future is the power electronics of solar modules and equipment for analyzing electrical parameters, current, voltage and strings, including inverter optimization. The Chilean startup Axys Solar has already managed to develop an inverter, which can aim to improve the control systems of photovoltaic plants. Axys Solar received support from the Solar Committee for product development.<sup>214</sup>

With the enactment of the Extended Producer Responsibility Law (REP Law) in Chile and with a general solar panel life of 20–30 years, there is a need to recycle solar panels after use. Currently the solar panels in use in Chile contain about 250,000 tons of glass, about 30,000 tons of aluminum and 4,000 tons of silicon.<sup>215</sup> This will require the development of recycling solutions for the panels in the coming years, especially considering that, at present, Chile has only one recycling plant for panels.<sup>216</sup> So, interesting business opportunities arise in recycling of the panels and in better recycling methods.

### Wind energy

Wind turbine installations in Chile almost tripled in recent years from 909 MW installed in 2015 to 2,522 MW in 2020.<sup>217</sup> Of that installed capacity, the Magallanes Region, which has very constant winds in some areas, only has 3 MW installed, which are the only renewable energy source installed and thus only represents 2% of the installed electricity generation capacity in the Magallanes Electricity System, while natural gas accounts

<sup>211</sup> Electromov (2020): Energía solar y cuatro apuestas de futuro, en: <https://www.electromov.cl/2020/05/19/energia-solar-y-cuatro-apuestas-de-futuro/>

<sup>212</sup> El Mostrador (2019): Robot chileno que limpia paneles solares fue seleccionado por universidad de la NASA para llegar a Silicon Valley, en: <https://www.elmostrador.cl/agenda-pais/2019/06/19/robot-chileno-que-limpia-paneles-solares-fue-seleccionado-por-universidad-de-la-nasa-para-llegar-a-silicon-valley/>

<sup>213</sup> Electromov (2020): Energía solar y cuatro apuestas de futuro, en: <https://www.electromov.cl/2020/05/19/energia-solar-y-cuatro-apuestas-de-futuro/>

<sup>214</sup> Electromov (2020): Energía solar y cuatro apuestas de futuro, en: <https://www.electromov.cl/2020/05/19/energia-solar-y-cuatro-apuestas-de-futuro/>

<sup>215</sup> Revista Electricidad (2020): Energía solar: Informe aborda futuro de la vida útil de paneles fotovoltaicos instalados en Chile, en: <https://www.revistaeci.cl/2020/10/05/energia-solar-informe-aborda-futuro-de-la-vida-util-de-los-paneles-fotovoltaicos-instalados-en-chile/>

<sup>216</sup> Revista Energía (2018): Chile tiene primera planta de reciclaje con 100% de energía solar, en: <https://www.revistaenergia.com/13538/>

<sup>217</sup> ACERA (2020): Estadísticas, en: <https://acera.cl/estadisticas/>

for 83% of installed capacity with 89 MW.<sup>218 219</sup> In 2021, a new wind farm with 10.3 MW of power is likely to come into operation, which will increase the share of wind energy to about 18%.<sup>220</sup> Since the Magellan region has a fairly low natural gas production, wind power has to compete with those natural gas prices. However, the government's plan considers a 30% share of renewable energy in the region's power generation by 2030.<sup>221</sup>

Given that Chile has a coastline of more than 4,000 km, offshore wind also has quite a high potential. However, the installation costs are still very high because the sea near the coast is very deep. Floating wind turbines could be a solution for the future, but currently there are only prototypes with that technology.<sup>222</sup>

### Wave power

Wave power theoretically has great potential in Chile. It is estimated that the west coast of South America has a gross power of 325 GW, of which Chile has a power of 240 GW.<sup>223</sup> However, there are several technological challenges to be solved such as the extreme conditions for the material to resist over time at sea, the extreme fluctuation of generation by the waves. Therefore, in the world there is an installed capacity of only 5.4 MW and 14.4 MW that are in planning in a total of 10 countries in the world (the information dates from 2016).<sup>224</sup> In Chile, there is a pilot developed by the company Maestranza Diesel in conjunction with the Universidad Técnica Federico Santa María, located at the Muelle Barón pier in Valparaíso. It was put into operation in 2020 and has an installed capacity of 3 kW. The project took advantage of CORFO's R&D law and contemplates a total investment of 300 million CLP.<sup>225</sup>

## 5.2 Infrastructure

### Challenges of the transmission grid

With the great growth of renewable energies with variable electricity generation, the need to build new electric transmission lines is growing. That process has generated local opposition, resulting in a delay and increased costs of building them.<sup>226</sup>

For shorter lines with a higher degree of innovation, transmission lines with superconductivity cable could be installed. The city of Munich is in the process of installing a 12 km superconducting cable, which has a capacity of 500 MW with a voltage of 110,000. It can transmit up to 8 times more electricity, but it needs less space than a conventional cable because the wires can be put closer to each other. The cable uses its own cooling system, which lowers the temperature of the cable to  $-196^{\circ}\text{C}$ .<sup>227 228</sup> Research and innovative concepts are still needed to develop superconducting cables that can operate at a higher temperature.

<sup>218</sup> Energía Región (2020): Región de Magallanes y de la Antártica Chilena, en <https://energiaregion.cl/region/MAG>

<sup>219</sup> Energía Abierta (2020): Reporte Mensual Sector Energético – Noviembre 2020, en: [https://www.cne.cl/wp-content/uploads/2020/11/RMensual\\_v202011.pdf](https://www.cne.cl/wp-content/uploads/2020/11/RMensual_v202011.pdf)

<sup>220</sup> El Mostrador (2020): Concluyen con éxito pruebas de parque eólico Vientos Patagónicos, en: <https://www.elmostrador.cl/agenda-pais/2020/10/09/concluyen-con-exito-pruebas-de-parque-eolico-vientos-patagonicos/>

<sup>221</sup> Ministerio de Energía (2017): Energía 2050 – Política Energética Magallanes y Antártica Chilena, en: <https://energia.gob.cl/sites/default/files/documentos/energia-magallanes-2050.pdf>

<sup>222</sup> La Tercera (2020): Turbinas eólicas en alta mar: una apuesta que se acerca al continente, en: <https://laboratorio.latercera.com/tiempo-de-actuar/noticia/turbinas-eolicas-alta-mar-una-apuesta-se-acerca-al-continente/974084/>

<sup>223</sup> Raúl Castillo Villagra, Vivian Segovia Barros, Gabriel Díaz Flores y Claudia Araya Medina (2018): Potencial undimotriz de la región de Tarapacá (Chile) como foco de fomento productivo, en: [https://scielo.conicyt.cl/scielo.php?script=sci\\_arttext&pid=S0718-33052018000100072#B22](https://scielo.conicyt.cl/scielo.php?script=sci_arttext&pid=S0718-33052018000100072#B22)

<sup>224</sup> Francis Mwasilu, Jin-Woo Jung: Potential for power generation from oceanwave renewable energy source: a comprehensive review on state-of-the-art technology and future prospects, en: [https://www.researchgate.net/publication/329450718\\_Potential\\_for\\_power\\_generation\\_from\\_ocean\\_wave\\_renewable\\_energy\\_source\\_A\\_comprehensive\\_review\\_on\\_state\\_of\\_the\\_art\\_technology\\_and\\_future\\_prospects](https://www.researchgate.net/publication/329450718_Potential_for_power_generation_from_ocean_wave_renewable_energy_source_A_comprehensive_review_on_state_of_the_art_technology_and_future_prospects)

<sup>225</sup> Universidad Técnica Federico Santa María (2020): USM desarrolla innovador proyecto con energía undimotriz en Valparaíso, en: <https://noticias.usm.cl/2020/03/28/usm-desarrolla-innovador-proyecto-con-energia-undimotriz-en-valparaiso/>

<sup>226</sup> El Mercurio (2018): Problemas en transmisión eléctrica, en: <http://www.infraestructurapublica.cl/problemas-transmision-electrica/>

<sup>227</sup> Archyde (2020): Munich is laying superconducting cable, en: <https://www.archyde.com/munich-is-laying-superconducting-cable/>

<sup>228</sup> Golem (2020): Spezialkabel bringt Strom verlustfrei über weite Strecken, en: <https://www.golem.de/news/hochtemperatur-supraleiter-spezialkabel-bringt-strom-verlustfrei-ueber-weite-strecken-2009-150634.html>

### Intelligent electricity networks

Another technology, which may increase the efficiency of the electrical infrastructure and alleviate the demand for new transmission lines are technologies that can adapt electricity demand to generation in the form of smart grids. On electricity generation, transmission and distribution, several stakeholders are already implementing intelligent systems.<sup>229</sup> Components such as smart electric meters are also needed for consumers, which has raised controversy in Chile over the costs of these meters. However, the integration of smart residential buildings with energy management systems may also be a viable option for Chile.<sup>230</sup>

Apart from residential consumers, industrial consumers should also be considered, such as companies with high electrical demand – foundries, refrigerators, industrial boilers, greenhouses – for air conditioning, electric heating and street lighting. According to Zheng Ma, Alla Asmussen and Bo Nørregaard Jørgensen, the greatest potential of flexible demand is in refrigerators, ventilation, pumps and process air.<sup>231</sup>

### Electricity storage

With a power generation system based on variable renewable energies, it is also necessary to store electricity. Apart from large batteries, of which the AES generator already has some systems installed, decentralized home batteries can play an important role which, in some countries such as Germany, with more than 34,000 systems installed, are already making an important contribution.<sup>232</sup> In Chile, to date they are not yet of greater importance due to current legislation. That may change if the new Distribution Law stipulates 'energy marketers', who can sell electricity directly<sup>233</sup>. In addition, the country already has more than 6,500 distributed power generation projects, where almost 2,000 of these were introduced into the system in 2019.<sup>234</sup> The new 'energy marketer' would allow the development of business models as an 'energy cloud' for owners of distributed facilities with renewable energy and batteries, in which all customers can exchange energy generated and stored by their systems in a virtual community. In Germany, there are already 15 companies with similar business models.<sup>235</sup>

### Thermal storage

Like electricity storage, thermal storage is key to the energy transition and the massive use of renewable energy in all sectors. On the one hand, it is important to optimize storage technology in solar concentration projects (CSP). In this area the Universidad de Antofagasta has already worked with molten salts and the addition of lithium nitrate. Along these lines, there is also potential in the use of thermal storage in traditional thermal plants to make them greener. In this area there may be potential for startups to manufacture this type of storage if the use in CSP projects and thermal plants in Chile is increased. The Universidad de Antofagasta has another project, called "DESCOM", which is financed by the Innovation Fund for Competitiveness (FIC) of the Regional Government of Antofagasta. The project aims to recycle molten salts from solar thermal plants after their useful life, which is also a potential business for a startup.<sup>236</sup>

### Grid resilience

The resilience of the electricity grid has taken on more and more importance in the discussion, also because every winter there are power outages affecting hundreds of thousands of users in Chile. The power grid can be affected by several elements, such as rain and wind, but also by other natural phenomena such as earthquakes

<sup>229</sup> BNamericas (2020): Siemens Chile redobla su apuesta por las redes inteligentes, en: <https://www.bnamericas.com/es/entrevistas/siemens-chile-redobla-su-apuesta-por-las-redes-inteligentes>

<sup>230</sup> Frédéric Wurtz and Benoît Delinchant (2017): "Smart buildings" integrated in "smart grids": A key challenge for the energy transition by using physical models and optimization with a "human-in-the-loop" approach, en: <https://www.sciencedirect.com/science/article/pii/S1631070517300634>

<sup>231</sup> Zheng Ma, Alla Asmussen and Bo Nørregaard Jørgensen (2018): Industrial Consumers' Smart Grid Adoption: Influential Factors and Participation Phases, p. 6, en: <https://doi.org/10.3390/en11010182>

<sup>232</sup> US Department of Energy (2020): Energy Storage Projects, en: <https://www.sandia.gov/ess-ssl/global-energy-storage-database-home/>

<sup>233</sup> El Mercurio (2020): Comercializadores de energía se anticipan al debate por ley de distribución y crean gremio, en: <https://digital.elmercurio.com/2020/01/03/B/5K3O43IG#zoom=page-width>

<sup>234</sup> Energía Abierta (2020): Generación Distribuida – Instalaciones Inscritas, en: <http://datos.energiaabierta.cl/dataviews/235587/generacion-distribuida-instalaciones-inscritas/>

<sup>235</sup> EUPD Research (2020): Vergleichsanalyse von Community und Cloud Angeboten in Deutschland 2020, p. 4, en: [https://www.eupd-research.com/wp-content/uploads/EUPD\\_Research\\_Angebot\\_Community\\_Vergleich\\_2020.pdf](https://www.eupd-research.com/wp-content/uploads/EUPD_Research_Angebot_Community_Vergleich_2020.pdf)

<sup>236</sup> País Circular (2020): Mauro Henríquez: el primer doctor en energía solar graduado en el país apuesta por el almacenamiento térmico "hecho en Chile", en: <https://www.paiscircular.cl/industria/mauro-henriquez-el-primer-doctor-en-energia-solar-del-pais-apuesta-por-el-almacenamiento-termico-hecho-en-chile/>

and volcanic eruptions.<sup>237</sup> A possible area of research for a comprehensive system of interruption prevention is the construction of micro-networks or adding intelligence to the network to detect short circuits. On the other hand, considering possible causes of outages, planning plays an important role. Other possible measures that require further research are volcanic eruption, earthquakes and climate prediction systems combined with other data from the power grid.<sup>238</sup>

### 5.3 Technologies to link sectors

#### Green hydrogen

Given the great potential to generate renewable energy at low cost, in Chile the production of green hydrogen is especially relevant. In its National Hydrogen Strategy, the Government of Chile sets out three main objectives:

- Producing the cheapest green hydrogen on the planet by 2030
- Being among the top three exporters by 2040
- Having 5 GW of electrolysis capacity in development by 2025 with a production of 200 kton/year

The Ministry of Energy estimates that the first applications of green hydrogen in Chile will be the use of hydrogen in refineries, the production of ammonia and the injection into gas networks up to 20% even before 2025. By 2030, Chile aspires to enter the export market.<sup>239</sup> To achieve this, the Ministry of Energy has developed an action plan, which will conduct a US\$50 million financing round for green hydrogen projects to support investors in closing gaps.<sup>240</sup>

In the areas mentioned, Chile will need technology related to hydrogen storage such as ponds, hydrogen purification and compressors for injection into the grid. Also in a second step, the government has the use in transport in the case of medium trucks, mining trucks and buses, as well as the methanization of hydrogen for injection into the grid. In those areas that will use synthetic fuel production technology, there is a need to increase the efficiency of methanization processes and the construction of hydrogen fuel pumps for buses and trucks with all the infrastructure such as compressors, storage and transport of hydrogen.

In Chile there are already two hydrogen production plants that will be built over the next few years: the HIF Global project that will use wind energy for the production of green hydrogen and synthetic fuels in the Magallanes region. On the other hand, Engie and Enaex are planning to build a plant in the north of the country that will use solar energy to produce ammonia.<sup>241</sup> At industrial level, the mining industry stands out for its potential for the use of hydrogen in equipment such as excavators, front loaders and tractors.<sup>242</sup> It should be highlighted that CORFO is currently co-financing two technological consortia aiming at adapting extraction trucks and mobile mining equipment to dual oil-hydrogen combustion and fuel cells, respectively. This can be seen as an important step for technological development, but also for boosting demand that will be critical to the rapid development of the new hydrogen economy.

