

# Finland's Moonshots for Green Growth

Maximizing Finland's Growth and Handprint in the Green Transition

February 2023  
By Boston Consulting Group and Climate Leadership Coalition

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**Climate Leadership Coalition is the largest non-profit climate business network in Europe.**

CLC has 93 organizational members.

CLC believes that profound transition to a sustainable world can be economically beneficial, viable and financeable. Together we aim to make a significant positive climate impact through business solutions. CLC encourages decision makers to speed up the green transition and the green recovery by attracting investments via predictable and ambitious policies and systemic market-driven solutions.



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# Executive Summary

The green transition is one of the biggest drivers of change during the current and coming decades, and an opportunity Finland cannot afford to miss

- Globally, it is estimated that required climate-aligned investments will total between \$100 trillion and \$150 trillion by 2050, representing an average of \$3 trillion to \$5 trillion per year<sup>1</sup>
- EU regulation (e.g., Fit for 55) reinforces the transition, triggering green demand across industries
- Finland needs to seize this growth opportunity to secure its future welfare; over the past decade, Finland's GDP growth has been trailing other Nordic countries<sup>2</sup> and its budget deficit has increased<sup>3</sup>

Finland has several competitive advantages to tap into the growing green demand, and surprisingly many green innovations and growth opportunities across key value chains

- Advantages comprise of tangible resources (such as forests, minerals, and rapidly growing renewable energy capacity), competitiveness in industrial process efficiency and digitalization, and national commitment to a green future - 'climate neutral by 2035' target set in law
- Finland can maximize its growth and handprint by providing solutions to the five consumer-facing value chains (Housing, Food, Travel, Fashion, and Consumer Products), that account for nearly all global GHG emissions when considering end-to-end value chains from raw materials to end-of-life
- Research revealed in total 28 green growth opportunities for Finnish companies across key value chains, energy, and industrial processes

In this report, we identify five Moonshots for green growth to future-proof Finland's existing export sectors and create new industrial mainstays, having a total export potential of €85 billion to €100 billion by 2035:

1. NET-POSITIVE LIVING, incl. wooden construction, net-zero living solutions, and demand response systems
2. BIO-BASED PRODUCTS AND MATERIALS, incl. circular textile fibers, circular consumer packaging, long-lasting consumer products, and advanced lightweight biomaterials
3. DECARBONIZATION TECHNOLOGY AND SERVICES, incl. electrification, lifecycle services, and energy system optimization
4. CIRCULAR BATTERIES AND GREEN METALS, incl. circular battery ecosystem, and green specialty steel for advanced applications
5. GREEN HYDROGEN-ENABLED SOLUTIONS, incl. green steel, synthetic fuels, green ammonia-based fertilizers, and food proteins

Finland's ultimate success in the green transition depends on actions taken now. There are several levers to catalyze green growth and unlock the full potential of the Moonshots

- Levers include accelerating green investments, catalyzing domestic green demand, ensuring prerequisites for green growth, and positioning Finland as the forerunner in green solutions

To ensure that Finland seizes this opportunity, Boston Consulting Group (BCG) and Climate Leadership Coalition (CLC) initiated the Moonshot work and interviewed over 60 stakeholders comprising company and industry representatives, researchers and academia with sustainability expertise, senior ministry officials, and representatives from the largest political parties. This report showcases how, through the five Moonshots, Finland can simultaneously drive growth and thereby well-being, reach its own ambitious climate targets, and become greater than its size in solving the climate crisis.



# Introduction: An Opportunity Finland Cannot Afford to Miss

The green transition is one of the biggest drivers for change during the current and coming decades. Globally, it is estimated that the required climate-aligned investments will total between \$100 trillion and \$150 trillion by 2050, representing an average of \$3 trillion to \$5 trillion per year.<sup>1</sup> Switching to renewable energy will not be enough to reach the 1.5°C target set by the Paris Agreement – a reduction in energy demand is also needed.<sup>4</sup> In addition, the loss of biodiversity in marine, freshwater, and terrestrial ecosystems sets further limitations on future demand. The required change is reinforced by an unprecedented amount of new regulation, with the EU leading the way, including an extended energy trading scheme and more stringent requirements for energy efficiency.

The rules of the game are fundamentally changing for companies across value chains. Companies must rapidly adapt and future-proof their businesses for a new era in which an increasing amount of goods and services must be produced using fewer resources and less energy, and value creation maximized within the planetary boundaries. Across all major value chains, demand for green solutions will grow, ranging from more sustainable and circular raw materials to net-zero production technology to smarter and more energy-efficient end products.

Finland has several competitive advantages to tap into the growing green demand. First, Finland possesses rich natural resources such as forests, minerals, and growing renewable energy capacity that are valuable assets in the green transition. Second, the country's export sectors, focused mainly on industrial processes and technologies, have for decades relied on process efficiency, optimization, and digitalization. Third, Finland's government and corporations have set an ambitious target to be climate neutral by 2035, backed up by citizens that highly value nature.

Tapping into new areas of growth is an opportunity that Finland cannot afford to miss. GDP growth for the past decade has been weak: Finland's average GDP growth was 0.7% per annum between 2012 and 2021, trailing other Nordic countries with average annual GDP growth between 1.6% and 1.9%.<sup>2</sup> Over the same period, Finland's budget deficit increased from 42% of GDP to 51%.<sup>3</sup> The Organization for Economic Co-operation and Development (OECD) has highlighted that Finland is falling behind its Nordic peers in attracting direct foreign investments.<sup>5</sup> Most worryingly, the foundations upon which Finland's future welfare is built are beginning to show cracks: the level of basic education, healthcare, public R&D, and youth well-being are not where they used to be.

To ensure that Finland seizes the unique opportunity at hand and maximizes its growth in the green transition, Boston Consulting Group (BCG) and Climate Leadership Coalition (CLC) have initiated an effort to identify the country's Moonshots for green growth and the prerequisites needed for them to reach their full potential. (See the Sidebar "What's a Moonshot?").

This work builds on [BCG's Nordic Net Zero: The Green Business Opportunity report](#) that presented how Finland, as part of the Nordics, can meet its own net zero targets through 'smart decarbonization'.<sup>6</sup> Now, the focus is on how Finland can maximize its export growth in the global green transition. Besides optimizing economic growth, the objective is to identify potential new sources of competitive advantage for Finland that could enable developing new industrial mainstays. Moreover, by enabling decarbonization of the world's highest-emitting value chains, Finland can become greater than its size in solving the global climate crisis.



The five Moonshots that we have identified for Finland are the following:

#### NET-POSITIVE LIVING

Finland as the leader in providing holistic net-positive living offering (e.g., wooden construction, net-zero living solutions, and demand response systems).

#### BIO-BASED PRODUCTS AND MATERIALS

Finland as the global leader in developing and supplying bio-based solutions (such as circular textile fibers, circular packaging materials, long-lasting consumer products, and advanced lightweight biomaterials e.g., for automotive).

#### DECARBONIZATION TECHNOLOGY AND SERVICES

Finland as the forerunner in providing smart technology solutions for high-emitting industrial processes (e.g., electrification, lifecycle services, and energy system optimization).

#### CIRCULAR BATTERIES AND GREEN METALS

Finland with a circular battery ecosystem, and Finland as the leading supplier of green specialty steel, and other metals in Europe (e.g., for automotive and aviation).

#### GREEN HYDROGEN-ENABLED SOLUTIONS

Finland as a competitive country for producing green hydrogen-enabled solutions (e.g., green steel, synthetic fuels, green ammonia-based fertilizers, and food proteins).

In this report, we will detail these Moonshots and outline the research that led to their identification, as well as offer deep dives on the following topics: Finland's competitive advantages in the green transition; the regulatory tailwinds that will trigger green demand; and the actions that the Finnish government can take to unlock the full potential of the Moonshots and Finland's green growth. Finland has an opportunity to be at the forefront of the green transition and become a leader in green technology and solutions. Given the magnitude of change, how Finland plays its cards in the green transition should be high on the national agenda.



**Finland's main export sectors – machinery, forest products, metals, and chemicals – will remain the same, but they need to transform within to remain competitive in the green transition**

- Antti Herlin  
Chair, KONE,  
Chair, Tiina and Antti Herlin Foundation

#### WHAT'S A MOONSHOT?

The Moonshot, a term originating in the 1960s from the US project to send men to the moon and return them safely to earth, essentially means focusing collective attention and effort to achieve highly ambitious, outside-the-box goals to serve the greater good. Finland's Moonshots for green growth have four distinctive characteristics (See Exhibit 1).



#### SIGNIFICANT LEAP in terms of export growth and carbon handprint

Future-proofing existing export sectors or converting emerging green opportunities into new industrial mainstays



#### LASTING COMPETITIVE ADVANTAGE enabled by unique resources or capabilities

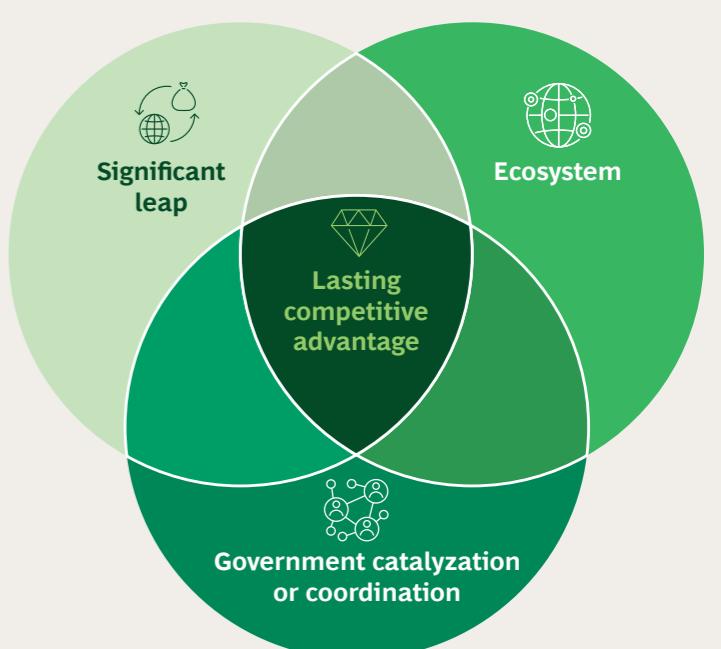
Unique resources or strong domestic capabilities and knowhow providing strong starting position and sustainable advantage, making moonshots long-term growth drivers for Finland



#### ECOSYSTEM with potential to become more than the sum of its parts

Comprising more than one strong company, bringing together leading corporate, academic and public players while providing a growth platform for smaller players

EXHIBIT 1



#### GOVERNMENT CATALYZATION OR COORDINATION needed to realize full potential

Government with possibility to accelerate the growth opportunities that would otherwise take longer to takeoff due to lack of coordination in the ecosystem, limited domestic demand, insufficient investments and R&D, challenges in scaling, or limited go-to-market efforts

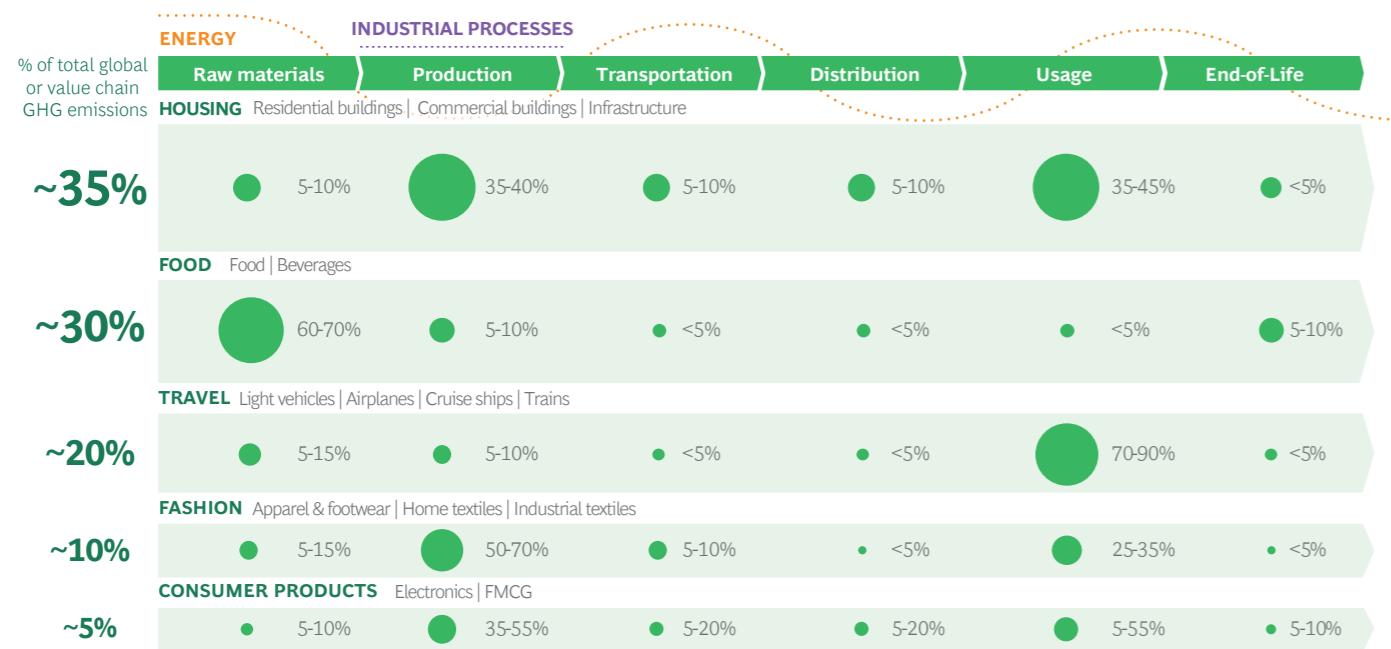
# Global Value Chains: Where Are the Opportunities for Green Growth?

**F**inland can make the greatest contribution to reducing global GHG emissions by providing solutions to the five consumer-facing value chains that account for nearly all global GHG emissions: housing (~35%), food (~30%), travel (~20%), fashion (~10%), and consumer products (~5%). (See Exhibit 2). The first three are responsible for roughly 80% of GHG emissions around the world. A value chain, in this context, is the sum of all activities that cause GHG emissions during a product's lifecycle – from raw material extraction to production,

transportation, distribution, and usage by consumers, until the end-of-life stage, where products are discarded, recycled, or reused in some other form.

In identifying Finland's Moonshots, we considered which parts of the value chain generate the most emissions, and hence provide the greatest opportunities for decarbonization. (See the sidebar "Guiding Principles for Identifying Green Growth Opportunities").

EXHIBIT 2 | Global GHG emissions along the highest-emitting value chains



For example, the **housing** value chain, which includes residential and commercial buildings along with infrastructure, represents more than one-third of all emissions globally. Reducing emissions from the production of building materials such as steel and concrete, and day-to-day living (usage), has very high leverage in terms of GHG emission reduction. In **food** production, the greatest impact comes from renewing agricultural or aquacultural practices and switching to alternative food products (raw materials).

Meanwhile, in the **travel** sector, reduction of emissions from driving, flying, and shipping (usage) provide the greatest opportunities for decarbonization. In **fashion** and **consumer products**, the production of goods has the

highest leverage, followed by usage, which includes emissions generated, for example, by washing, using, and charging products.

**Energy, industrial processes, and transportation** of goods serve all value chains, accounting for roughly 80% of global emissions. Some of the highest-leverage measures involve shifting away from fossil fuels through renewable power and heat generation, and decarbonizing industrial processes through, for example, electrification, energy efficiency improvements and process optimization. Currently, process industries represent about 75% of Finnish product exports.<sup>34</sup> With the right solutions, Finnish companies can tap into green growth and support decarbonization of the highest-emitting value chains.

## GUIDING PRINCIPLES FOR IDENTIFYING GREEN GROWTH OPPORTUNITIES

The BCG/CLC Moonshot project draws on three fundamental concepts as guiding principles for identifying the most viable green growth opportunities.

First, the "handprint" concept was developed at the VTT Technical Research Centre and LUT University. While a footprint measures emissions that are directly or indirectly caused by a company's activities, the carbon handprint is a metric based on the full life cycle assessment of a company's product or service, capturing the positive environmental impact of a greener product or service instead of a conventional offering. The larger the handprint, the greater the GHG reduction potential.<sup>7</sup>

Second, of high importance for customers looking for green solutions is the question of exactly how emissions are reduced. The Science Based Targets initiative (SBTi) has established a hierarchy for measures to reduce emissions. Above all, avoid emissions altogether (e.g., by decreasing consumption and prolonging the lifetime of a product); then reduce demand (e.g., by material usage reduction) and replace high-emissions inputs with more sustainable alternatives (such as recycled materials and renewable energy); and finally, remove remaining GHGs through carbon capture.<sup>8</sup>

A third concept is to recognize the link between decarbonization and value creation. A green solution can simultaneously reduce GHG emissions and improve economic returns for its user by reducing operating costs and enabling faster topline growth. Examples include net-zero living solutions and decarbonization technology that improve energy efficiency and thus reduce operating costs, smart product-lifecycle solutions that create savings for the user through lower waste generation and energy consumption, and new product designs that reduce usage of materials while providing more attractive value propositions for customers.

By taking all three concepts into account - maximizing the handprint, following the emission reduction hierarchy, and linking decarbonization to value creation - we can identify green growth opportunities that have the most attractive value propositions for customers, both in terms of economic and environmental impact.





# Finland's Competitive Advantages and Regulatory Tailwinds

**F**inland has a unique starting position to be a forerunner in providing green solutions.

As tangible sources of competitive advantage, Finland has valuable natural resources for the green transition, including forest, minerals, and rapidly growing renewable energy capacity. As intangible advantages, Finland can leverage its export industries' existing competitiveness in process efficiency and digitalization – levers needed for the green transition. Finally, Finland as a nation is committed to a green future and has set one of the most ambitious climate targets in the world.