<sup>237</sup> Chile National Committee of the IEC (2019): La Resiliencia Eléctrica (y la necesidad de desarrollar Sistemas Inteligentes), en: <https://cornelec.cl/2019/04/29/la-resiliencia-electrica-y-la-necesidad-de-desarrollar-sistemas-inteligentes/>

<sup>238</sup> Chile National Committee of the IEC (2019): La Resiliencia Eléctrica (y la necesidad de desarrollar Sistemas Inteligentes), en: <https://cornelec.cl/2019/04/29/la-resiliencia-electrica-y-la-necesidad-de-desarrollar-sistemas-inteligentes/>

<sup>239</sup> Gobierno de Chile (2020): Estrategia Nacional de Hidrógeno verde, p. 19-21, en: [https://energia.gob.cl/sites/default/files/estrategia\\_nacional\\_de\\_hidrogeno\\_verde\\_-\\_chile.pdf](https://energia.gob.cl/sites/default/files/estrategia_nacional_de_hidrogeno_verde_-_chile.pdf)

<sup>240</sup> Ministerio de Energía (2020): Gobierno presenta la Estrategia Nacional para que Chile sea líder mundial en hidrógeno verde, en: <https://energia.gob.cl/noticias/nacional/gobierno-presenta-la-estrategia-nacional-para-que-chile-sea-lider-mundial-en-hidrogeno-verde>

<sup>241</sup> Revista Electricidad (2020): Cuatro proyectos de hidrógeno verde fueron presentados en última sesión de Cavendish Tour Patagonia, en: <https://www.revistaei.cl/2020/12/01/cuatro-proyectos-de-hidrogeno-verde-fueron-presentados-en-ultima-sesion-de-cavendish-tour-patagonia/#>  
Corporate page of Engie (2020): ENAEX & ENGIE: La transición hacia el cero carbono en la minería chilena, en [ENAEX & ENGIE: La transición hacia el cero carbono en la minería chilena](#) (reviewed on 22-12-2020)

<sup>242</sup> Reporte Minero (2020): El hidrógeno verde y su potencial en el mundo de las maquinarias, en: <https://www.reporteminero.cl/noticia/noticias/2020/11/el-hidrogeno-verde-y-su-potencial-en-el-mundo-de-las-maquinarias>



Apart from this, there are several other projects in the planning stage: The salmon company Salmo&boats in conjunction with the Universidad Austral de Chile wants to build a boat, which will use green hydrogen as fuel.<sup>243</sup>

However, in salmon farming there is potential for use in other areas as well, which have a high energy consumption: fish farms, processing plants, food plants, land transport and other means of maritime transport. In the areas mentioned, the director of the Aquaculture Innovation Club, Adolfo Alvia sees a possible start of the use of green hydrogen in wellboats and vessels transporting food.<sup>244</sup>

### Efficient buildings

Buildings in Chile have a very low energy efficiency standard.<sup>245</sup> The commercial, public and residential sectors are responsible for 22% of the country's energy consumption. If one analyzes the life cycle of a building, only 10% to 20% of the energy consumed is destined to the manufacture of the materials used, construction and renovation. In the operational phase, 80% to 90% of the energy is used.<sup>246</sup> Therefore, in reducing energy consumption, insulating materials play an important role. Among them, especially biobased insulators may have a great importance in the future, because they also have a lower environmental impact on their production. However, to develop those materials and implement production for large-scale use, research is still needed. Examples for those materials that can be used as insulators are sheep's wool, wood wool, recycled cellulose, cork panel and hempcrete. Residual fibers from crops such as sunflower, raps, hemp, wheat, flax, agave, among many others, are also being investigated as raw materials.<sup>247</sup>

On the other hand, all the equipment used in a building can also contribute to a reduction in energy consumption. Many times, the initial investment is more expensive, but with the reduction of energy consumption in the first third of the useful life the investment is recovered, and the next two thirds of its use manage to generate significant savings. Examples of this are efficient lighting, heat pumps, high-efficiency motors, compressors and pumps, high-efficiency boilers for ACS production, variable frequency drives, efficient ventilation, photovoltaic energy, solar thermal energy, and thermal reconditioning.<sup>248</sup>

### Technology for construction systems<sup>249</sup>

- Building automation
  - Development of technologies for the automation of buildings, i.e. surveillance, control, regulation and optimization facilities, are an important component for a more efficient management and use of energy<sup>250</sup>
  - Development of building automation technologies for the intelligent use of the network of buildings and neighborhoods (Smart Grid)
- Heat storage
  - Optimization of insulation and storage materials to increase storage capacity
  - Integration of the building structure with heat storage concepts
- Energy storage
  - Development of storage with stable cycle

<sup>243</sup> Electromov (2020): Este proyecto en Chile busca desarrollar embarcaciones propulsadas por H2 verde, en:

<https://www.electromov.cl/2020/11/26/este-proyecto-en-chile-busca-desarrollar-embarcaciones-propulsadas-por-h2-verde/>

<sup>244</sup> Salmonexpert (2020): Las oportunidades del hidrógeno verde para su uso en la salmonicultura, en: <https://www.salmonexpert.cl/article/las-oportunidades-del-hidrogeno-verde-para-su-uso-en-salmonicultura/>

<sup>245</sup> Universidad de Talca (2020): *UTalca midió eficiencia energética en 300 edificios y el 90% no cumple estándares mínimos*, <https://www.otalca.cl/noticias/otalca-midio-eficiencia-energetica-en-300-edificios-y-el-90-no-cumple-estandares-minimos/> (reviewed on 22-12-2020)

<sup>246</sup> Centro Tecnológico Construcción (2019): *Los materiales que construirán el futuro*, <https://ctecinnovacion.cl/los-materiales-que-construiran-el-futuro/> (reviewed on 22-12-2020)

<sup>247</sup> Centro Tecnológico Construcción (2019): *Los materiales que construirán el futuro*, <https://ctecinnovacion.cl/los-materiales-que-construiran-el-futuro/> (reviewed on 22-12-2020)

<sup>248</sup> Edifica (2020): Seminario online de Edifica: *Destaca los beneficios de la eficiencia energética en la construcción*, <https://www.edifica.cl/seminario-online-de-edifica-destaca-los-beneficios-de-la-eficiencia-energetica-en-la-construccion/> (reviewed on 22-12-2020)

<sup>249</sup> Wuppertal institute für Klima, Umwelt, Energie (2018): *Technologien für die Energiewende - Politikbericht*, [https://www.energieforschung.de/lw\\_resource/datapool/systemfiles/elements/files/70013C70EE963F41E0539A695E8680ED/current/document/TFE-Politikbericht\\_komplett.pdf](https://www.energieforschung.de/lw_resource/datapool/systemfiles/elements/files/70013C70EE963F41E0539A695E8680ED/current/document/TFE-Politikbericht_komplett.pdf), (reviewed on 22-12-2020), p. 117, 118

<sup>250</sup> Ministerio de Medio Ambiente, Protección de la Naturaleza, Construcción y Seguridad de los Reactores (2014): *GreenTech made in Germany 4.0*, [https://www.rolandberger.com/publications/publication\\_pdf/roland\\_berger\\_greentech\\_atlas\\_4\\_0\\_final\\_20141128.pdf](https://www.rolandberger.com/publications/publication_pdf/roland_berger_greentech_atlas_4_0_final_20141128.pdf), (reviewed on 22-12-2020), p.

- Development of redox flow batteries that have the advantage of a very long service life with unlimited cycle stability, very low self-discharge and a high level of operational safety<sup>251</sup>
- Major development of super-condensers to be used in buildings
- Heating, ventilation and air conditioning systems, especially Low-Ex systems
  - Development of new and optimized materials (e.g. phase change materials – PCM), and development of more efficient components (e.g. storage, pumps)
  - Development of concepts of systems based on environmental heat/thermal solar energy
  - Optimization of complete systems (e.g. monitorization, control of the temperature of the air and the external wall)

### Planning and building operations

- Information management
  - There is still great potential for expansion in building information modeling (BIM), which allows construction projects to be carried out faster, cheaper and with less environmental impact, since it records all relevant construction data digitally, combines them and connects them.<sup>252</sup>
- Life cycle analysis (ACV), monitoring and diagnosis
  - Integration of ecological data sets for the future energy and electrical matrix for the correct evaluation of the weighting between construction and the life cycle of buildings
  - There is still potential in the development of new monitoring equipment and intelligent and automated assessment systems for recorded data (e.g. self-learning of systems, fault detection)

### Energy efficiency and efficiency resources in the industry

The industry is becoming aware of the growing importance of energy efficiency and associated emission reductions; however, there is still ample room for improvement. Increasing energy efficiency in industry and mining not only increases productivity and competitiveness, but also reduces its carbon footprint and impact on the environment. The goal by 2035 is that 100% of large industrial and mining energy consumers should make efficient use of energy through the implementation and operation of energy management systems and the active implementation of energy efficiency improvements.<sup>253</sup> In addition, the current government is developing a Cold-Heat Strategy focused on the main issues that must be addressed to allow an efficient and sustainable development of thermal uses.<sup>254</sup>

A major obstacle to the introduction of energy efficiency measures is that still very few companies are aware of the energy consumption of their production processes. The first step is to identify energy consumption through an audit so that we can act accordingly. In addition, few have monitoring and measurement systems that are essential for data assessment and therefore the integration of energy efficiency systems.<sup>255</sup>

Self-sufficiency with renewable energies is an attractive alternative for the industry due to the high electrical and thermal demands. Through self-sufficiency, especially with renewable energies, energy costs can be reduced and/or the waste generated reused, as in the case of the agricultural sector. There is also a lot of potential for the commercialization of products produced 100% with renewable energies, for example, in the wine industry or in mining with "green copper".<sup>256</sup> According to figures from Fraunhofer Chile, agribusiness could meet 40% of its heat demand with solar thermal energy.<sup>257</sup> However, self-sufficiency is not yet

<sup>251</sup> Fraunhofer (2020): Redox-Flow-Batterien – Energiegroßspeicher der Zukunft, <https://www.umsicht.fraunhofer.de/de/presse-medien/interviews/redox-flow.html> (reviewed on 22-12-2020)

<sup>252</sup> Energie Experten (2013): *Building Information Modeling optimiert energieeffiziente Neu. Und Altbauplanung*, <https://www.energie-experten.org/experte/meldung-anzeigen/news/building-information-modeling-optimiert-energieeffiziente-neu-und-altbauplanung-4095.html> (reviewed on 22-12-2020)

<sup>253</sup> Ministerio de Energía (2015): *Energía 2050*, [https://www.energia.gob.cl/sites/default/files/energia\\_2050\\_-\\_politica\\_energetica\\_de\\_chile.pdf](https://www.energia.gob.cl/sites/default/files/energia_2050_-_politica_energetica_de_chile.pdf), (reviewed on 22-12-2020), p. 85

<sup>254</sup> Ministerio de Energía (2019): En Puerto Montt realizan taller multisectorial de estrategia Frío-Calor, en: <https://energia.gob.cl/noticias/los-lagos/en-puerto-montt-realizan-taller-multisectorial-de-estrategia-frio-calor>

<sup>255</sup> Cornelia Sonnenberg (2016): *Los desafíos para lograr una mayor eficiencia energética en Chile*, en: El Mostrador, <https://www.elmostrador.cl/mercados/2016/02/25/los-desafios-para-lograr-una-mayor-eficiencia-energetica-en-chile/> (reviewed on 22-12-2020)

<sup>256</sup> La Tercera (2020): El cobre verde, un paso obligado para la neutralidad de carbono, en: <https://www.latercera.com/opinion/noticia/el-cobre-verde-un-paso-obligado-para-la-carbono-neutralidad/JUBSNAZIQVCCZP72VJJ43H7ILI/>

<sup>257</sup> Revista Electricidad (2020): Energía solar térmica puede suplir hasta 40% de la demanda en la agroindustria, en: <https://www.revistaeci.cl/informes-tecnicos/energia-solar-termica-puede-suplir-hasta-40-de-la-demanda-en-la-agroindustria/#>

widespread in Chile, despite the enormous natural potential of renewable energies. The National Center for Innovation and Promotion of Sustainable Energies (CIFES) identified as the main obstacles to technical, economic and financial barriers that slow down or prevent the introduction of efficient energy management with energy efficiency and renewable energy measures.<sup>258</sup>

## 5.4 Technologies for energy-efficient processes

The industrial sector is responsible for 40% of energy consumption in Chile. Since mining leads as a subsector with 40%, followed by various industries (30%), paper and pulp (20%), the mining and forestry industry sectors will be analyzed in more detail below.

### Mining industry

Mining accounts for 29% of Chile's electricity consumption and is estimated to account for 11% of the industry's operating costs. It is estimated that by 2029 electricity consumption would grow by approximately 2.9% per year.<sup>259</sup> The concentrator process represents the largest consumption in the sector and an increase from 50% is expected.<sup>260</sup> In addition, Cochilco estimates that by 2028 the energy consumption of the mining sector may increase by 38%.<sup>261</sup>

- According to the study "Roadmap 2.0 of Chilean Mining" published by Alta Ley, there is a potential for the development of fuel substitution and energy efficiency related to the transport of minerals for trucks and belts and technology for the self-generation of energy from ore conveyor belts.
- Another aspect is the development of technologies for increasing storage capacity and technologies for power generation.
- In mining production processes (value chain), especially in concentrate plant operations, there is an opportunity to incorporate more renewable energies, such as solar, wind and green hydrogen.<sup>262</sup>
- Moreover, the energy consumption of processes can be studied and predicted through a greater incorporation of simulations of virtual scenarios to analyze the impact of possible changes or for the comparison of different technological alternatives.<sup>263</sup>

### Forest industry

Forest biomass energy has great potential in Chile, as waste and products resulting from the management of native forest and forest plantations can be used as a resource for energy recovery. The industry is not only expanding with new plants, but also expanding and modernizing existing facilities and that means an increase in energy demand.<sup>264</sup>

The processing of wood in sawmills generates a significant amount of waste that can be used even better. Large forestry companies are already using this waste as a renewable energy source to self-supply through their own generation and cogeneration of heat for their industrial processes, such as drying. However, there is an opportunity to increase energy efficiency in small and medium-scale producers, who today do not use the

<sup>258</sup> Chile Sustentable (2015): *Nuevo programa promueve el autoabastecimiento energético sustentable en la actividad turística del país*, <http://www.chilesustentable.travel/noticias/nuevo-programa-promueve-el-autoabastecimiento-energetico-sustentable-en-la-actividad-turistica-del-pais/> (reviewed on 22-12-2020)

<sup>259</sup> Cochilco (2018): *Proyección del Consumo de Energía Eléctrica en la Minería del Cobre 2018-2029*, <https://www.cochilco.cl/Listado%20Temtico/Proyecci%C3%B3n%20Consumo%20EE%202018-2029.pdf>, (reviewed on 22-12-2020), p. 2

<sup>260</sup> Alta Ley (2019): *Hoja de Ruta 2.0 de la Minería Chilena. Actualización y consensos para una Mirada renovada*, [https://corporacionaltaley.cl/wp-content/uploads/2019/12/ACTUALIZACION%CC%81N-HOJA-DE-RUTA-MINERIA-DEL-COBRE\\_2019.pdf](https://corporacionaltaley.cl/wp-content/uploads/2019/12/ACTUALIZACION%CC%81N-HOJA-DE-RUTA-MINERIA-DEL-COBRE_2019.pdf), (reviewed on 22-12-2020), p. 7

<sup>261</sup> Revista Electricidad (2019): *Las 10 mineras con mayor consume eléctrico en MWh*, <https://www.revistaei.cl/reportajes/las-10-mineras-con-mayor-consumo-electrico-en-mwh/> (reviewed on 22-12-2020)

<sup>262</sup> [https://corporacionaltaley.cl/wp-content/uploads/2019/12/ACTUALIZACION%CC%81N-HOJA-DE-RUTA-MINERIA-DEL-COBRE\\_2019.pdf](https://corporacionaltaley.cl/wp-content/uploads/2019/12/ACTUALIZACION%CC%81N-HOJA-DE-RUTA-MINERIA-DEL-COBRE_2019.pdf), (reviewed on 22-12-2020), p. 7

<sup>263</sup> Consejo Minero, Fundación Chile y Corporación Alta Ley (2020). *Roadmap: Digitalización para una Minería 4.0*, <https://digitalizacionmineria.fch.cl/wp-content/uploads/2020/08/roadmap-digitalizacion.pdf>, (reviewed on 22-12-2020), p. 13

<sup>264</sup> Deutsche Gesellschaft für Technische Zusammenarbeit y National Energy Commission (2008): *Potencial de Biomasa Forestal*, [https://energia.gob.cl/sites/default/files/estudio\\_potencial\\_biomasa\\_forestal.pdf](https://energia.gob.cl/sites/default/files/estudio_potencial_biomasa_forestal.pdf) (reviewed on 22-12-2020), p. 18

potential of forest waste because they do not have the necessary technology.<sup>265</sup> A CONAF study concluded that, among small forest owners, who own almost 25% of forest plantations, and large forest plantations, there is a significant technological gap between small forest owners, who own almost 25% of forest plantations.<sup>266</sup>

### Integrating aspects: Electromobility

In terms of energy, the transport sector accounts for 35% of the country's energy demand and generates more than 20% of total emissions.<sup>267</sup>

With the publication of the National Electromobility Strategy, the Chilean government stressed the importance of electromobility as a fundamental component for the reduction of CO<sub>2</sub> emissions in the transport sector. The goal is that 100% of urban public transport will be electric by 2040 and that by 2050 electric private vehicles will be 40% of the automotive fleet.<sup>268</sup> Electromobility and electric heating are essential to ensure cleaner cities and counter climate change.