## Tangible advantages

Finland is the most heavily forested country in Europe with more than 75% of the country's land area covered by forest.<sup>9</sup> The value of these forest assets is between €240 billion and €510 billion, according to estimates in a BCG report: [The Staggering Value of Forests](#).<sup>10</sup> Finland has shown a longstanding commitment to sustainable forestry management practices, and with a National Forestry Strategy in place since 2015, both the public and private sectors have committed to biodiversity.

Mineral reserves represent another unique source of competitive advantage for Finland. The Geological Survey of Finland estimates the economic value of mineral reserves at more than €500 billion.<sup>11</sup> Finland is the only European producer of cobalt, and it has significant reserves of base metals (copper, zinc, nickel, aluminum), ferrous metals (iron), and precious metals (gold, platinum), along with the rare specialty metals used in batteries and electronics (cobalt, lithium). Moreover, Finland has expertise in green mining and an established recycling infrastructure for metals.

Other tangible assets include the carbon-neutral electricity generation capacity and abundant water resources. Roughly 90% of power generation is already carbon neutral.<sup>12</sup> With a strong nuclear power baseload and increasing wind power capacity – projected to grow from ~5,700 MW production capacity in 2022 to more

than 20,000 MW in the 2030s, according to Fingrid – carbon neutral electricity is expected to be relatively affordable compared to other countries.<sup>13 14</sup> The increasing wind power capacity provides Finland a clear advantage for the production of green solutions (such as green hydrogen and green steel) that require significant amounts of renewable electricity. Finally, Finland is the water-richest country in the world, with an existing €5 billion water-industry sector and expertise in wastewater-to-X, flood prediction, restoration, and water infrastructure management.<sup>15</sup>

**Finland's forests are a strong asset. Wood is a natural polymer with valuable features for abundant use cases – it is light, flexible, durable, and biodegradable while sequestering carbon**

**- Henrik Ehrnrooth**  
Chair, CLC Advisory Board  
Chair, Otava

## Intangible advantages

Finland also has several intangible advantages that it can leverage for the green transition. The Finnish workforce is highly educated and digitally skilled with a large number of scientists and engineers proportionate to the population. Since 2019, the country has been at the top of the EU's Digital Economy and Society Index (DESI) that tracks the member countries' progress in digitalization.<sup>16</sup> The competitiveness of Finland's main export sectors – machinery, forest products, metals, and chemicals – relies on process efficiency, optimization, and digitalization, the same levers needed to tackle the climate crisis. Furthermore, according to the Global Innovation Index 2021 (GII) relying on over 80 different indicators, Finland has the most stable business environment in the world, which promotes a steady investment landscape<sup>17</sup>. Finally, Finland has attracted venture capital and fostered innovation in recent years. Finnish startups receive the most VC funding in Europe in relation to GDP.<sup>18</sup> Also the country has one of the top rankings in innovation in the world, based on patent applications per GDP.<sup>19</sup>

**A majority of Finnish exports are already in process industries, for example, more than half of the world's primary copper and nickel is produced using Finnish smelting processes.<sup>20</sup>**

**There is a strong starting position to decarbonize these solutions**

**- Jouni Keronen,**  
Chair, CLC Advisory Board  
Former CEO of CLC

## Green ambition

Finland's ambitious climate targets and highly regarded reputation provide a strong starting point for green growth. The country already targets to become climate neutral by 2035, and the world's first national carbon neutrality target law was passed by the Finnish government in 2022.<sup>21</sup> The corporate landscape is also committed to net zero, as Finland has one of the highest corporate SBTi engagement rates worldwide.<sup>22</sup> Furthermore, according to a survey by SITRA, the Finnish Innovation Fund, roughly 90% of the population has said that nature is important to them.<sup>23</sup> Finally, Finland shares a valuable "cleantech" and green country image with fellow Nordic countries that it can leverage in green positioning.

## Regulatory tailwinds for green demand

As a European Union member, Finland is well-positioned to benefit from the trajectory of EU regulation that will trigger green demand across industries. Over the past two years, the EU Commission has announced a series of forward-looking regulatory frameworks to accelerate the green transition. Housing, food, travel, fashion, and consumer products will all be affected, with most of the regulations coming into effect between 2023 and 2030.

Within the housing sector, the EU Commission has exerted strong pressure to reduce energy-related emissions from both existing building stock and new

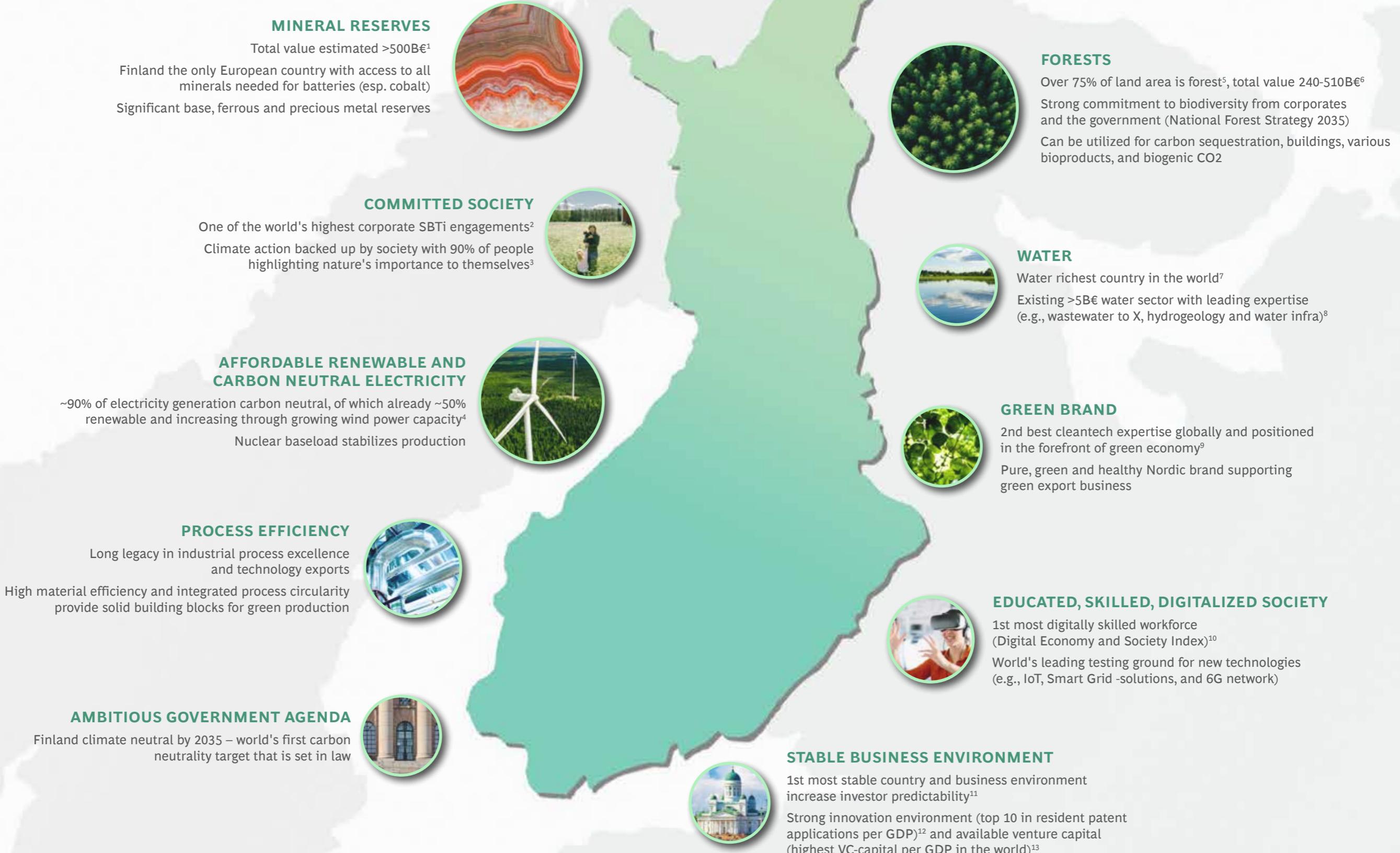
construction projects. For example, the Energy Efficiency Directive sets a binding requirement of a 13% reduction in energy consumption by 2030 (compared to 2020), while the Renewable Energy Directive requires at least a 49% renewable energy share in buildings by 2030.<sup>24</sup> Additionally, energy-intensive industrial sectors, such as steel and cement, are under the EU Emission Trading System (ETS), in place since 2005 and reformed in 2021, and a separate ETS for the heating of buildings will begin in 2027.<sup>25</sup>

In the food industry, the Farm to Fork Strategy (part of the European Green Deal) will accelerate transition to a sustainable food system.<sup>26</sup> In travel and transport, the Sustainable Aviation Fuel Mandate will require aviation fuel available in EU airports to contain sustainable aviation fuel from 2025 onwards, and a separate ETS for road transportation will be introduced in 2027.<sup>27 28</sup>

Meanwhile, the EU is pushing the fashion industry towards circularity, durability, and sustainability. For example, the Ecodesign for Sustainable Products Regulation sets binding requirements for product quality and environmental performance, and at the same time imposes limitations on the use of microplastics and the disposal of unsold products.<sup>29</sup> In addition, within the consumer products sector, the EU is aiming to make sustainable products and packaging the norm. Upcoming regulations include the Packaging and Packaging Waste Directive that will require all packaging placed in the market to be reusable or recyclable by 2030, and sets thresholds for the share of recycled materials in plastic packaging.<sup>30</sup> Finally, the Waste Shipment Framework will increase producer responsibility for waste.<sup>31</sup>

Both by foreseeing where demand will shift and by developing green solutions early on, Finnish companies can gain first-mover advantage and secure a strong position in the emerging circular value chains.

# Finland Has Several Competitive Advantages to Tap into Green Demand



1. Estimate by Geological Survey of Finland; 2. Report by The Science Based Targets initiative (SBTi); 3. Survey by Finnish Innovation Fund Sitra; 4. Statistics Finland; 5. Estimate by Metsäteollisuus; 6. Estimate by BCG; 7. Keele University; 8. Estimate by Finland Toolbox; 9. Global Cleantech Innovation Index; 10. EU Digital Economy and Society Index; 11. Global Innovation Index; 12. World Intellectual Property Indicators; 13. European Venture Capital Statistics



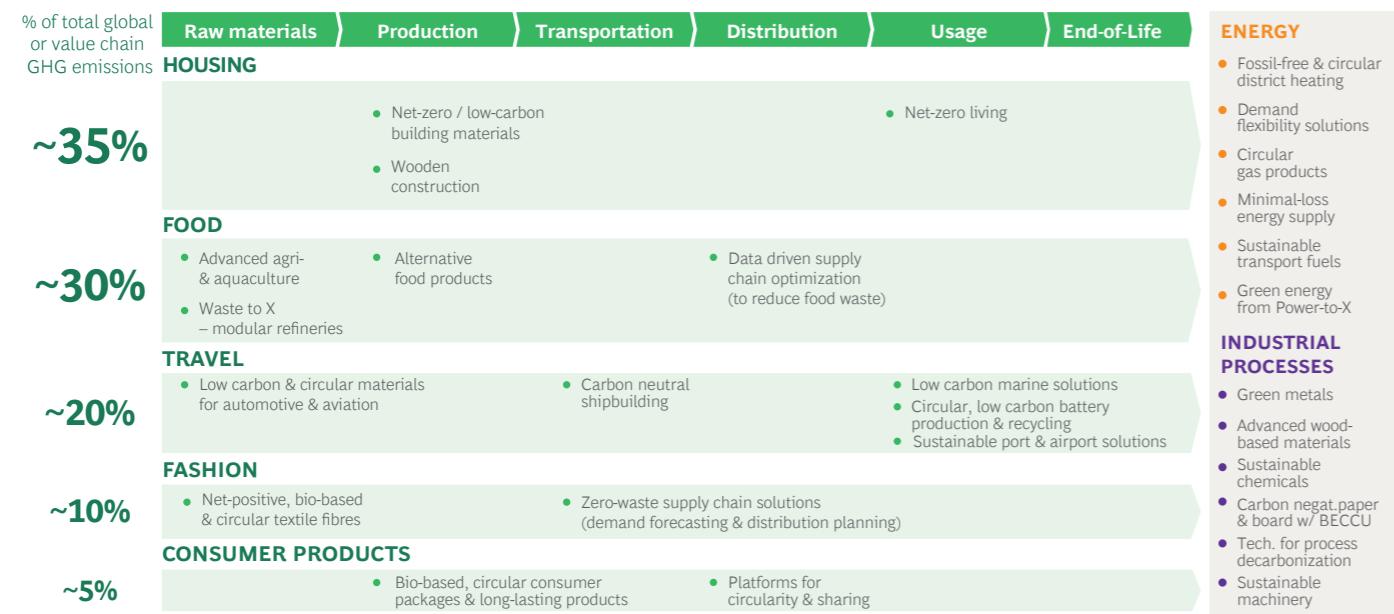
**Energy transition is very much a connectivity challenge when the whole energy system is moving from a one-directional pipe, large generating units, and passive consumers, to a much more decentralized system**

- Pekka Lundmark  
President and CEO, Nokia

# Finland's Green Growth Opportunities

To identify the Moonshots for Finland, CLC and BCG conducted an analysis involving three phases of work. First, we mapped the sources of global emissions across key value chains, identifying a long list of green growth opportunities, particularly noting those where Finnish anchor companies or spearhead offerings existed. We then assessed the impact of each opportunity along six criteria: export potential, GHG handprint (and other environmental benefits), competitive advantages, maturity level of technology, regulatory pressure, and other potential economic or national benefits for Finland. In addition, as part of this initiative, we interviewed more than 60 stakeholders comprising company and industry representatives, researchers and academics with

EXHIBIT 3 | Finland's green growth opportunities along key value chains, energy, and industrial processes



sustainability expertise, senior ministry officials, and representatives from the largest political parties.

Our findings revealed more opportunities than initially expected – a total of 28 green growth opportunities for Finnish companies across sectors. (See Exhibit 3). Common themes include, for example, innovative materials, sustainable production processes, supply chain optimization to reduce waste, sustainable product design, and more energy-efficient usage of goods and services.

In **housing**, emerging opportunities for Finland include low-carbon building materials (e.g., green steel and sustainable alternatives for cement), net-positive wooden

building materials (e.g., cross-laminated timber) that could replace conventional carbon-intensive building materials, and net-zero living solutions that reduce energy-related emissions.

In the **food** sector, identified opportunities comprise solutions that reduce emissions from existing agri- and aquaculture practices, such as net-zero fertilizers and advanced animal feed additives that reduce methane emissions from livestock. Other opportunities include waste-to-x solutions that turn manure and food waste to biogas, biochar, or alternative fertilizers, and data-driven demand forecasting that optimizes food flows in the supply chain. These solutions represent significant abatement potential since between 60-70% of emissions are caused by agricultural practices – the first step in the food value chain. Additionally, alternative proteins and food products provide a significant opportunity to reduce the need for land, farming, and livestock altogether.

In **travel and transportation**, green growth opportunities include circular batteries and lightweight bio-based materials for automotive and aviation industries. Moreover, solutions in sustainable marine transport have the potential to abate emissions from shipping and cruise operations – for example low carbon marine solutions (e.g., hybrid propulsion systems and data-driven routing optimization), sustainable port operations (e.g., electric lifting machinery), and climate-neutral shipbuilding.

In **fashion and consumer products**, green growth opportunities cover innovations in raw materials, such as sustainable textile fibers from biomaterials (e.g., cellulose) and textile waste, as well as bio-based, circular consumer products and packaging. Other opportunities

include AI-enabled systems that reduce overproduction and waste across the value chain, as well as platforms for reuse and sharing that increase the utilization rate of products and extend their useful lifetime.

**As a result of climate change and biodiversity loss, resources are becoming increasingly scarce – circular economy and circular business models are significant opportunities for Finland**

- Minna Halme  
Professor of Sustainability Management,  
Aalto University School of Business

In **energy and industrial processes** – the sectors serving all the industry value chains – opportunities with the highest abatement potential enable the shift away from fossil fuels to renewable energy sources and raw materials. Globally, fossil fuels still account for roughly 80% of primary energy sources used for power and heat, according to the International Energy Agency (IEA).<sup>32</sup> In energy, green growth opportunities for Finland include renewable fuels (e.g., sustainable transport fuels, biogases, power-to-x), as well as fossil-free heat supply (e.g., district heating through geothermal, nuclear, or circular heat generation). Other opportunities contribute to optimized energy generation (e.g., combined heat and power) and consumption (e.g., demand response systems) that minimize energy losses and enable a shift to distributed renewable energy generation (e.g., advanced, connected smart grid systems). Within industrial processes, opportunities include, for example, the electrification of carbon-intensive processes, (e.g., high-temperature process heating) and smart machinery designed for energy, process, and material efficiency.