There is a need to invest in R&D for innovative battery and battery management systems. For example, to increase vehicle autonomy and reduce the use of resources in production.<sup>269</sup> In addition to traction technologies, charging infrastructure is a necessary prerequisite for electromobility.

There are still some outstanding issues in relation to technical aspects, such as increasing the autonomy of electric vehicles, reducing charging times, improving the interoperability of technology and generating electricity infrastructure.<sup>270</sup>

In addition, the Federico Santa María Technical University (UTFSM) identified four trends to advance in R&D in electromobility for Chile, which are: 1) working on vehicle parts and parts (i.e., more efficient mechanisms in engines and regenerative braking), 2) improving energy storage (higher energy density, greater capacity to (dis)load in shorter times), 3) controlling energy flows and integration (electronic development for a more efficient use of electrical energy, integration to the electrical grid to inject electricity into a distribution system) and 4) data management (capture data of interest, vehicle connectivity, business models for demand management etc.)<sup>271</sup>

### Integrating aspects: Information and communication technology (ICT)

By closely linking information and communication technologies, controllable systems can be enabled with generation or consumption components in the energy sector.<sup>272</sup> Intelligent connection and networking of individual components is an important prerequisite for approaches to end-to-end solutions.<sup>273</sup> There is a great need for efficient data transmission, storage and processing.

<sup>265</sup> Pontificia Universidad Católica de Chile (2011): *Energía de biomasa forestal, lecciones internacionales y su potencial en Chile*, [http://hrudnick.sitios.ing.uc.cl/alumno01/biomass/Energy\\_from\\_Forestry\\_Biomass\\_in\\_Chile\\_-\\_Bellolio\\_&\\_Karelovic.pdf](http://hrudnick.sitios.ing.uc.cl/alumno01/biomass/Energy_from_Forestry_Biomass_in_Chile_-_Bellolio_&_Karelovic.pdf) (reviewed on 22-12-2020), p. 4, 21

<sup>266</sup> CONAF (2015): *Propuesta de acciones para minimizar las brechas en el manejo de plantaciones forestales de pequeños y medianos propietarios informe final*, [https://www.conaf.cl/wp-content/files\\_mf/1465506616EstudioparaMinimizarBrechasenManejodePlantaciones.pdf](https://www.conaf.cl/wp-content/files_mf/1465506616EstudioparaMinimizarBrechasenManejodePlantaciones.pdf) (reviewed on 22-12-2020), p. 84

<sup>267</sup> Nueva Minería y Energía (2018): *Electromovilidad: oportunidades y desafíos para la nueva industria*, <http://www.nuevamineria.com/revista/electromovilidad-oportunidades-y-desafios-para-la-nueva-industria/> (reviewed on 22-12-2020)

<sup>268</sup> Ministerio de Energía (s. a.): *Plataforma de Electromovilidad*, en: <https://energia.gob.cl/electromovilidad/orientaciones-de-politicas-publicas>

<sup>269</sup> Deutsche Energie-Agentur (2015): *Elektromobilität als Baustein der Energiewende im Verkehr*, [https://www.dena.de/fileadmin/dena/Dokumente/Presse\\_\\_\\_Medien/Gastbeitraege/Interviews/DVGW\\_Newsletter91466.pdf](https://www.dena.de/fileadmin/dena/Dokumente/Presse___Medien/Gastbeitraege/Interviews/DVGW_Newsletter91466.pdf) (reviewed on 22-12-2020)

<sup>270</sup> Revista de Electricidad (2020): *Electromovilidad: Lo que viene en 2020*, [https://www.revistaei.cl/wp-content/uploads/2020/01/ELECTRICIDAD\\_230\\_Digital.pdf](https://www.revistaei.cl/wp-content/uploads/2020/01/ELECTRICIDAD_230_Digital.pdf) (reviewed on 22-12-2020), p. 12

<sup>271</sup> Revista de Electricidad (2019): *Las cuatro tendencias en I+D para la electromovilidad en Chile*, <https://www.revistaei.cl/2019/07/04/las-cuatro-tendencias-en-id-para-la-electromovilidad-en-chile/#> (reviewed on 22-12-2020)

<sup>272</sup> Revista de Electricidad (2020): *Ciudades inteligentes: Innovación energética ante la crisis*, <https://www.revistaei.cl/reportajes/ciudades-inteligentes-innovacion-energetica-ante-la-tesis/#> (reviewed on 22-12-2020)

<sup>273</sup> Ministerio de Medio Ambiente, Protección de la Naturaleza, Construcción y Seguridad de los Reactores (2014): *GreenTech made in Germany 4.0*, [https://www.rolandberger.com/publications/publication\\_pdf/roland\\_berger\\_greentech\\_atlas\\_4\\_0\\_final\\_20141128.pdf](https://www.rolandberger.com/publications/publication_pdf/roland_berger_greentech_atlas_4_0_final_20141128.pdf) (reviewed on 22-12-2020), p.

In order for ICT to help make the energy system more efficient and user-friendly, the following concepts and technologies could be developed<sup>274</sup>:

1. Data measurement and processing: mechanisms for identifying data characteristics and the purposes for which they can serve, in what form they are added (energy information network).
2. Condition measurements and forecasts of generation and consumption have a major impact on the energy system's safety and efficiency (it facilitates accurate knowledge of the current state and the near future enabling safe energy operation).
3. Make production processes more flexible and automated, which can also contribute to the stability of the energy system with fluctuating power generation.

Especially in the mining sector and in industry there is a great potential for automation and implementation of technological innovation. Part of that so-called Industry 4.0 can be autonomous robots, process simulation, horizontally and vertically integral systems, the Internet of Things, cybersecurity, the cloud, additive manufacturing, augmented reality and "big data" and analysis. In their Industry 4.0 Strategy, Marfán and Meller recommend that productive companies take care of<sup>275</sup>:

- Integration of the new and existing technological "capabilities"
- Effective and efficient management of the "Information architecture"
- Design of a "Roadmap" of the company's structural transformation
- Implementation of a strategic project at "management" level for Industry 4.0

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<sup>274</sup> Wuppertal Institute für Klima, Umwelt, Energie (2018): *Technologien für die Energiewende - Politikbericht*, [https://www.energieforschung.de/lw\\_resource/datapool/systemfiles/elements/files/70013C70EE963F41E0539A695E8680ED/current/document/TFE\\_Politikbericht\\_komplett.pdf](https://www.energieforschung.de/lw_resource/datapool/systemfiles/elements/files/70013C70EE963F41E0539A695E8680ED/current/document/TFE_Politikbericht_komplett.pdf), (reviewed on 22-12-2020), p. 145

<sup>275</sup> Asimet (2019): *Estrategia Industria 4.0: Diseñando el Chile futuro*, en: <https://consejominero.cl/wp-content/uploads/2019/08/Estrategia-Industria-4.0-Dise%C3%B1ando-el-Chile-Futuro.pdf>

## 6 Oportunidades de Colaboración entre Chile y Alemania / Opportunities for Collaboration between Germany and Chile

Chile y Alemania se ven enfrentados a desafíos similares en relación con la transición energética y para alcanzar las metas propuestas, el emprendimiento innovador de base tecnológica se presenta como un elemento fundamental para generar las nuevas tecnologías, servicios y modelos de negocio requeridos. Con el inicio de la ‘Energiewende’ en Alemania y la meta que Alemania y Chile se han propuesto de lograr la neutralidad de carbono al 2050, se presentan una serie de oportunidades para emprendimientos para desarrollar y probar tecnologías y modelos de negocio en mercados emergentes que en muchos otros países recién se irán desarrollando en unos años más. Al comparar Alemania y Chile podemos constatar que en campos como, por ejemplo, la calefacción distrital, las baterías caseras y la eficiencia energética en edificaciones, entre otros, Alemania ya lleva un camino recorrido en cuanto a desarrollos e implementaciones tecnológicas, mientras que en otros ámbitos, *startups* de ambos países están haciendo su contribución para desarrollar nuevas tecnologías y servicios, entendiendo que las metas políticas definidas en ambos países son las que van a ir gatillando la demanda por parte del mercado. Es en este contexto que se abren interesantes oportunidades de colaboración entre ambos ecosistemas del emprendimiento para apoyar el desarrollo de *startups* de ambos países.

### ***Innovation-driven versus Efficiency-driven***

Al analizar el ecosistema de emprendimiento de ambos países, una característica que influye fuertemente en cada una de las seis dimensiones analizadas son los dos estados diferentes en que están clasificadas las economías de Alemania y Chile: Alemania se caracteriza por tener una economía “*innovation-driven*”, lo cual hace referencia a su capacidad de producir nuevos productos innovadores mediante procesos sofisticados<sup>276</sup>. Las empresas alemanas se basan en conocimiento e invierten fuertemente en habilidades y tecnologías avanzadas, por lo cual el *Global Competitiveness Report 2019* del *World Economic Forum* (WEF) le otorga a Alemania la mejor capacidad de innovación del mundo con un puntaje de 86,8 puntos de 100<sup>277</sup>.

Chile, en cambio, es clasificado como una economía ‘*efficiency driven*’, es decir, impulsada por mejoras en eficiencia de los procesos de producción donde la mayor parte de la tecnología se importa de los países desarrollados. Según el *Global Competitiveness Report 2019*<sup>278</sup>, el indicador de innovación es el más bajo de todos los indicadores analizados dejando a Chile en el lugar 52 de 137 países con un puntaje de 28,6 puntos de 100 en su capacidad de innovación. Las principales debilidades de Chile se encuentran en una baja capacidad de innovación, un bajo gasto en I+D por parte del sector privado y baja colaboración en I+D entre universidad e industria.

<sup>276</sup> Sternberg, Rolf et al. (2019): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2018/19*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20182019/> (reviewed on 16-12-2020) p. 20

<sup>277</sup> WEF (2019): *The Global Competitiveness Report 2019*, [http://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf) (reviewed on 22-12-2020), p.16.

<sup>278</sup> WEF (2019): *The Global Competitiveness Report 2019*, [http://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf) (reviewed on 22-12-2020), p.16., p. 13



Es aquí donde se abre un espacio interesante de colaboración a nivel de política pública entre ambos países para intercambiar experiencias y encontrar las mejores formas para el fomento del emprendimiento en energía: Según el análisis desarrollado en la dimensión “Política Pública” del ecosistema de emprendimiento chileno, en Chile hoy están dadas las condiciones para que se abra un proceso coordinado entre el Ministerio de Energía y CORFO para definir las áreas estratégicas que requieren de apoyo para su desarrollo y de esta manera armar fondos y programas específicos para el desarrollo de *startups* en energía que tengan soluciones innovadoras para enfrentar los desafíos de la transición energética.

En Alemania, en cambio, ya existen este tipo de programas de fomento específico a la innovación en energía, asociados además a la implementación de la infraestructura de I+D y de pilotaje necesaria. Alemania también ha creado otros instrumentos financieros de apoyo, como es el High-Technology Entrepreneurship Fund (HTGF, por sus siglas en alemán), un fondo de inversión financiado por el Ministerio de Economía y Energía, la KfW y 28 empresas privadas. Este fondo es el inversionista de capital de riesgo más importante para *startups* enfocadas en tecnología y modelos de negocio innovadores. En este sentido, Alemania le atribuye un rol muy importante al Estado como financista de innovaciones tecnológicas, tal como lo grafica Mariana Mazzucato en el libro “*The Entrepreneurial State*”<sup>279</sup>. Por lo general tiene un rol primordial en lo que son innovaciones radicales en los ámbitos considerados como estratégicos y por ende muy a menudo este es el inversionista más temprano y que asume un alto riesgo. Esto también se refleja en la Estrategia Nacional de Hidrógeno de Alemania, donde se están destinando importantes recursos fiscales para fomentar aceleradamente una economía del hidrógeno.

#### **Infraestructura para I+D y Pilotaje: Un Factor de Relevancia**

En esta misma línea, Alemania ha logrado implementar amplia infraestructura para los procesos de I+D al alero de las *startups* a través de la implementación, entre otros, de 309 Centros de Emprendimiento y Tecnología<sup>280</sup> para el desarrollo empresarial regional: los Centros de Emprendimiento y Tecnología son complejos de edificios en los que las *startups* orientadas a la tecnología se instalan en “sus propias” salas, pero en una comunidad con otras empresas de la misma región y orientadas a la innovación. Las necesidades de infraestructura y apoyo para desarrollar nuevos productos y servicios son claves para *startups* innovadoras, por lo cual estos centros brindan a los emprendedores buenas oportunidades para una cooperación estrecha con instituciones científicas y de investigación, para así acceder a la infraestructura necesaria. En este sentido, el ecosistema de emprendimiento alemán cuenta con una evaluación excelente en relación con todos los aspectos relacionados con la infraestructura para realizar I+D y pilotajes.

Con esto se abre una interesante oportunidad para la cooperación entre ambos países: En comparación con Alemania, el gasto de I+D en Chile es muy bajo alcanzando solo el 0,35 % del PIB para el 2018, equivalente a 1.044 MM de dólares<sup>281</sup>. Así mismo, en Chile actualmente, en comparación con Alemania, la infraestructura para realizar actividades de I+D y de pilotaje de nuevas tecnologías está muy poco desarrollada y es poco accesible para las *startups*, aun cuando, según lo analizado anteriormente, se está buscando cambiar esto a través de los esfuerzos de diferentes actores al alero de CORFO y de la Agencia Nacional de Investigación y Desarrollo (ANID). Entre varios otros factores, el difícil acceso a infraestructura adecuada para desarrollar actividades de I+D y de pilotaje tiene una incidencia en el bajo grado de innovación en los productos y procesos desarrollados por los emprendedores chilenos.

Por ende, una potencial colaboración entre ambos países en este ámbito podría mejorar la tasa de innovación tecnológica de las *startups* chilenas en energía al abrir, por ejemplo, a través de programas de intercambio, el acceso a la infraestructura existente en ese país para desarrollar sus ideas.

<sup>279</sup> Mazzucato, Marianna (2013): *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*

<sup>280</sup>La Asociación Federal de Centros Alemanes de Innovación, Tecnología y Emprendimiento (Bundesverband Deutscher Innovations-, Technologie- und Gründerzentren) representa como organización central los intereses de los Centros de Emprendimiento y Tecnología y las *startups* relacionadas. Además, ha desarrollado su propio procedimiento de auditoría para aplicar normas de calidad uniformes a los centros.

<sup>281</sup> Ministerio de Ciencia, Tecnología, Conocimiento e Innovación (2020): *Encuesta de I+D: Resultados año de referencia 2018 y mejoras a futuro* [https://www.minciencia.gob.cl/sites/default/files/webinar\\_resultados\\_id\\_20200507.pdf](https://www.minciencia.gob.cl/sites/default/files/webinar_resultados_id_20200507.pdf) (reviewed on 10-12-2020)



Así mismo, si Chile con el tiempo busca transformarse en un *hub* de innovación, fomentar la internacionalización de las *startups* es fundamental. En Chile hay un gran potencial para que *startups* desarrollen soluciones B2B (*business to business*), considerando que el mercado nacional para soluciones B2C (*business to consumer*) es relativamente pequeño con 17 millones de habitantes, pero hay mucho desarrollo a nivel industrial. Lograr una vinculación con los diferentes actores del ecosistema de emprendimiento de Alemania facilitaría la apertura de un nuevo mercado para *startups* chilenas, razón por la cual sería importante desarrollar diferentes instrumentos públicos que apoyen estos procesos. Además, como las regulaciones en Alemania en algunos ámbitos son mucho más estrictas, sería fundamental que ambos países colaboraran para asegurar que los desarrollos hechos en Chile puedan cumplir con el marco regulatorio alemán en el ámbito energético.

### Potencial del Mercado Chileno

Aun cuando uno de los principales obstáculos identificados en la dimensión “Mercados” para el emprendimiento en energía en Chile es la baja cultura innovadora de las empresas en el país, el mercado chileno tiene dos ventajas importantes y atractivas para fomentar la colaboración en el ámbito del emprendimiento en energía: por un lado, una vez que las tecnologías ya se encuentran en una fase de maduración, el mercado chileno tiene un potencial interesante para la aplicación de tecnologías y servicios en el ámbito energético dado su claro marco regulatorio en temas energéticos, sus condiciones macroeconómicas relativamente estables, una cultura fiable para hacer negocios y su estado de ‘*efficiency-driven*’ que hace que la mayoría de las tecnologías se importen. Además, se presenta como una atractiva puerta de entrada a otros mercados de Latinoamérica, debido a que ha sido una de las economías más estables, además de contar con la infraestructura, el financiamiento y la calidad de vida suficientes para desarrollar negocios. Por ende, para las *startups* alemanas en energía al igual que para los inversionistas, Chile se presenta como un mercado muy atractivo y un lugar para establecer una base de operaciones.

Por otro lado, debido a sus extraordinarias y al mismo tiempo desafiantes condiciones naturales, Chile se presenta como un mercado muy atractivo para el pilotaje de tecnologías en el ámbito de las energías renovables, como la energía solar (una tecnología capaz de resistir las condiciones extremas del desierto de Atacama tiene un buen desempeño en cualquier otro lugar), energía mareomotriz (4.000 km de costa, pero con una corriente muy fuerte y una gran profundidad a muy poca distancia de la costa), geotermia (cadena de volcanes que brinda excelentes condiciones) y eólica (vientos muy fuertes en la Patagonia y profundidad del mar para construir plataformas offshore u otras alternativas tecnológicas). Por ende, puede ser de mucha relevancia para *startups* alemanas en estos ámbitos, encontrar alianzas con socios estratégicos (centros de pilotaje, incubadoras, el Instituto de Tecnologías Limpias, el Centro de Electromovilidad, el Centro de Economía Circular, etc.) para poder llevar a cabo los procesos de pilotaje que requieran, además de armar alianzas comerciales con *startups* y Pymes que podrían ser socios comerciales.

*Chile and Germany are facing similar challenges in connection with the energy transition and in order to achieve the proposed goals, innovative technology-based entrepreneurship is a crucial element to enable them to develop the new technologies, services and business models required. With the launch of the 'Energiewende' in Germany and the goal that Germany and Chile have set to achieve carbon neutrality by 2050, there is a series of opportunities for ventures to develop and test technologies and business models in emerging markets that in many other countries will only be developed in a few more years. A comparison between Germany and Chile shows that in fields such as district heating, home batteries and energy efficiency in buildings, among others, Germany has already come a long way in terms of technological developments and implementations, while in other areas, startups from both countries are making their contribution to develop new technologies and services, understanding that the political goals defined in both countries are the ones that will trigger the demand from the market. It is in this context that interesting collaboration opportunities are opening up between the two entrepreneurship ecosystems to support the development of startups in both countries.*

### Innovation-Driven Versus Efficiency-Driven

*In analyzing the entrepreneurship ecosystem of both countries, one feature that strongly influences each of the six dimensions analyzed is the two different statuses in which the economies of Germany and Chile are classified: Germany is characterized by having an “innovation-driven” economy, which refers to its ability to produce new*

innovative products through sophisticated processes.<sup>282</sup> German companies are knowledge-based and invest heavily in advanced skills and technologies, which is why the World Economic Forum's (WEF) Global Competitiveness Report 2019 ranks Germany as the world's best innovator with a score of 86.8 out of 100 points<sup>283</sup>.

Conversely, Chile is classified as an 'efficiency driven' economy, i.e., driven by efficiency improvements in production processes where most of the technology is imported from developed countries. According to the Global Competitiveness Report 2019<sup>284</sup>, the innovation indicator is the lowest of all the indicators analyzed, ranking Chile 52nd out of 137 countries with a score of 28.6 points out of 100 for its innovation capability. Chile's main weaknesses are low innovation capacity, low R&D spending by the private sector and low R&D collaboration between academia and industry.

Germany's outstanding position in innovation goes hand in hand with a public policy focused on fostering R&D activities. Germany has the fourth highest total R&D expenditure in the world<sup>285</sup>. In 2018, the government and industry together invested €104.7 billion in R&D, accounting for 3.13% of GDP. By 2025, the government seeks to increase this figure to 3.5% of GDP, together with the federal states and industry. Underpinning this goal is the 'High-Tech Strategy 2025' with a roadmap that defines the fields of action and milestones of research and innovation policy for the coming years<sup>286</sup>. Germany set up an Energy Research Program in this context (Energieforschungsprogramm)<sup>287</sup>, which now in its seventh version is called "Innovations for the Energy Transition" (Innovationen für die Energiewende) and whereby the German government establishes guidelines for research funding in the strategic topics for the Energy Transition between 2018 and 2022, pursuing a strategy that focuses on technology transfer and innovation. Through "real laboratories" (Reallabore), it seeks to implement and pilot new and promising technological solutions under real market conditions. The experience gained in the "laboratories" serves as a compass for the subsequent application of the technologies on a large scale.

An interesting space for collaboration at the public policy level between the two countries to exchange experiences and find the best ways to promote energy entrepreneurship opens up: According to the analysis undertaken in the "Public Policy" dimension of the Chilean entrepreneurship ecosystem, the conditions are now in place in Chile for a coordinated process between the Ministry of Energy and CORFO to define the strategic areas that require support for their development and thus create specific funds and programs for the development of energy startups that have innovative solutions to meet the challenges of the energy transition.

By contrast, Germany already has this type of program to specifically promote innovation in energy, which is also linked to the implementation of the necessary R&D and piloting infrastructure. Germany has also created other financial support instruments, such as the High-Tech Venture Fund (HTGF), an investment fund financed by the Ministry of Economics and Energy, KfW and 28 private companies. This fund is the most important venture capital investor for startups focused on technology and innovative business models. As Mariana Mazzucato illustrates in the book "The Entrepreneurial State", Germany attaches a very important role to the state as a financier of technological innovations<sup>288</sup>. It usually plays a leading role in what are considered to be radical innovations in strategic areas and is therefore very often the earliest and most risk-taking investor. This is also echoed in Germany's National Hydrogen Strategy, where significant government resources are being earmarked for the fast-paced promotion of a hydrogen economy.

<sup>282</sup> Sternberg, Rolf et al. (2019): *Global Entrepreneurship Monitor - Unternehmensgründungen im weltweiten Vergleich. Länderbericht Deutschland 2018/19*, <https://www.rkw-kompetenzzentrum.de/gruendung/studie/global-entrepreneurship-monitor-20182019/> (visited on 12-16-2020) p. 20

<sup>283</sup> WEF (2019): *The Global Competitiveness Report 2019*, [http://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf) (visited on 12-22-2020), p.16.

<sup>284</sup> WEF (2019): *The Global Competitiveness Report 2019*, [http://www3.weforum.org/docs/WEF\\_TheGlobalCompetitivenessReport2019.pdf](http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf) (visited on 12-22-2020), p.16., p. 13

<sup>285</sup> BMBF (2020a): *Daten und Fakten zum deutschen Forschungs- und Innovationssystem. Bundesbericht Forschung und Innovation 2020*, [https://www.bundesbericht-forschung-innovation.de/files/BMBF\\_BuFI-2020\\_Datenband.pdf](https://www.bundesbericht-forschung-innovation.de/files/BMBF_BuFI-2020_Datenband.pdf) (visited on 12-22-2020), p.10.

<sup>286</sup> BMBF (2018): *Forschung und Innovation für die Menschen. Die Hightech-Strategie 2025*, [https://www.bmbf.de/upload\\_filestore/pub/Forschung\\_und\\_Innovation\\_fuer\\_die\\_Menschen.pdf](https://www.bmbf.de/upload_filestore/pub/Forschung_und_Innovation_fuer_die_Menschen.pdf) (visited on 12-22-2020)

<sup>287</sup> Since the late 1970s, the German government has been funding research into energy technologies within the framework of Energy Research Programs (Energieforschungsprogramme). These programs take up the strategic political objectives of energy policy and set the guidelines for research funding. Under these programs, the ministries call for applications for research projects..

<sup>288</sup> Mazzucato, Marianna (2013): *The Entrepreneurial State: Debunking Public vs. Private Sector Myths*

**Infrastructure For R&D and Piloting: A Significant Factor**

Similarly, Germany has managed to implement extensive infrastructure for R&D processes in support of startups through the implementation of more than 309 Entrepreneurship and Technology Centers, among others<sup>289</sup> for regional business development: the Entrepreneurship and Technology Centers are building complexes in which technology-oriented startups are set up in “their own” rooms, but in a community with other innovation-oriented companies from the same region. The infrastructure and support needs for developing new products and services are key for innovative startups, so these centers provide entrepreneurs with good opportunities for close cooperation with scientific and research organizations to access the necessary infrastructure. As such, the German entrepreneurship ecosystem is highly rated with regard to all aspects related to infrastructure for R&D and piloting.

Thus, this opens an interesting opportunity for cooperation between the two countries: compared to Germany, R&D expenditure in Chile is very low amounting to only 0.35 of the GDP as of 2018, accounting for 1,044 billion USD<sup>290</sup>. Moreover, in Chile, compared to Germany, the infrastructure for R&D activities and piloting of new technologies is currently underdeveloped and poorly accessible to startups, even though, as discussed above, efforts are being made to change this through the joint work of different stakeholders under the auspices of CORFO and the National Agency for Research and Development (ANID). Among several other factors, the difficult access to a suitable infrastructure to develop R&D and piloting activities has an impact on the low innovation level of the products and processes developed by Chilean entrepreneurs.

Hence, a potential collaboration between the two countries in this area could improve the rate of technological innovation of Chilean startups in energy by opening, for example, access to the existing infrastructure in that country to develop their ideas through exchange programs.

Similarly, if Chile eventually seeks to become an innovation hub, it is essential to encourage the globalization of startups. In Chile there is great potential for startups to develop B2B (business to business) solutions, given that the national market for B2C (business to consumer) solutions is relatively small with a population of 17 million, but there is a lot of development at the industrial level. Achieving a linkage with the different stakeholders of the German entrepreneurship ecosystem would facilitate the opening of a new market for Chilean startups, which is why it is important to implement different public instruments to support these processes. In addition, as regulations in Germany in some areas are much stricter, both countries should collaborate to ensure that developments made in Chile can comply with the German regulatory framework in the energy field.

**Chilean Market Potential**

While one of the main obstacles identified in the “Markets” dimension for energy entrepreneurship in Chile is the low innovative culture of companies in the country, the Chilean market has two important and attractive advantages to foster collaboration in the field of energy entrepreneurship: firstly, once the technologies are mature, the Chilean market has an interesting potential for the application of technologies and services in the energy field given its clear regulatory framework on energy issues, its relatively stable macroeconomic conditions, a reliable culture for doing business and its 'efficiency-driven' status that makes most of the technologies to be imported. It is also an attractive gateway to other Latin American markets, as it has been one of the most stable economies, as well as having sufficient infrastructure, financing, and quality of life to develop business. Therefore, for German energy startups as well as for investors, Chile is an attractive market and a place to establish a base of operations.

<sup>289</sup>The Federal Association of German Innovation, Technology and Entrepreneurship Centers (*Bundesverband Deutscher Innovations-, Technologie- und Gründerzentren*) acts as the umbrella organization representing the interests of Entrepreneurship and Technology Centers and related startups. In addition, it has developed its own audit procedure to apply standardized quality standards to the centers..

<sup>290</sup> Ministry of Science, Technology, Knowledge, and Innovation (2020): R&D Survey: 2018 baseline year results and forward-looking improvements. [https://www.minciencia.gob.cl/sites/default/files/webinar\\_resultados\\_id\\_20200507.pdf](https://www.minciencia.gob.cl/sites/default/files/webinar_resultados_id_20200507.pdf) (visited on 12-10-2020)

Furthermore, due to its extraordinary and equally challenging natural conditions, Chile appears as a very attractive market for piloting renewable energy technologies, such as solar energy (a technology capable of coping with the extreme conditions of the Atacama Desert performs well anywhere else), wave energy (4,000 km of coastline, but with a very strong current and a great depth at a very short distance from the coast), geothermal (chain of volcanoes that provides excellent conditions) and wind (very strong winds in Patagonia and depth of the sea to build offshore platforms or other technological alternatives). Therefore, it may be of great relevance for German startups in these areas to find alliances with strategic partners (pilot centers, incubators, the Institute for Clean Technologies, the Center for Electromobility, the Center for Circular Economy, etc.) to carry out the piloting processes they require, as well as to build commercial alliances with startups and SMEs that could become commercial partners.

## 6.1 Potenciales Líneas de Acción (español)

Los objetivos ambiciosos de la transición energética sólo pueden alcanzarse, implementando una mezcla de diferentes tecnologías, servicios y modelos de negocio. Según lo descrito anteriormente, el rol de las *startups* en este contexto es de suma importancia ya que, junto con tecnologías maduras que ya se están comercializando, se requiere de nuevos desarrollos tecnológicos, de servicios y modelos de negocio para cerrar las brechas tecnológicas.

Con el fin de obtener resultados positivos se requiere de una agenda de trabajo y de actividades de largo plazo, asegurando que todos los grupos de interés permanezcan articulados y sean constantes, lo que permite una mejora de la toma de decisión a nivel privado y público. Para ello, sin duda es necesario fortalecer un ambiente igualitario y justo para el ecosistema de emprendimiento de energía, fortaleciendo el mercado, implementando acuerdos de doble tributación y facilitando la inversión. Al mismo tiempo debe asegurarse la disminución de la burocracia, un sistema impositivo simple y soluciones atractivas de financiamiento.

En vista de las principales áreas de cooperación identificadas, a continuación, se proponen las siguientes líneas de acción como una herramienta clave para que aumente el aporte financiero por parte de las empresas en I+D y la cooperación entre *startups* y empresas establecidas, que más *startups* sobrevivan al “valle de la muerte” y mejoren su perfil de financiamiento para atraer potenciales inversionistas. Además, permitirán mejorar la cultura de innovación y una mayor presencia de aceleradoras corporativas, lo que a su vez fomentará una cultura de emprendimiento favorable y dinámica, que incluya una percepción positiva de las tecnologías innovadoras, la voluntad de asumir riesgos y la capacidad de tolerar el fracaso. Se dará visibilidad a los casos de éxito de emprendimiento lo que puede ser un instrumento importante para un ecosistema de emprendimiento favorable para la innovación. Con ello se mejorará la capacidad de innovación, se permitirá un mayor gasto en I+D por parte del sector privado y mejorar la colaboración en I+D entre universidad e industria.

### 6.1.1 Desarrollo de una agenda de trabajo bilateral de política pública de I+D+i+e

El desarrollo de *startups* en el ámbito energético requiere de un marco político y regulatorio definido y estable en cuanto al fomento de las energías renovables variables y la eficiencia energética, que dé señales claras al mercado y, por ende, un respaldo al desarrollo de este tipo de empresas, creando y aprovechando oportunidades de negocios que ofrece la transición energética.