## NET-POSITIVE LIVING

Finland as the leader in providing holistic net-positive living offering (e.g., wooden construction, net-zero living solutions, and demand response systems)

## BIO-BASED PRODUCTS & MATERIALS

Finland as the global leader in developing & supplying bio-based solutions (such as circular textile fibers, long-lasting consumer products, advanced lightweight biomaterials)

## DECARBONIZATION TECHNOLOGY & SERVICES

Finland as the frontrunner in providing smart technology solutions for high-emitting industrial processes (e.g., electrification, lifecycle services, and energy system optimization)

## CIRCULAR BATTERIES & GREEN METALS

Finland with a circular battery ecosystem, and Finland as the leading supplier of green specialty steel, and other metals in Europe (e.g., for automotive & aviation)

## GREEN HYDROGEN-ENABLED SOLUTIONS

Finland as a competitive country for producing green hydrogen-enabled solutions (e.g., green steel, synthetic fuels, green ammonia-based fertilizers, and food proteins)

# The Five Moonshots for Green Growth: Business as Unusual

The five Moonshots we have identified fulfill the Moonshot characteristics introduced at the beginning of this report: they lean on Finland's lasting competitive advantages and have the potential to help the country make significant leaps in terms of exports and carbon handprint. (See Exhibits 4-8). In addition, the Moonshots are not the province of one or two companies but of a larger stakeholder ecosystem, bringing businesses in the value chain together and leveraging academia and research institutions. Finally, the government can play a role as a catalyst, enabling the Moonshots to realize their full potential.

# NET-POSITIVE LIVING

## Moonshot 1

### VISION

Become a leader in aggregating net-positive living offering

**Wooden construction:** Become a leading supplier of wooden building components (e.g., glue laminated timber, laminated veneer lumber, and cross laminated timber) in the global construction market

**Net-zero living:** Be a world-leading provider of net-zero solutions that minimize operational emissions in new and existing buildings through renewable energy solutions (e.g., geothermal heating, wastewater heat recovery) and smart solutions and design for energy efficiency (e.g., controls and sensors, insulation)

**Demand response systems:** Develop demand response solutions and be a leading networks provider and operator (e.g., generation and storage, ICT systems), enabling a shift to distributed renewable energy generation

**Net-positive buildings:** Position as a leader in aggregating wooden construction, net-zero living and demand response systems into a holistic, net-positive living offering

### SIGNIFICANT LEAP IN TERMS OF EXPORTS AND HANDPRINT

Potential to abate emissions in Housing (~35% of global GHG emissions) by shifting to wooden construction and net-zero living and energy solutions.

>€900 billion projected global market by 2030 driven by regulatory push. Within the EU, Fit-for-55 forcing more stringent requirements on energy efficiency both for new and existing buildings.

The total export potential for Finnish net-positive living products and services is from €9 billion to €12 billion by 2035, based on the country's current exports and market expansion for green alternatives that are projected to grow at a 10%-20% CAGR until 2035 (vs. conventional by only 2%-5%).<sup>33 34 35</sup>

Moreover, the Moonshot has a significant handprint potential. For example, within wooden construction, a cross-laminated timber (CLT) frame has a carbon handprint of ~280 kg CO<sub>2</sub> per m<sup>3</sup> compared to a concrete frame (carbon footprint of CLT ~200 kg CO<sub>2</sub> per m<sup>3</sup> vs. ~480 kg CO<sub>2</sub> per m<sup>3</sup> for concrete frame) while storing 800-900 kg CO<sub>2</sub> per m<sup>3</sup>).<sup>36 37</sup>

### LASTING COMPETITIVE ADVANTAGE

Finland has a lasting right-to-win as one of world's most forested (~75% of land area) and digitally advanced country (#1 in EU's Digital Economy and Society Index).

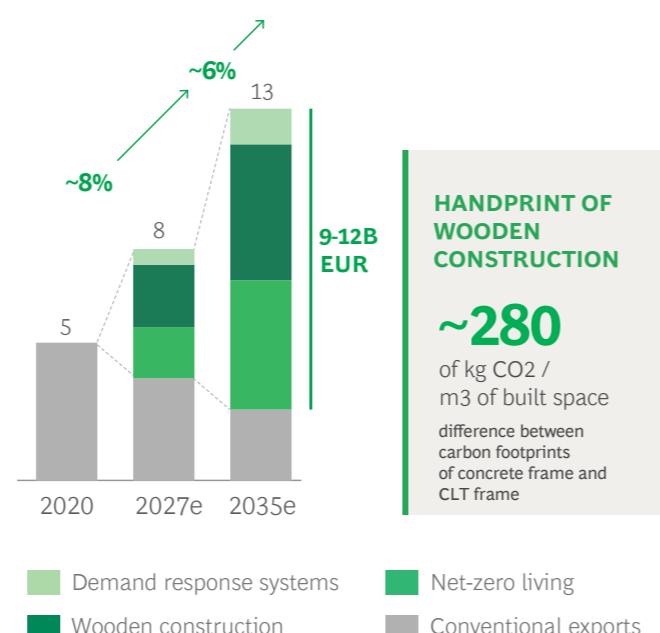
### ECOSYSTEM PLAYERS

The Moonshot brings together housing sector players (providers of wooden building materials, constructors, and energy solutions providers) to create a holistic net-positive living offering.

### HOW COULD GOVERNMENT CATALYZE

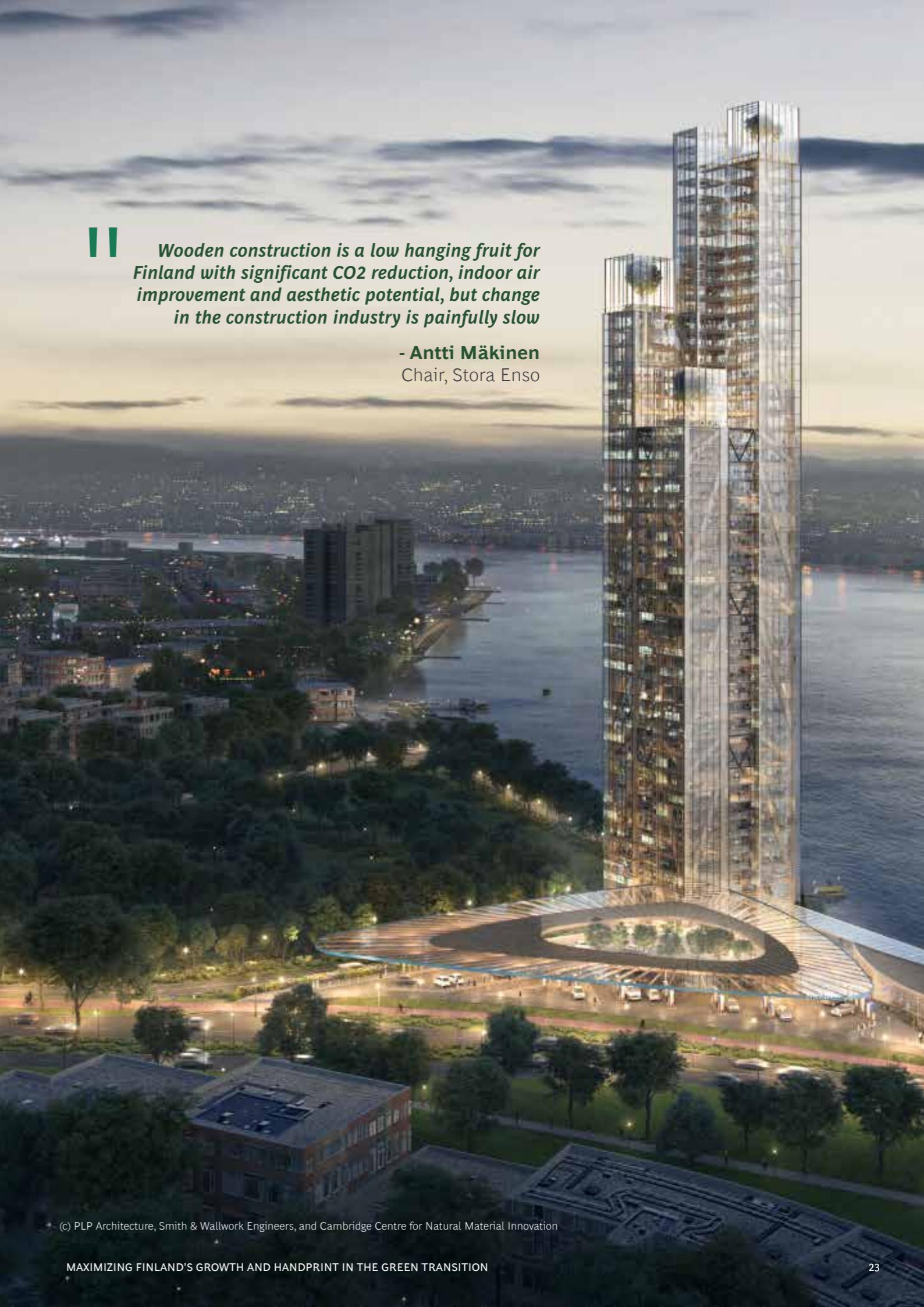
1. Ensure world-leading know-how in net-positive architecture and wooden construction
2. Accelerate domestic demand through public-sector procurement, zoning, and urban planning
3. Coordinate the net-zero living industry through a Center of Excellence to accelerate the exchange of ideas, drive innovation, and facilitate coordination among corporate, academic and research organizations

EXHIBIT 4 | Finland's export potential, B EUR



Wooden construction is a low hanging fruit for Finland with significant CO<sub>2</sub> reduction, indoor air improvement and aesthetic potential, but change in the construction industry is painfully slow

- Antti Mäkinen  
Chair, Stora Enso



(c) PLP Architecture, Smith & Wallwork Engineers, and Cambridge Centre for Natural Material Innovation

# BIO-BASED PRODUCTS AND MATERIALS

## Moonshot 2

### VISION

**Finland as the global leader in developing and supplying advanced bio-based solutions**

**Bio-based consumer products and packaging:** Position as a main supplier of bio-based and circular consumer packaging materials and long-lasting products, enabling the phase-out of commodity plastics and increasing the use of circular materials in the global FMCG market

**Circular textile fibers:** Become a leading supplier of bio- or waste-based, circular textile fibers to global fashion brands, later moving further in value chain to fiber processing

**Advanced biomaterials for automotive and aviation:** Be a leading supplier of advanced, lightweight biomaterials for global vehicle and airplane production, replacing engineering plastics in the markets

**Bio-based chemicals:** Become a pioneering supplier of advanced bio-based alternatives for fossil-based chemicals e.g., in global resins, cosmetics, and pharma markets

### SIGNIFICANT LEAP IN TERMS OF EXPORT AND HANDPRINT

Potential to abate 5%-10% of global GHG emissions by shifting to bio-based materials.