#### Canal de comunicación formal

Establecer un canal de comunicación para el intercambio de buenas prácticas entre los encargados de fomento del emprendimiento en energía por parte de los ministerios e instituciones públicas involucradas, a través de reuniones periódicas, para intercambiar experiencias con los diferentes programas de fomento e ir analizando la posibilidad de crear algunos programas de fomento colaborativos, como *matching funds*, para el emprendimiento en energía que facilitan la cooperación entre *startups* chilenas y alemanas. Además, se identificarán casos de éxito de *startups* en energía que servirán como ejemplo de lo que se espera lograr como parte de la estrategia de comunicación.

### Mesas de trabajo temáticas

Crear mesas de trabajo binacionales en tres áreas temáticas específicas de buenas prácticas en política pública para la eliminación sistemática de barreras y burocracia, además del mejoramiento del ecosistema de emprendimiento en energía. Para ello, se tomará en consideración las necesidades y demanda real de innovaciones en energía de las empresas grandes y clientes estratégicos para complementar los vacíos de mercado con programas de fomento y que éstos se ajusten a la realidad. Las mesas de trabajo serán en los siguientes ámbitos:

- Política pública e instrumentos de fomento (por ejemplo: apoyo a *scale-ups* que deseen instalarse en Chile o Alemania, con instrumentos de atracción de inversiones, *matching funds*, etc.).
- Marco regulatorio y normativas (por ejemplo: un acuerdo de doble tributación para *startups* e inversionistas en el ámbito de energía).
- Fomento de modelos de trabajo colaborativos y de co-creación (por ejemplo: redirección de subvenciones existentes en ambos países para proyectos binacionales, como un fondo chileno-alemán de emprendimiento de alta tecnología).

### Consejo público-privado para una estrategia binacional de largo plazo

Avanzar en el trabajo conjunto entre los gobiernos y la industria (tanto a nivel de proveedores como de la demanda) de Alemania y Chile en temáticas de índole estratégica como estándares industriales, sustentabilidad, transformación digital o condiciones marco para facilitar los negocios en ambas regiones. Además de identificar claramente las brechas en energía de cada sector industrial para poder articular medidas complementarias, definir una estrategia binacional para mejorar la capacidad de innovación, aumentar el gasto en I+D por parte del sector privado y mejorar la colaboración en I+D entre universidades e industria. Finalmente, implementar numerosas medidas para promover el emprendimiento y el crecimiento de las *startups* de energía, como también medidas concretas que apunten a la transformación digital, la creación de empresas, el emprendimiento en serie y atraer a más mujeres a la actividad empresarial. Esta instancia además permitirá posicionar las necesidades y la demanda de innovación para permitir la generación de nuevas industrias de bienes y servicios en torno a la energía.

#### 6.1.2 Generación de redes de financiamiento chileno-alemanas

Las *startups*, en el ámbito energético, desarrollan *hardware* de alta tecnología y por ende requieren montos de inversión superiores a lo que son, por ejemplo, las inversiones en *software* para el desarrollo de productos y servicios. En comparación con el desarrollo de *software* sin *hardware* asociado, este tipo de emprendimientos requiere ciclos más largos de pilotaje y por ende inversiones más altas, aumentando además el riesgo

#### Red binacional de VC & CVC

Establecer una red de fondos de capital de riesgo y capital de riesgo corporativo en Alemania y Chile, con interés de invertir en *startups* en energía que facilite el acceso de *startups* chilenas y alemanas al financiamiento. Esta red estará conformada por fondos que invierten tanto en proyectos en etapa temprana (*early stage funds*), como en etapas de crecimiento (*middle stage* y *late stage funds*), además de poner énfasis en emprendimientos con resultados económicos, ambientales y sociales. De esta forma la red buscará abarcar además el amplio universo de “inversionistas responsables” (un inversionista que busca mitigar los efectos negativos en el medio ambiente y a nivel social) y de “inversiones sustentables” (que aprovechan oportunidades que tienen el potencial de operar en una forma más sustentable que sus pares en el largo plazo) para promover las “inversiones de impacto” (que se hacen cargo de desafíos ambientales y sociales urgentes) e “inversiones *impact-only*” (que se hacen cargo de desafíos ambientales y sociales urgentes que no cuentan con soluciones comercialmente viables).

#### Empresas públicas como inversionistas estratégicos

Encausar a las empresas públicas, como Codelco y Metro en Chile, que además son clientes importantes del consumo eléctrico chileno, para que inviertan un porcentaje de sus ganancias en la industria de alta tecnología en energía para permitir un crecimiento elevado del sector, al invertir en un sector que la empresa privada

considera muy riesgoso. Siguiendo el ejemplo de EPM (Empresas Públicas de Medellín)<sup>291</sup> que invierte en innovación, tecnología y *startups* de base tecnológica. De este modo las empresas públicas serán los inversionistas tempranos que asuman el alto riesgo para la generación de un mercado de innovaciones radicales en los ámbitos considerados como estratégicos como el de la energía, permitiéndoles capturar el valor de una tecnología o producto innovador que pueden ser beneficiosos para su negocio y generando un mercado más sofisticado y maduro.

#### **Registro binacional de *startups* de energía**

Crear un registro de las *startups* de energía que permita generar un perfil de cumplimiento de cada una, al definir KPI comunes para el sector, facilitando así información estratégica en el ámbito económico, ambiental y social para atraer inversionistas nacionales e internacionales. Esta información permitirá la legitimización social de las *startups* de energía y además generar un mapa de los ecosistemas de energía en Alemania y Chile.

### **6.1.3 Fortalecimiento de la cultura de innovación**

Una demanda importante por parte de las *startups* es la de un apoyo especial respecto del compromiso empresarial con la protección del medio ambiente y la sustentabilidad, lo que pone de relieve la necesidad de desarrollar programas de apoyo específicos para fortalecer la cultura de innovación en ambos países.

#### **Programa de intercambio para *startups* de energía entre Alemania y Chile**

Similar a la plataforma GINSEP (*German-Indian-Startup-Exchange-Program*)<sup>292</sup> que se creó para facilitar el *networking* y la internacionalización de *startups* alemanas e indias, se propone implementar un programa similar para Chile para que se establezca una plataforma de colaboración entre los principales *stakeholders* de los dos ecosistemas de emprendimiento, incluyendo a grandes empresas, incubadoras, aceleradoras, inversionistas, empresas, organizaciones de apoyo, mentores, etc. y que apoya a *startups* alemanas y chilenas ofreciendo oportunidades de *networking* mediante eventos, talleres, encuentros de *elevator pitches*, viajes de estudio y de negocios para *startups* de ambos países, proporcionando además información y asesoría para acceder al otro mercado. Además, el programa debiera fomentar pasantías al alero de incubadoras y aceleradoras de negocios tecnológicos de *startups* chilenas en Alemania para poder hacer uso de la infraestructura de I+D, de pilotaje y de internacionalización, así como de *startups* alemanas en Chile para testear su tecnología en condiciones más desafiantes y abrir el mercado latinoamericano.

#### **Hubs pilotos para *startups* de energía en Alemania y Chile**

Creación de dos *hubs* pilotos en ambos países en que se genere una red de colaboración entre *startups* chilenas y alemanas a través de eventos virtuales de *matchmaking* y de *networking*, además de contar con una metodología de apoyo para las necesidades más específicas de *startups* en energía para impulsar sus avances a través de laboratorios de innovación, talleres sobre regulación en el ámbito energético, modelos de negocio, etc. Los *hubs* además contarán además con el apoyo de una red de mentores con experiencia en el rubro energía y redes activas con la industria que demanda soluciones.

#### **Red chileno-alemana de mentores expertos para *startups* de energía**

Creación de una red de mentores chileno-alemana de expertos en el ámbito de la energía para apoyar a las *startups* de energía, permitiendo así que todas las *startups* además generen una cartera de contactos estratégicos en la industria. De acuerdo con el reporte Industria de redes de mentores Chile 2020 publicado por la UAI,<sup>293</sup> las redes de mentores hacen un gran trabajo generando espacios para el aprendizaje, aumentando el tamaño de las redes de contacto y generando instancias de socialización entre pares. En vista de las dificultades para acceder a financiamiento para *startups* innovadoras en el ámbito de la energía, cobra importancia la red de contactos privados de los mentores a la que los emprendedores podrán acceder para por ejemplo obtener

<sup>291</sup> Página web EPM <https://www.epm.com.co/site/home/sala-de-prensa/noticias-y-novedades/epm-invierte-100-mil-millones-en-innovacion>

<sup>292</sup> Website of GINSEP: <https://ginsep.co/>

<sup>293</sup> Reporte UAI <https://ecosistemaemprendimiento.uailab.cl/wp-content/uploads/2020/09/Reporte-redes-BAJA.pdf>

financiamiento, reduciendo la brecha de inequidad para aquellos emprendedores que carecen de esta red de contactos.

#### 6.1.4 Diversificación en los instrumentos de apoyo para las startups de energía

Muchas *startups* en el ámbito energético desarrollan *hardware* de alta tecnología y por ende requieren una sólida infraestructura para I+D (laboratorios, plantas de pilotaje, manufactura, etc.).

##### **Infraestructura pública para startups de energía en Alemania y Chile**

Como industria naciente, las *startups* de energía requieren del apoyo de inversión pública en infraestructura que al no existir constituye una barrera a la creación sistemática de *startups* de energía, de innovaciones incrementales y disruptivas en este ámbito. Infraestructura como plantas de pilotaje, laboratorios de calidad y de ensayo para nuevos materiales para permitir a los emprendedores poder concretar una prueba de concepto para un cliente en un tiempo razonable, considerando los flujos financieros de los emprendimientos, permitiéndole así captar los primeros clientes. A través de una infraestructura pública binacional como “laboratorios reales” (*Reallabore*) se buscará implementar y pilotear soluciones tecnológicas innovadoras en condiciones reales de mercado.

##### **Plataforma pública de información para startups de energía en Alemania y Chile**

Sistematización del conocimiento nuevo que se genera para que las innovaciones tecnológicas dependan menos de las personas y sean más fáciles de transferir por medio del acceso y la transparencia en la información. La plataforma será un instrumento de difusión de conocimientos y tecnologías nuevas, que permitirá la medición del avance de las innovaciones y un registro del crecimiento económico verificable de estas mismas. Además, permitirá publicar las historias de éxito de las *startups* de energía para aumentar su reputación nacional e internacional.

##### **Co-Works con servicios profesionales de apoyo en Alemania y Chile**

Apoyo a los *co-works* que trabajan con el ecosistema de emprendimiento de energía para que ofrezcan servicios de consultoría para todas las fases a lo largo de la creación de la empresa, y faciliten servicios profesionales como asesoría legal, de contabilidad, de inversiones, de gestión de personas, etc. La idea es que estos *co-work* además ofrezcan programas de aprendizaje, talleres prácticos, así como foros de expertos para consultas y otros.

#### 6.1.5 Diversificación y calificación del capital humano

Por lo general, el perfil del emprendedor en energía tiene un nivel educacional alto y enfrenta el desafío de requerir, en la mayoría de los casos, de personal altamente especializado y con conocimiento tecnológico específico para elaborar su producto/servicio en distintos ámbitos como de energía, TICs o electromovilidad.

##### **Summer Schools de emprendimiento en universidades de Alemania y Chile**

En la formación de una cultura emprendedora, intervienen múltiples actores, donde en vista del emprendimiento en energía, especialmente destacan las instituciones educativas que cumplen un rol fundamental incluyendo en sus mallas curriculares y estructuras físicas los temas de emprendimiento e innovación. Para esto, se propone realizar cada año escuelas de verano en universidades de Alemania y Chile para complementar los contenidos de la malla curricular con contenidos de emprendimiento. Además de fortalecer la motivación y las capacidades del estudiante para emprender, con el fin de formar estudiantes con espíritu emprendedor, se entregarán conocimientos duros y habilidades necesarias para generar innovaciones y empresas sustentables en el tiempo. Este programa dirigido a las universidades en Alemania y Chile permitirá además fomentar las publicaciones científicas chileno-alemanas y crear nuevas capacidades líderes de investigación en energía.

### **Programa binacional de formación dual, educación continua y capacitación en energía**

La formación dual, capacitación y certificación de competencias de los trabajadores en conocimientos tecnológicos específicos provee grandes ventajas a las *startups* de energía a la hora de contar con una mayor gama de capital humano calificado, lo que su vez mejora las posibilidades de atraer inversiones. Esto se convierte en un círculo virtuoso: mientras más personal calificado, más inversiones serán captadas por las *startups* de energía, lo que a su vez mejora el mercado laboral, los sueldos, baja la tasa de desempleo y permite el financiamiento para más educación, formación y capacitación. Por lo tanto, se propone, crear un programa binacional piloto de formación dual para instituciones de educación técnica que deseen complementar su oferta educativa, además de una gama de cursos de capacitación en ámbitos tecnológicos específicos para técnicos y ejecutivos.

### **Alianza binacional con incubadoras y aceleradoras para *startups* de energía**

Generación de alianzas con incubadoras en Alemania y Chile para permitir la capacitación específica para el emprendimiento en energía (tolerancia al riesgo, errores, fracaso), innovación, creatividad y experimentación como por medio de competencias de ideas y de emprendimiento y concursos de planes de negocios. Las alianzas con las aceleradoras en Alemania y Chile a su vez permitirán realizar competencias buscando cuestionar soluciones existentes y desarrollar nuevas propuestas de valor y modelos de negocio, entregándole herramientas concretas para la internacionalización a las *startups* de energía. Cada año entregarán además un premio a jóvenes líderes en energía, mejorando de este modo el estatus social del emprendedor.

## **6.1.6 Sofisticación del mercado para *startups* de energía en Alemania y Chile**

Las *startups* que introducen innovaciones en el ámbito de la energía y eficiencia energética, requieren un mercado con posibles clientes que tienen cierta apertura a tomar riesgos y decisiones rápidas. La capacidad de innovación de las grandes empresas se beneficia por su capacidad de cooperar con *startups*. Frecuentemente, las *startups* desarrollan nuevos productos o servicios complementarios junto con las empresas establecidas para satisfacer las necesidades de los clientes.

### **Proyectos binacionales de I+D+i+e para *startups* de energía**

Apoyo para proyectos binacionales de I+D+i+e que cumplen con las directrices para el financiamiento de la investigación en los temas estratégicos para la Transición Energética y puedan acceder a los instrumentos de apoyo y de financiamiento existentes en Alemania y Chile, como es el High-Technology Entrepreneurship Fund o los fondos disponibles para proyectos de hidrógeno a nivel internacional, europeo y alemán. Además, apoyo para el registro de patentes de innovaciones chileno-alemanas para proyectos que tienen un foco en los desafíos del sector de la energía, como por ejemplo proyectos que permitan la generación de una demanda sofisticada de productos.

### **Clústeres regionales de I+D+i+e para *startups* de energía**

Creación de clústeres regionales de I+D+i+e en energía que ofrecen actividades de colaboración sistemática a un ecosistema de *multi-stakeholders* del sector privado (grandes empresas, proveedores y la industria que demanda soluciones), público y de la investigación aplicada, permitiendo además la participación de entidades sin ánimo de lucro y asociaciones que promueven el emprendimiento. Aquí las *startups* de energía encontrarán *partners* para las pruebas de concepto, clientes de referencia y canales de distribución. Los clústeres podrán ofrecer servicios de apoyo para el registro de marcas chileno-alemanas, organizar conferencias y talleres en los distintos ámbitos de las oportunidades de negocios en biomasa, geotermia, energía fotovoltaica, energía eólica y undimotriz, además de crear soluciones tecnológicas para los desafíos de la red de transmisión, redes eléctricas inteligentes, el almacenamiento, la resiliencia de la red, la eficiencia energética y el hidrógeno verde.



### **Zona de I+D+i+e para startups de energía**

Creación de una zona de I+D+i+e piloto en ambos países para generar experiencias mejorables y buenas prácticas a nivel de política pública, instrumentos de apoyo y financiamiento, cultura de innovación, capital humano y mercados necesarios para facilitar un ecosistema de emprendimiento y de innovación para startups de energía. Inspiradas en las zonas francas, las zonas de I+D+i+e permitirán la atracción de inversiones, la generación de puestos de trabajo calificados y la diversificación tecnológica en el ámbito energético, permitiendo a su vez la sofisticación del mercado y aumentando el grado de innovación. Fomentará el trabajo colaborativo de las grandes empresas que demandan soluciones para que trabajen junto a las startups de energía y la investigación aplicada en proyectos de base tecnológica. Todos se beneficiarán del trabajo colaborativo, como el aprovechamiento consorcial de servicios de investigación aplicada y del talento humano.

## **6.2 Potential Courses of Action (English)**

*The ambitious goals of the energy transition can only be achieved by implementing a mix of different technologies, services, and business models. From the above, the role of startups in this context is of utmost importance as, along with mature technologies that are already being deployed on the market, new technological, service and business model developments are required to close the technology gaps.*

*Obtaining positive results requires a long-term work agenda and activities, ensuring that all stakeholders remain articulated and consistent, which allows for improved decision making at the private and public levels. For this, strengthening an equitable and fair environment for the energy entrepreneurship ecosystem, strengthening the market, implementing double taxation agreements, and facilitating investment is certainly necessary. The reduction of bureaucracy, a streamlined tax system and attractive financing solutions must be ensured at the same time.*

*In light of the main areas of cooperation identified, the following courses of action are proposed as a key tool to enhance the financial contribution of companies in R&D and cooperation between startups and established companies, help more startups survive the “valley of death” and improve their funding profile to attract potential investors. In addition, they will lead to an improved innovation culture and a greater involvement of corporate accelerators, which in turn will foster a favorable and dynamic entrepreneurship culture, including a positive perception of innovative technologies, a willingness to take risks and the ability to tolerate failure. Entrepreneurship success stories will be given visibility, which can be an important tool for an innovation-friendly entrepreneurship ecosystem. This will enhance innovation capabilities, enable greater R&D spending by the private sector and enable better academia-industry R&D collaboration.*

### **6.2.1 Developing A Bilateral Work Agenda For Public Policy On R&D+i+e**

*In the energy sector, the emergence of startups requires a defined and stable political and regulatory framework for the promotion of variable renewable energies and energy efficiency, which sends clear signals to the market and, therefore, supports the development of this type of businesses, creating and leveraging the business opportunities offered by the energy transition.*

#### **Formal Communication Channel**

*Establishing a communication channel for the exchange of best practices among those responsible for the promotion of energy entrepreneurship by the ministries and public agencies involved, through regular meetings, to exchange experiences with the different promotion programs and to analyze the possibility of creating some collaborative promotion programs, such as matching funds, for energy entrepreneurship that facilitate cooperation between Chilean and German startups. Additionally, some success stories of energy startups will be identified to serve as examples of what is expected to be achieved as part of the communication strategy.*

**Themed Working Groups**

Setting up binational working groups in three specific theme areas of best practices in public policy for the effective elimination of barriers and bureaucracy, as well as the strengthening of the energy entrepreneurship ecosystem. To that end, the needs and real demand for energy innovations of large corporations and strategic customers will be taken into consideration in order to bridge the market gaps with promotion programs and align them with reality. The working groups will be in the following areas:

- Public policy and promotion instruments (for example: support for scale-ups wishing to set up in Chile or Germany, with investment attraction instruments, matching funds, etc.).
- Framework and regulations (e.g., a double taxation agreement for startups and investors in the field of energy).
- Promotion of collaborative work and co-creation models (e.g., relocation of existing subsidies) for binational projects, such as a Chilean-German fund for high-tech entrepreneurship.

**Public-Private Board for A Long-Term Binational Strategy**

Improving joint work between governments and industry (both at the supply and demand level) in Germany and Chile on strategic issues such as industry standards, sustainability, digital transformation, or framework conditions to facilitate business in both regions. Furthermore, clearly identify the energy gaps in each industrial sector in order to articulate supplementary measures, define a binational strategy to improve innovation capabilities, increase R&D spending by the private sector and improve R&D collaboration between academia and industry. Finally, implement a range of measures to promote entrepreneurship and the growth of energy startups, as well as concrete measures aimed at digital transformation, business creation, serial entrepreneurship and attracting more women to entrepreneurship. This will also allow positioning the needs and demand for innovation to enable the growth of new goods and services industries around energy.

**6.2.2 Creating Chilean-German Funding Networks**

Startups in the energy sector develop high-tech hardware and therefore require higher investment amounts than, for example, investments in software for the development of products and services. By comparison with software development without associated hardware, these types of ventures require longer piloting cycles and thus higher investments, which also increases the risk.

**Binational VC & CVC Network**

Setting up a network of venture capital and corporate venture capital funds in Germany and Chile, willing to invest in energy startups in order to facilitate access to funding for Chilean and German startups. This network will be made up of funds investing in early-stage projects (early-stage funds), as well as in growth stages (middle stage and late-stage funds), in addition to highlighting ventures with economic, environmental, and social results. In this way the network will also seek to embrace the broad universe of “responsible investors” (an investor that seeks to mitigate negative environmental and social impacts) and “sustainable investments” (that leverage opportunities that have the potential to operate in a more sustainable manner than their peers in the long term) to promote “impact investments” (that address urgent environmental and social challenges) and “impact-only investments” (that address urgent environmental and social challenges that do not have commercially viable solutions).

**Public Companies as Strategic Investors**

Encourage state-owned companies, such as Codelco and Metro in Chile, which are also major customers of Chilean power consumption, to invest a share of their profits in the high-tech energy industry to enable high growth in the sector, by investing in a sector that private companies consider very risky. Following the example of EPM (Empresas Públicas de Medellín)<sup>294</sup> which invests in innovation, technology, and technology-based startups. Hence, public companies will be the early investors that bear the high risk for the generation of a market for radical innovations in the areas deemed as strategic, such as energy, allowing them to seize the value of an innovative technology or product that can be beneficial for their business and thereby create a more sophisticated and mature market.

<sup>294</sup> EPM website <https://www.epm.com.co/site/home/sala-de-prensa/noticias-y-novedades/epm-invierte-100-mil-millones-en-innovacion>

***Binational Energy Startup Database***

Creating a database of energy startups to generate a performance profile of each one, by defining common KPIs for the industry, thus providing strategic information in the economic, environmental, and social sphere to attract national and international investors. This information will allow the social validation of energy startups and also enable the creation of a map of the energy ecosystems in Germany and Chile.

**6.2.3 Strengthening The Culture Of Innovation**

One major demand from startups is for special support regarding corporate commitment to environmental protection and sustainability, which highlights the need to further develop specific support programs to strengthen the culture of innovation in both countries.

***Exchange Program For Energy Startups Between Germany And Chile***

Analogous to the GINSEP (German-Indian-Startup-Exchange-Program) platform that was launched to facilitate the networking and globalization of German and Indian startups, the proposal is to implement a similar program for Chile to establish a platform for collaboration between the main stakeholders of the two entrepreneurship ecosystems, including large companies, incubators, accelerators, investors, companies, support organizations, mentors, etc. and that supports German and Chilean startups by offering networking opportunities through events, workshops, elevator pitch meetings, study and business trips for startups from both countries, as well as providing information and advice to access the other market. In addition, the program should promote internships with incubators and accelerators for Chilean startups in Germany to make use of the R&D, piloting, and globalization infrastructure, as well as for German startups in Chile to test their technology under more challenging conditions and open up the Latin American market.

***Pilot Hubs For Energy Startups In Germany And Chile***

Creating two pilot hubs in both countries to generate a collaboration network between Chilean and German startups through virtual matchmaking and networking events, as well as a support methodology for the more specific needs of energy startups to boost their growth through innovation labs, workshops on energy regulation, business models, etc. The hubs will also have the support of a network of mentors with experience in the energy sector and active networks with the industry that demands solutions.

***Chilean-German Expert Mentoring Network for Energy Startups***

Creating a Chilean-German mentoring network of experts in the field of energy to support energy startups, thus allowing all startups to also build a portfolio of strategic contacts in the industry. According to the Chile 2020 mentoring network industry report published by UAI,<sup>295</sup> mentor networks play an important role in opening up opportunities for learning, increasing the size of contact networks and creating opportunities for socializing among peers. In view of the difficulties in accessing funding for innovative startups in the energy sector, the mentors' network of private contacts that entrepreneurs can access to obtain funding, for example, becomes important, thereby bridging the inequality gap for those entrepreneurs who lack this network of contacts.

**6.2.4 Diversification Of Support Instruments For Energy Startups**

Many energy startups develop high-tech hardware and therefore require a solid R&D infrastructure (laboratories, pilot plants, manufacturing, etc.).

***Public Infrastructure for Energy Startups in Germany And Chile***

As a new emerging industry, energy startups require the support of public investment in infrastructure, the lack thereof constituting a barrier to the systematic creation of energy startups, of incremental and disruptive innovations in this field. Infrastructure such as pilot plants, quality and new materials testing laboratories to enable entrepreneurs to complete a proof of concept for a customer in a reasonable amount of time, considering the financial flows of the ventures, thus allowing them to acquire the first customers. Through a binational public infrastructure such as “real laboratories” (Reallabore), innovative technological solutions will be implemented and piloted under real market conditions.

<sup>295</sup> UAI report <https://ecosistemaemprendimiento.uailab.cl/wp-content/uploads/2020/09/Reporte-redes-BAJA.pdf>

### **Public Information Platform for Energy Startups in Germany And Chile**

Systematizing the new knowledge that is created so that technological innovations are less reliant on individuals and easier to transfer through information access and transparency. The platform will be a tool for the dissemination of new knowledge and technologies, allowing the measurement of the development of innovations and a verifiable economic growth record of these innovations. In addition, it will allow the publication of success stories of energy startups to enhance their national and international reputation.

### **Professional Co-Works Support Services in Germany And Chile**

Support for co-works helping the energy entrepreneurship ecosystem to offer consulting services for all phases throughout the startup of the company, and provide professional services such as legal, accounting, investment, people management, etc. The idea is that these co-works will also offer learning programs, hands-on workshops, as well as expert panels for discussions, among others.

## **6.2.5 Diversification And Training Of Human Capital**

The profile of the energy entrepreneur generally shows a high educational level and faces the challenge of requiring, in most cases, highly specialized professionals with specific technological knowledge to develop their product/service in different areas such as energy, ICTs or electromobility.

### **Entrepreneurship Summer Schools at German And Chilean Universities**

Numerous stakeholders are involved in the shaping of an entrepreneurial culture, in which, in view of energy entrepreneurship, educational organizations play a fundamental role by including entrepreneurship and innovation topics in their curricula and physical structures. For this purpose, the proposal is to hold annual summer schools at universities in Germany and Chile to supplement the contents of the curricula with entrepreneurship contents. In addition to strengthening the student's motivation and skills for entrepreneurship, in order to train students with an entrepreneurial spirit, hard knowledge and skills necessary to foster innovations and sustainable businesses over time will be provided. This program aimed at universities in Germany and Chile will also promote Chilean-German scientific publications and create new leading capabilities in energy research.

### **Binational Program for Dual Education, Continuing Education, And Training in The Energy Sector**

Dual education, training, and certification of workers in specific technological skills provides great advantages to energy startups in terms of having a wider range of qualified human capital, which in turn improves the chances of attracting investment. This becomes a virtuous cycle: the more skilled personnel, the more investments will be attracted by energy startups, which in turn enhances the labor market, raises salaries, lowers the unemployment rate, and allows funding for further education, training, and skill development. Therefore, the proposal is to create a pilot binational dual training program for technical education schools that wish to expand their educational offerings, as well as a range of training courses in specific technological fields for technicians and executives.

### **Binational Partnership with Incubators and Accelerators for Energy Startups**

Building partnerships with incubators in Germany and Chile to enable specific training for energy entrepreneurship (risk tolerance, mistakes, failure), innovation, creativity and experimentation through idea and entrepreneurship competitions and business plan contests. Partnerships with accelerators in Germany and Chile will in turn enable competitions to challenge existing solutions and develop new value propositions and business models, thus providing concrete tools for the globalization of energy startups. Each year they will also award a prize to young energy leaders, thus improving the social recognition of the entrepreneur.

## 6.2.6 Market Sophistication For Energy Startups In Germany And Chile

Startups that introduce innovations in the field of energy and energy efficiency require a market with potential customers who are open to taking risks and quick decision-making. The innovative capacity of large companies benefits from their ability to cooperate with startups. Often, startups develop new products or supplementary services together with established companies to meet the needs of customers.

### **Binational R&D+i+e Projects for Energy Startups**

Support for binational R&D+i+e projects that meet the guidelines for funding research on strategic topics for the Energy Transition and can access existing support and funding instruments in Germany and Chile, such as the High Technology Entrepreneurship Fund or the funds available for hydrogen projects at the international, European, and German level. Furthermore, support for the filing of patents of Chilean-German innovations for projects focused on the challenges of the energy sector, such as projects that allow the creation of a sophisticated demand for energy products.

### **Regional R&D+i+e Clusters for Energy Startups**

Creation of regional energy R&D+i+e clusters that offer collaborative activities to an ecosystem of multi-stakeholders from the private sector (large companies, suppliers and the industry that demands solutions), the public sector and applied research, also allowing the participation of non-profit organizations and associations that promote entrepreneurship. Energy startups will find partners for proof of concept, referral customers and distribution channels. The clusters will be able to offer support services for the filing of Chilean-German trademarks, organize conferences and workshops in the different areas of business opportunities in biomass, geothermal, photovoltaic, wind and wave energy, as well as create technological solutions for the challenges of the transmission grid, smart grids, storage, grid resilience, energy efficiency and green hydrogen.

### **R&D+i+e Zone for Energy Startups**

Creation of a pilot R&D+i+e zone in both countries to generate scalable experiences and best practices in terms of public policy, support and funding instruments, innovation culture, human capital, and markets necessary to facilitate an entrepreneurship and innovation ecosystem for energy startups. Inspired by free trade zones, the R&D+i+e zones will enable the attraction of investment, the creation of skilled jobs and technological diversification in the energy field, while enabling market sophistication and increasing the degree of innovation. It will foster the collaborative work of large companies that demand solutions to work together with energy startups and applied research in technology-based projects. All will benefit from collaborative work, such as leveraging consortia of applied research services and human talent.

## 7 Conclusiones

El futuro requiere un modelo competitivo completamente nuevo; el nuevo ciclo económico que trae consigo la transformación digital, además del desafío de enfrentar y mitigar el cambio climático, obliga a todos los países a reconocer este contexto. El impulso de un modelo de desarrollo sustentable y para cambio climático, que permita hacerle frente a este escenario, refuerza la necesidad de generar y fortalecer la cooperación global, alianzas multilaterales y bilaterales. El *Energy Partnership* entre Chile y Alemania, una cooperación que apoya el diálogo intergubernamental de alto nivel en materia energética permite un intercambio activo sobre cómo lograr las metas de la transición energética. Con ello, Alemania y Chile se toman en serio este nuevo orden y lo convierten en un tema prioritario en sus agendas políticas, porque no habrá inclusión social, sin mejorar la productividad y la diversificación de la economía productiva. No habrá inclusión social sin la participación de los ecosistemas de emprendimiento que permitan que esto suceda. No hay inclusión social sin alianzas globales para enfrentar los desafíos de la era digital.

Las oportunidades de negocios en América Latina son interesantes y diversas debido a la gran necesidad de innovación y tecnología. En el ámbito de la transición energética existen importantes oportunidades no solo para las empresas, sino también para las *startups*. Las ventajas del mercado latinoamericano son, por ejemplo, mejores costos laborales, una alta necesidad de modernización tecnológica, industrias de clase mundial que demandan soluciones y ecosistemas de emprendimiento dinámicos. Varios países de América Latina tienen *startups* altamente innovadoras y sus ecosistemas de *startups* han crecido significativamente en los últimos años. Una de las razones de esto es que los gobiernos latinoamericanos han reconocido la importancia de apoyar el emprendimiento como un motor vital para la transformación tecnológica, económica y social para fomentar así la creación de empleo, el crecimiento económico y la prosperidad de largo plazo.