>€1 trillion projected global market by 2030 that needs sustainable alternative materials (~€800 billion commodity plastics, ~€100 billion engineering plastics, ~€100 billion textiles).

By 2035, the overall export potential of bio-based and circular products and materials is between €10 billion and €13 billion. The green alternatives are projected to grow at a 6%-12% CAGR up to 2035 (vs. conventional only 1%-4%).<sup>33 34 35</sup>

As replacements for emission-intensive and non-degradable materials and products in many industries, these products will have a positive carbon handprint and environmental impact. For example, sustainable textile fibers have a carbon handprint of ~3.3 kg CO<sub>2</sub> per kg of textile fiber compared to conventional cotton fibers.<sup>36</sup>

### LASTING COMPETITIVE ADVANTAGE

Finland has a lasting right-to-win as one of the world's most forested (~75% of land area) countries (assuming logging is done within set boundaries, to retain forests' role as carbon sinks).

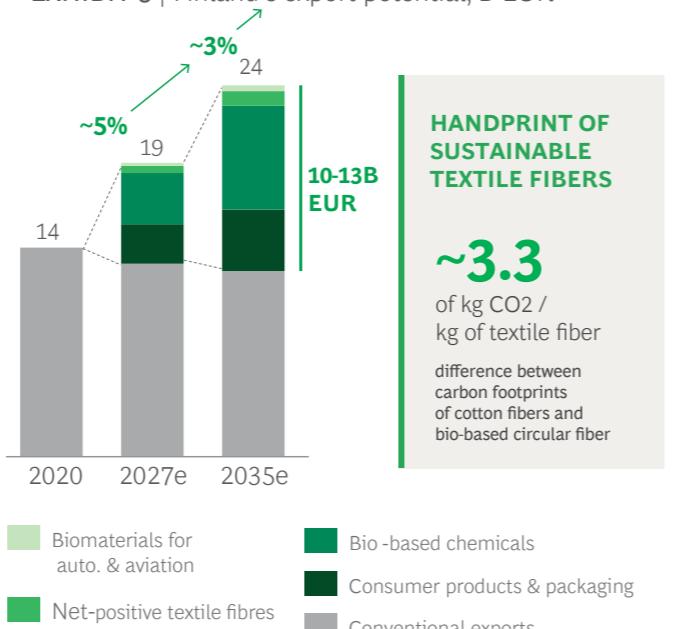
### ECOSYSTEM PLAYERS

The Moonshot forms a foundation for bio-based and circular products and materials, bringing together players producing specialized bio-based products and materials for different industries.

### HOW COULD GOVERNMENT CATALYZE

1. Accelerate transition to advanced bio-based materials and higher value-add products through e.g., incentives, securing forest industry's competitiveness in the future
2. Speed up innovation of high-tech solutions from wood and other bio-based materials through collaborative innovation programs among the ecosystem players (incl. corporate, academic, and public institutions)
3. Position Finland as the global R&D hub for bio-based innovations, attracting foreign investment and leading capabilities, e.g., through facilitated pilot and demonstration processes
4. Revise higher-level education programs to future-proof talent, ensuring world-leading know-how and sufficient resources in bioeconomy. Attract international students and workforce to Finland

EXHIBIT 5 | Finland's export potential, B EUR



# DECARBONIZATION TECHNOLOGY AND SERVICES

## Moonshot 3

### VISION

**Finland as the forerunner in providing smart technology solutions for high-emitting industrial processes, such as electrification and decarbonization-as-a-service**

**Decarbonization technology:** Become the leading provider of decarbonization technology, such as efficient, smart motors and drives that improve energy efficiency, and smart electrification technology that replaces fossil fuels and reduces CO<sub>2</sub> emissions in heat-intensive manufacturing (e.g., steel)

**Decarbonization solutions and services:** Be a forerunner in decarbonization-as-a-service, such as energy system optimization (e.g., energy management and demand response systems), smart lifecycle solutions (to decarbonize existing process operations), or designing sustainable industrial processes and plant retrofitting (e.g., oil refineries to produce renewable fuels)

### SIGNIFICANT LEAP IN TERMS OF EXPORTS AND HANDPRINT

Industrials account for ~18% of global GHG emissions, a majority of which are process related.

With a >€2 trillion industrial machinery market that needs to decarbonize, the export potential of decarbonization technology and services is between €30 billion and €32 billion by 2035 based on Finland's current exports and projected market growth for the green solutions. The green alternatives will grow at a projected 8%-15% CAGR until 2035 (vs. conventional only 3%-6%).<sup>33 34 35</sup>

Both decarbonization technology and services have a significant carbon handprint. As an example, electrified cracking and polymerization technology in plastic production has an estimated handprint of 1.3 kg CO<sub>2</sub> per kg of plastic, reducing the emissions from plastic production by more than 30%.<sup>39</sup>

### LASTING COMPETITIVE ADVANTAGE

Finland has an established industrial machinery sector that represents a significant share of its exports (~30% of total exports) and leans on strong engineering, process efficiency, and digitalization capabilities.

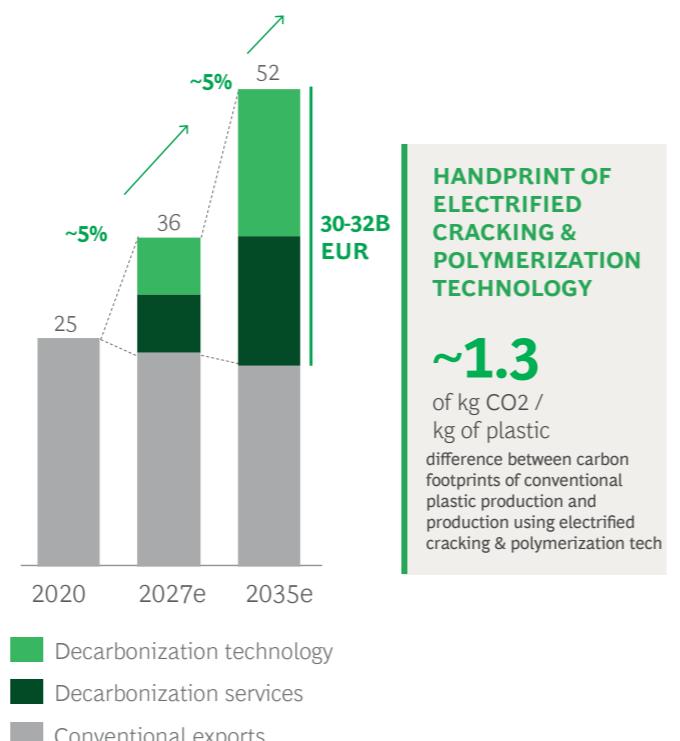
### ECOSYSTEM PLAYERS

Brings together established machinery players and emerging players with pioneering green technology solutions, taking the existing Finnish machinery industry to the next level through decarbonization.