Aunque los ecosistemas de emprendimiento en Alemania y Chile cuentan con el apoyo del gobierno, actores públicos y privados, este estudio ha demostrado que todavía hay espacio para mejorar, y estos ecosistemas podrían beneficiarse del intercambio de buenas prácticas y de modelos de trabajo colaborativos a nivel nacional e internacional. Colaboración para acelerar la innovación dentro de la industria de la energía con la ayuda de *startups* de alta tecnología o para apoyar *startups* de energía que necesitan un tamaño de mercado razonable, que solo el continente latinoamericano o grandes mercados como Europa pueden ofrecer y una colaboración para innovar con el fin de resolver desafíos ambientales y sociales. Innovaciones que no solo agregan valor, sino que también tienen un impacto social y ambiental, son la clave de la estrategia de innovación en el sector de la energía.

Para fomentar el *networking* y la confianza entre los actores de ambos ecosistemas necesarios para que esta alianza entre Alemania y Chile se convierta en una ventaja competitiva, la Cámara Chileno-Alemana de Comercio e Industria (AHK Chile) puede ser el articulador central de las líneas de acción propuestas en el presente estudio, coordinando y apoyándose en las capacidades instaladas existentes de los diferentes actores de ambos ecosistemas para no duplicar esfuerzos. De esta manera se podrá incluir, por ejemplo, a la PYME como otro actor relevante, aparte de las empresas grandes que demandan soluciones, la investigación aplicada, la academia y al ecosistema de emprendimiento, para fortalecer la red proactiva y virtuosa entre Alemania y Chile con enfoque en el desarrollo de *startups* de energía y alianzas para la innovación tecnológica. El rol del articulador cobra especial importancia a la hora de querer aprovechar todas las oportunidades detectadas en este estudio no sólo con miras hacia una recuperación económica, una mejora en la competitividad y el desarrollo de una industria de valor agregado, sino también para el anhelado desarrollo sustentable. Un desarrollo sustentable que no sólo mitiga y previene el cambio climático, sino que también logra la inclusión social para reducir la desigualdad de oportunidades y la pobreza.

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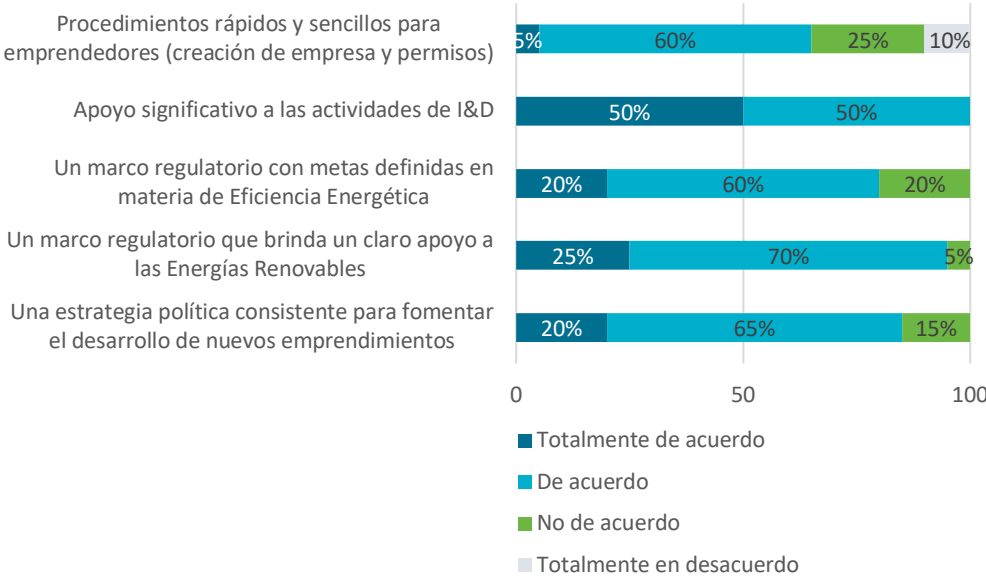
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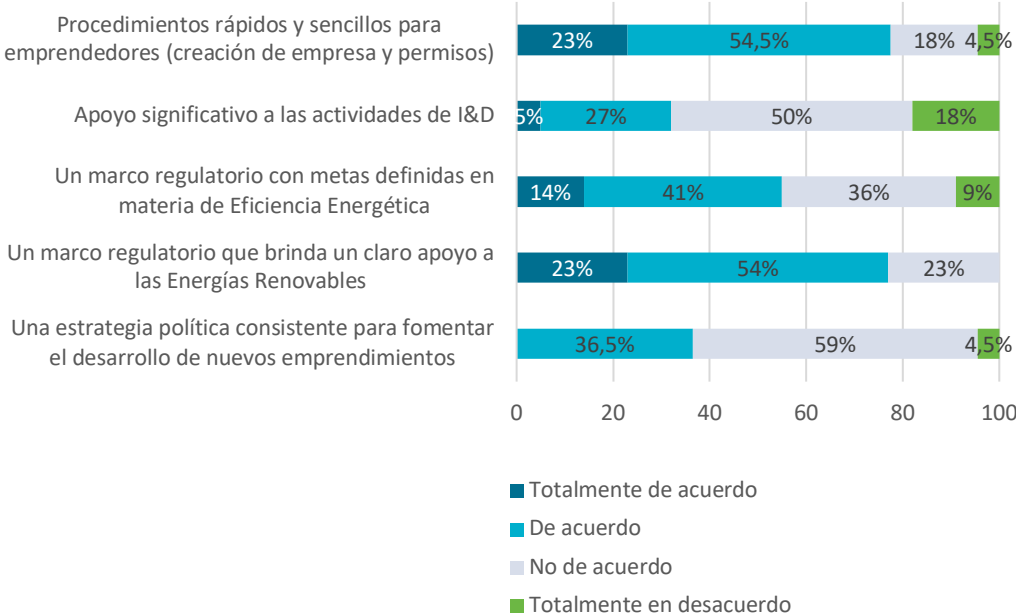
# Anexo 1: Encuesta sobre Emprendimiento y Energía

## 1. Política: Existencia de lineamientos para el desarrollo de emprendimientos y proyectos de innovación en el ámbito de la energía. En nuestro país existe...

### Alemania (n=20)



### Chile (n=22)





**1.1 ¿Qué importancia le atribuyes a cada uno de los siguientes elementos para fomentar el emprendimiento en energía en tu país desde el ámbito de la política pública?**

**1 = más importante; 4 = menos importante**

Alemania

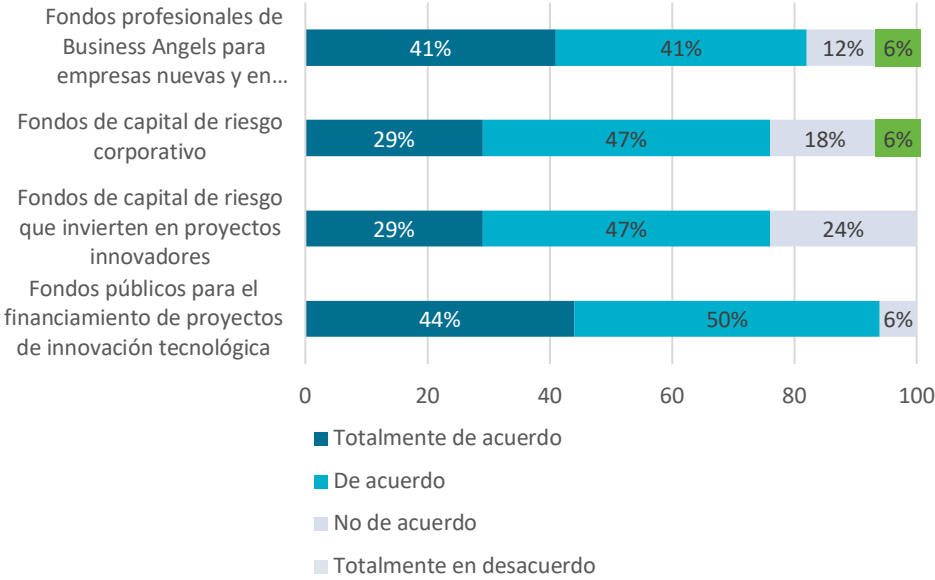
	1	2	3	4	Total
Una estrategia política consistente para fomentar el desarrollo de nuevos emprendimientos	50,00%	22,22%	27,78%	0,00%	18
Un marco regulatorio que brinda un claro apoyo a las Energías Renovables y la Eficiencia Energética	31,25%	18,75%	37,50%	12,50%	16
Apoyo significativo a las actividades de I+D	11,11%	33,33%	22,22%	33,33%	18
Procedimientos rápidos y sencillos para emprendedores en cuanto a la creación de empresas y obtención de permisos	20,00%	30,00%	10,00%	40,00%	20

Chile

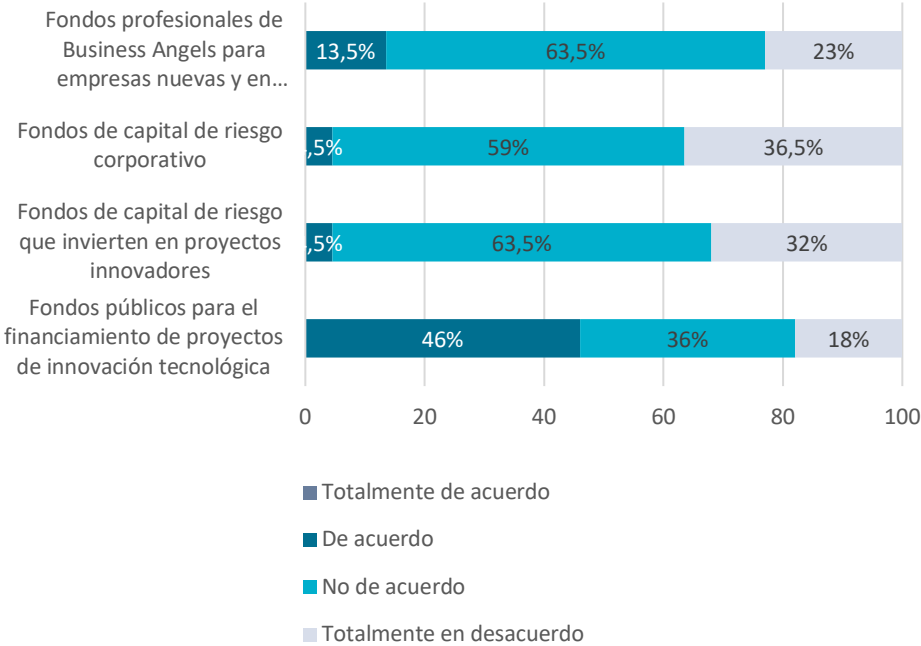
	1	2	3	4	Total
Una estrategia política consistente para fomentar el desarrollo de nuevos emprendimientos	42,11%	42,11%	15,79%	0,00%	19
Un marco regulatorio que brinda un claro apoyo a las Energías Renovables y la Eficiencia Energética	40,00%	25,00%	25,00%	10,00%	20
Apoyo significativo a las actividades de I+D	13,64%	22,73%	40,91%	22,73%	22
Procedimientos rápidos y sencillos para emprendedores en cuanto a la creación de empresas y obtención de permisos	4,55%	13,64%	18,18%	63,64%	22

**2. Finanzas: Existencia de fondos focalizados en iniciativas de innovación en el ámbito energético. En nuestro país existen suficientes...**

Alemania (n=17)



Chile (n=22)



## 2.2 ¿Qué importancia le atribuyes a cada uno de los siguientes elementos relacionados con el apoyo financiero para fomentar el emprendimiento en energía en tu país?

1 = más importante; 4= menos importante

### Alemania

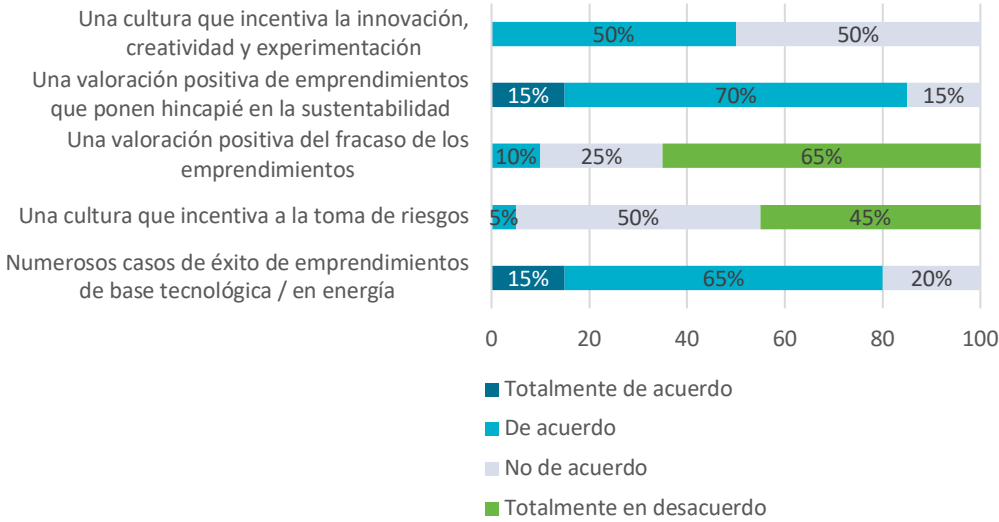
	1	2	3	4	Total
Fondos públicos para el financiamiento de proyectos de innovación tecnológica	64,29%	14,29%	14,29%	7,14%	14
Fondos de capital de riesgo que invierten en proyectos innovadores	21,43%	35,71%	28,57%	14,29%	14
Fondos de capital de riesgo corporativo	6,67%	13,33%	20,00%	60,00%	15
Fondos profesionales de <i>Business Angels</i> para empresas nuevas y en crecimiento	14,29%	42,86%	35,71%	7,14%	14

### Chile

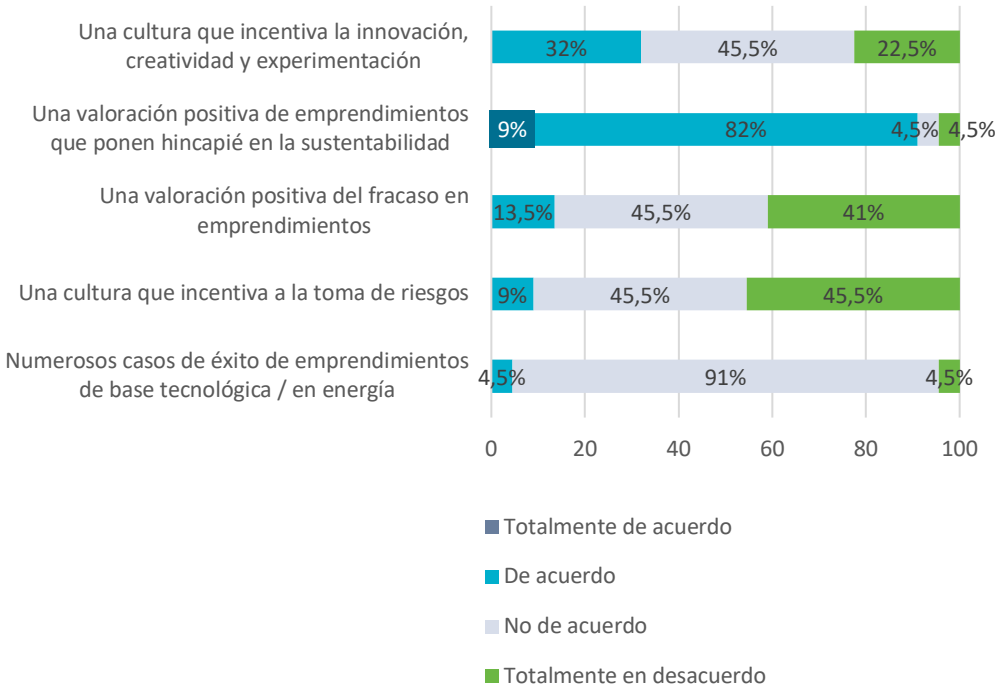
	1	2	3	4	Total
Fondos públicos para el financiamiento de proyectos de innovación tecnológica	45,00%	15,00%	15,00%	25,00%	20
Fondos de capital de riesgo que invierten en proyectos innovadores	30,00%	45,00%	20,00%	5,00%	20
Fondos de capital de riesgo corporativo	20,00%	25,00%	25,00%	30,00%	20
Fondos profesionales de <i>Business Angels</i> para empresas nuevas y en crecimiento	4,55%	13,64%	40,91%	40,91%	20

### 3. Cultura: En nuestro país existe...

Alemania (n=20)



Chile (n=22)



### 3.3 ¿Qué importancia le atribuyes a cada uno de los siguientes elementos culturales para fomentar el emprendimiento en energía en tu país?

1 = más importante; 5 = menos importante

#### Alemania

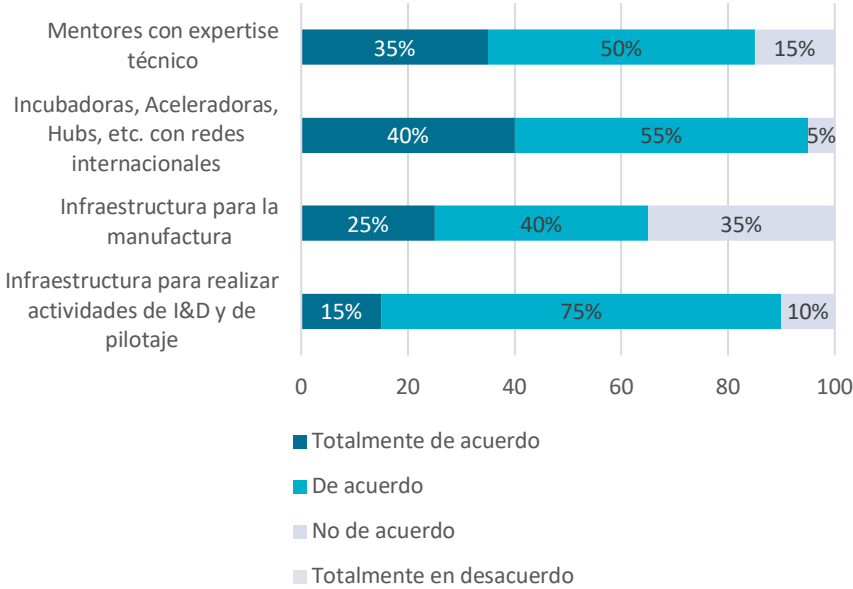
	1	2	3	4	5	Total
Numerosos casos de éxito de emprendimientos de base tecnológica	35,29%	5,88%	23,53%	23,54%	11,76%	17
Una cultura que incentiva correr riesgos	16,67%	38,89%	16,67%	16,67%	11,11%	18
Una cultura que incentiva la innovación, creatividad y experimentación	17,65%	23,53%	17,65%	11,76%	29,41%	17
Una valoración positiva de emprendimientos que hacen hincapié en la sustentabilidad	16,67%	22,22%	5,56%	33,33%	22,22%	18
Una valoración positiva del fracaso en emprendimientos	22,22%	16,67%	33,33%	11,11%	16,67%	18

#### Chile

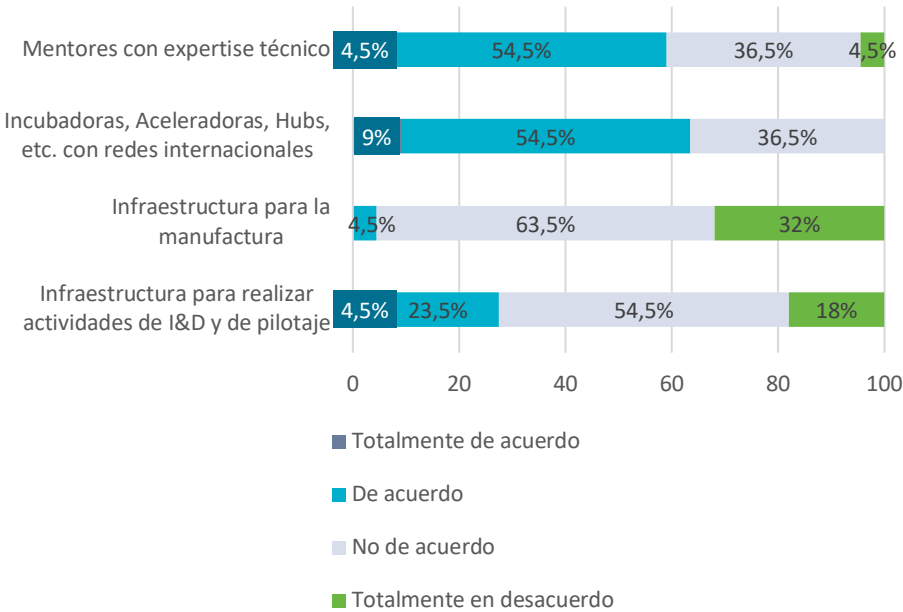
	1	2	3	4	5	Total
Numerosos casos de éxito de emprendimientos de base tecnológica	21,05%	15,79%	15,79%	21,05%	26,32%	19
Una cultura que incentiva correr riesgos	15,79%	21,05%	26,32%	36,84%	0,00%	19
Una cultura que incentiva la innovación, creatividad y experimentación	42,11%	36,84%	15,79%	5,26%	0,00%	19
Una valoración positiva de emprendimientos que hacen hincapié en la sustentabilidad	19,05%	9,52%	23,81%	19,05%	28,57%	21
Una valoración positiva del fracaso en emprendimientos	4,55%	13,64%	13,64%	22,73%	45,45%	22

**4. Soportes: Existencia de una infraestructura que facilite el emprendimiento en energía, considerando que muy a menudo son emprendimientos de base científico-tecnológica. En nuestro país existe suficiente...**

Alemania (n=20)



Chile (n=22)



#### 4.1 ¿Qué importancia le atribuyes a cada uno de los siguientes elementos de soporte para fomentar el emprendimiento en energía en tu país?

1 = más importante; 4 = menos importante

##### Alemania

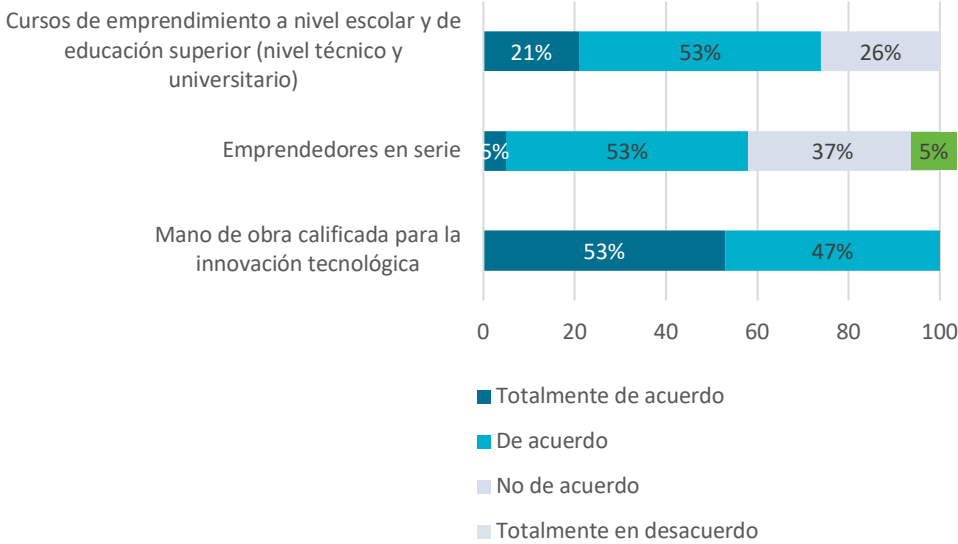
	1	2	3	4	Total
Una infraestructura para realizar actividades de I+D y de pilotaje	46,67%	20,00%	13,33%	20,00%	15
Una infraestructura para la manufactura	12,50%	25,00%	25,00%	37,50%	16
Incubadoras, Aceleradoras, <i>Hubs</i> , etc. con redes internacionales	37,50%	43,75%	0,00%	18,75%	16
Mentores con experiencia técnica	11,76%	17,65%	52,94%	17,65%	17

##### Chile

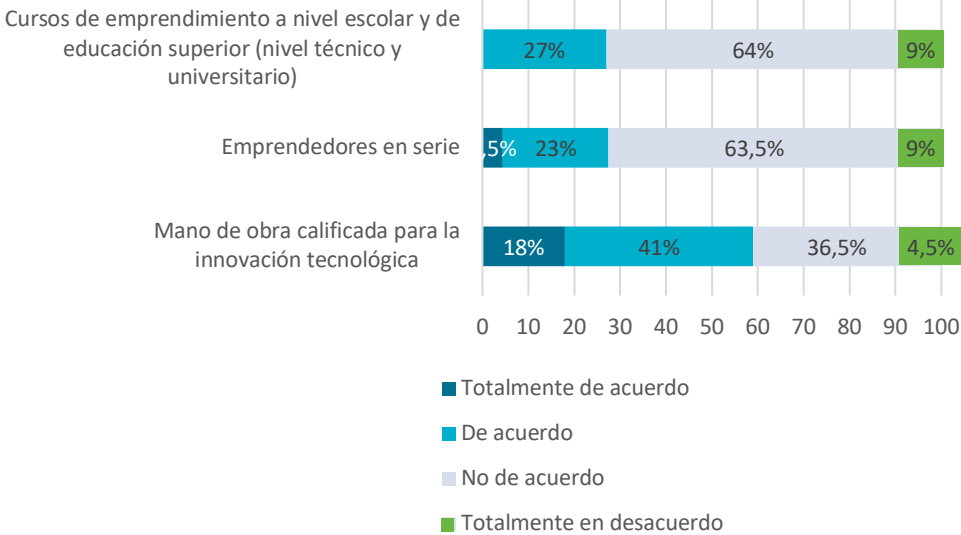
	1	2	3	4	Total
Una infraestructura para realizar actividades de I+D y de pilotaje	73,68%	26,32%	0,00%	0,00%	19
Una infraestructura para la manufactura	15,79%	42,11%	26,32%	15,79%	19
Incubadoras, Aceleradoras, <i>Hubs</i> , etc. con redes internacionales	10,00%	25,00%	45,00%	20,00%	20
Mentores con experiencia técnica	4,55%	4,55%	31,82%	59,09%	20

### 5. Capital Humano: En nuestro país existe suficiente...

Alemania (n=19)



Chile (n=22)





**5.1 ¿Qué importancia le atribuyes a cada uno de los siguientes elementos relacionados con el capital humano para fomentar el emprendimiento en energía en tu país?**

**1 = más importante; 3 = menos importante**

Alemania

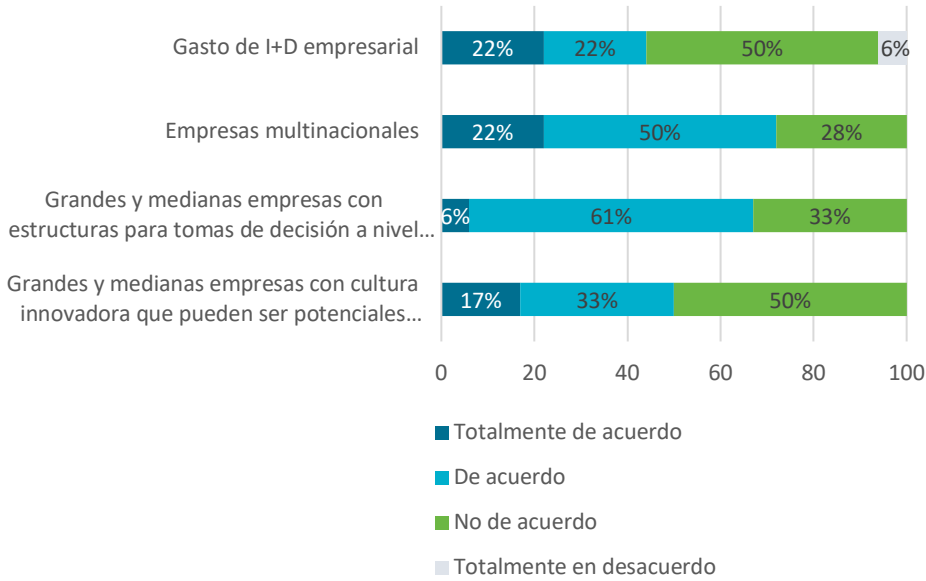
	1	2	3	Total
Mano de obra calificada para la innovación tecnológica	47,06%	35,29%	17,65%	17
Emprendedores en serie	5,56%	33,33%	61,11%	18
Cursos de emprendimiento a nivel escolar y de educación superior (nivel técnico y universitario)	52,94%	29,41%	17,65%	17

Chile

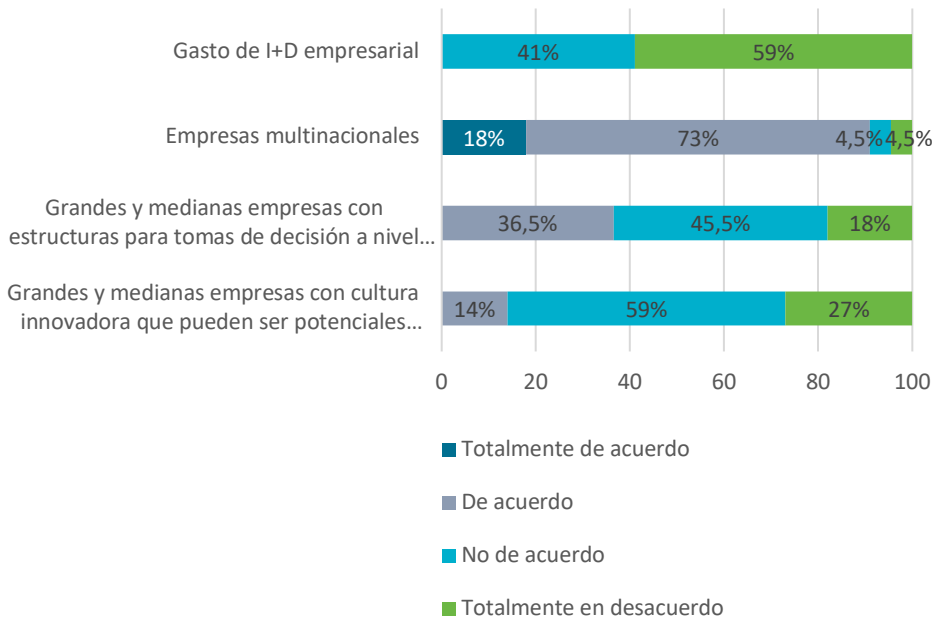
	1	2	3	Total
Mano de obra calificada para la innovación tecnológica	41,11%	36,84%	21,05%	19
Emprendedores en serie	38,10%	19,05%	42,86%	21
Cursos de emprendimiento a nivel escolar y de educación superior (nivel técnico y universitario)	22,73%	40,91%	36,36%	22

### 6. Mercados: En nuestro país existen suficientes...

Alemania (n=18)



Chile (n=22)



## 6.1 ¿Qué importancia le atribuyes a cada uno de los siguientes elementos relacionados con el mercado para fomentar el emprendimiento en energía en tu país?

1 = más importante; 4 = menos importante

### Alemania

	1	2	3	4	Total
Grandes y medianas empresas con cultura innovadora que pueden ser potenciales primeros clientes	70,59%	23,53%	0,00%	5,88%	17
Gasto de I+D empresarial	6,25%	43,75%	18,75%	31,25%	16
Empresas multinacionales	0,00%	11,11%	33,33%	55,56%	18
Grandes y medianas empresas con estructuras para toma de decisión a nivel local	27,78%	27,78%	44,44%	0,00%	18

### Chile

	1	2	3	4	Total
Grandes y medianas empresas con cultura innovadora que pueden ser potenciales primeros clientes	33,33%	61,90%	4,76%	0,00%	21
Gasto de I+D empresarial	52,38%	28,57%	9,52%	9,52%	21
Empresas multinacionales	0,00%	5,26%	10,53%	84,21%	19
Grandes y medianas empresas con estructuras para toma de decisión a nivel local	9,09%	4,55%	72,73%	13,64%	22

[www.energypartnership.cl](http://www.energypartnership.cl)

[www.bmwi.de](http://www.bmwi.de)