### HOW COULD GOVERNMENT CATALYZE

- Provide coordinated support (R&D and investment funding) for first movers in scaling emerging technologies and capabilities – e.g, around process machinery electrification, sustainable process heat, smart lifecycle solutions, and energy optimization
- Accelerate domestic demand for decarbonization technologies and services through regulation and subsidies, enabling Finnish companies to pilot technologies and services domestically
- Mobilize technology partnerships across industrial sectors to enable new holistic decarbonization-as-a-service business model

EXHIBIT 6 | Finland's export potential, B EUR



**Finland already has a strong multibillion-euro industrial machinery sector but there is still significant growth potential – the green transition is a natural growth opportunity for Finland**

- Jukka Leskelä

Managing Director, Finnish Energy



(c) Coolbrook, RotoDynamic Technology, 2022

MAXIMIZING FINLAND'S GROWTH AND HANDPRINT IN THE GREEN TRANSITION

# CIRCULAR BATTERIES AND GREEN METALS

## Moonshot 4

### VISION

**Finland with a circular battery ecosystem, and Finland as the leading supplier of green specialty steel, and other metals in Europe (e.g., for automotive and aviation)**

**Nordic end-to-end sustainable and circular battery ecosystem:** Form a leading end-to-end sustainable battery ecosystem with sustainable extraction, green manufacturing, and circularity together with Nordic peers, such as Sweden

**Alternative battery technologies:** Position as a leader in alternative battery technologies, e.g., by leveraging bio-based lignin-materials in lithium-ion batteries to replace graphitic carbon

**Green steel for consumer products:** Become the leading European producer of green steel for consumer products (e.g., cooking products), helping brand owners broaden their sustainable offering

**Green specialty steel for automotive:** Become a leading European producer of green specialty steel for demanding end-use applications, helping e.g., automotive OEMs meet their net zero targets

### SIGNIFICANT LEAP IN TERMS

#### OF EXPORTS AND HANDPRINT

The iron and steel industry alone cause 7% of global GHG emissions. In travel and transport, electrification is the most significant lever to reduce emissions as the usage phase is responsible for 70%-90% of emissions. For EV's, existing battery manufacturing accounts for up to 50% of the footprint.

Global steel market is >€1 trillion, with growing demand for decarbonization driven by carbon border taxes and emission trading. The EU battery market is estimated to reach €25 billion by 2030. The total export potential for green steel and green batteries is estimated to be between €27 billion and €29 billion by 2035. The green alternatives are estimated to grow at a 15%-20% CAGR until 2035 (vs. conventional only 3%-4%).<sup>33 34 35</sup>

In the steel industry, green steel produced using an electric arc furnace (EAF) and green hydrogen-based direct reduced iron (DRI) can reduce CO<sub>2</sub> emissions from steel production by up to 100%, representing a carbon handprint of ~1.9 kg CO<sub>2</sub> per kg of steel produced.<sup>39</sup> Similarly, a medium-sized EV, powered by a sustainable battery produced in the Nordics, has an estimated handprint of ~38,000 kg CO<sub>2</sub> over the car's lifecycle compared to a conventional gasoline car.<sup>40</sup>

#### LASTING COMPETITIVE ADVANTAGE

Finland has comprehensive mineral reserves, access to increasing renewable electricity, and bio-based raw materials (e.g., lignin) to leverage in alternative battery materials and technology.

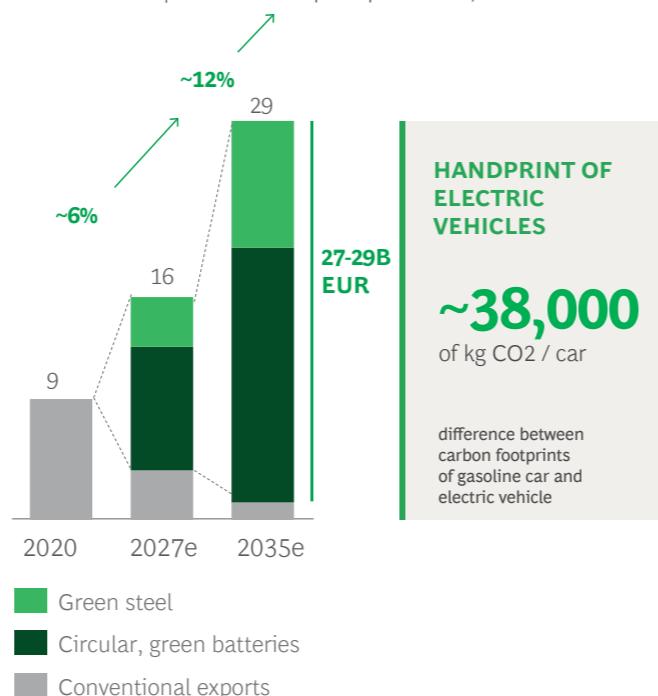
#### ECOSYSTEM PLAYERS

The Moonshot brings together players to enable green metal and circular battery production (leveraging green hydrogen), building on the existing Responsible Mining network.

### HOW COULD GOVERNMENT CATALYZE

1. Through permits and regulation, enhance importance of sustainable mineral extraction and processing of mineral reserves as a building block for green transition
2. Evaluate capability gaps to a green, end-to-end battery ecosystem, and coordinate its development through a Center of Excellence, focusing on circularity and capability development beyond raw materials (e.g., processing of cathode active materials and bio-based anode materials)
3. Support academic research and first movers in scaling emerging electrification technology in metals industry as well as biochar and hydrogen utilization. Promote circularity as an integral part of the emerging battery ecosystem

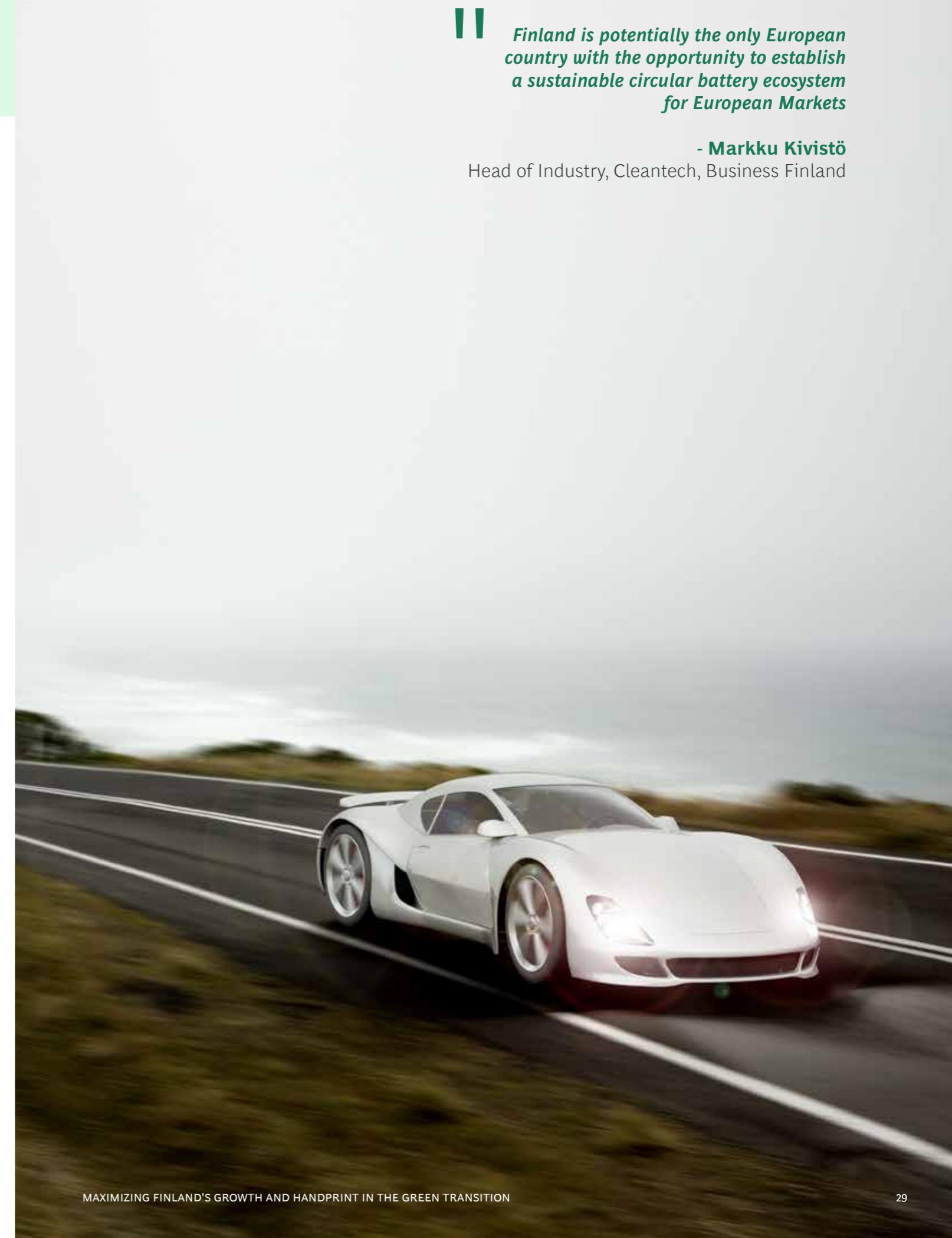
EXHIBIT 7 | Finland's export potential, B EUR



**Finland is potentially the only European country with the opportunity to establish a sustainable circular battery ecosystem for European Markets**

- **Markku Kivistö**

Head of Industry, Cleantech, Business Finland



# GREEN HYDROGEN-ENABLED SOLUTIONS

## Moonshot 5

### VISION

Finland as a competitive country for producing green hydrogen-enabled solutions, such as green steel, synthetic fuels, green ammonia-based fertilizers, and food proteins

**Green steel for consumer and industrial applications:** Finland producing green steel for consumer products, such as kitchen ware, and green specialty steel for demanding end-use applications, such as automotive

**Sustainable marine and aviation fuels for the green Nordic corridors:** Finland producing green ammonia-based fuels for marine and aviation, creating a lighthouse green corridor in the Nordics

**Green fertilizers:** Finland producing green ammonia-based fertilizers for the EU market, utilizing green hydrogen and bio-based ingredients

**Alternative proteins:** Finland supporting European food resilience by producing and supplying low carbon green hydrogen-based proteins to the EU market

### SIGNIFICANT LEAP IN TERMS OF EXPORTS AND HANDPRINT

Green hydrogen is key in decarbonizing hard-to-abate industries that contribute to the three most emitting value chains – Housing, Food and Travel – which account for ~80% of global GHG emissions.

Globally, green hydrogen and its derivatives will be an estimated >€1 trillion market by 2050. The EU has set a target to produce 10 Mt of green hydrogen within the region by 2030, of which Finland has the conditions to produce 10%. This would translate to a €50 billion investment in wind power and green hydrogen within this decade.<sup>41</sup>

The total export potential for green fertilizers, sustainable marine, and aviation fuels, as well as for alternative proteins is between €10 billion and €12 billion. The green alternatives will grow at a projected 16%-20% CAGR up to 2035 (vs. conventional only 3%-7%).<sup>33 34 35</sup>

The carbon handprint potential is substantial: for example, green hydrogen-based alternative proteins alone have an estimated carbon handprint of ~270 kg CO2e per kg of protein produced compared to beef.<sup>42 43</sup>

### LASTING COMPETITIVE ADVANTAGE

Finland is uniquely positioned with access to growing renewable electricity, biogenic CO2, freshwater, and strong engineering capabilities.

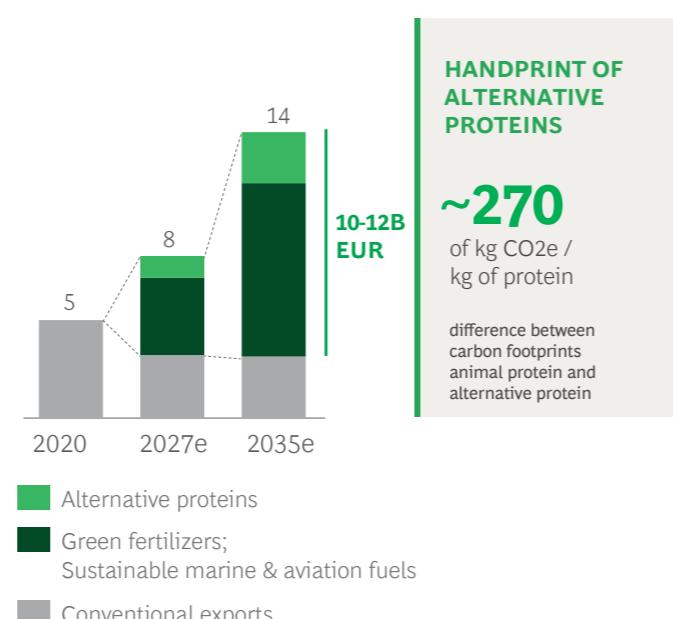
### ECOSYSTEM PLAYERS

The Moonshot forms a full green hydrogen economy comprising production, infrastructure, conversion, and utilization, contributing to decarbonization across industries.

### HOW COULD GOVERNMENT CATALYZE

1. Prepare an ambitious and comprehensive industrial strategy on green hydrogen and ensure its execution, building on the National Climate and Energy Strategy
2. Eliminate unnecessary regulatory barriers, accelerate permits and zoning processes, and catalyze investments to reach sufficient renewable electricity generation (wind power)
3. Provide coordinated support (R&D and investment funding) for first movers in scaling emerging technologies around industrial electrolysis, BECCU, and green hydrogen transportation and storage
4. Stimulate demand by broadening national “blending mandates” and implementing national targets for e.g., low-carbon fertilizers and green shipping corridors domestically

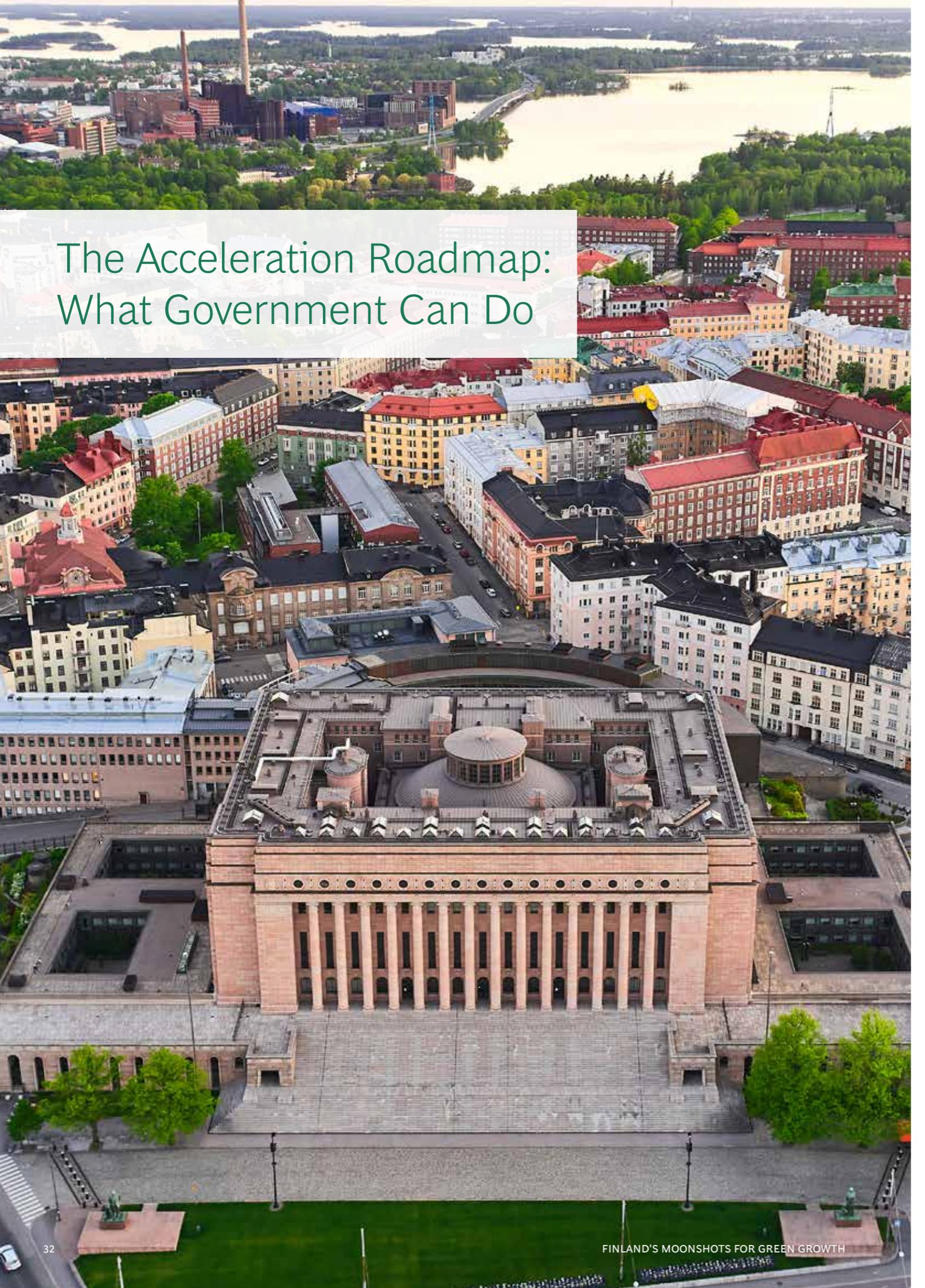
EXHIBIT 8 | Finland's export potential, B EUR



**Finland has a geographical advantage for green hydrogen and its derivatives production through affordable wind power, large amounts of biogenic carbon dioxide, and rich water resources**

- Herkko Plit,  
CEO, P2X Solutions





# The Acceleration Roadmap: What Government Can Do

FINLAND'S MOONSHOTS FOR GREEN GROWTH

Each Moonshot represents a major export and carbon handprint opportunity for Finland. Besides generating new sources of growth for Finland, these five Moonshots would ensure that Finland's existing export industries future-proof themselves for the green transition. However, it is not set in stone that these Moonshots will realize their full potential – Finland's ultimate success in the green transition depends on actions taken now. There are several levers to unlock the full potential: accelerating green investments, catalyzing domestic green demand, ensuring prerequisites for green growth, and positioning Finland as the forerunner in green solutions. Finland has already used several of these levers in the past. (See Sidebar "Government has Already Triggered Green Exports").

## Accelerating green investments

In order to attract green investments, predictable and profitable operating environment is needed, e.g., in terms of taxation (such as electricity tax). Moreover, as recommended by the OECD, Finland's government could more actively remove bottlenecks for foreign direct investments by streamlining inefficient and burdensome policies and reducing bureaucracy.<sup>5</sup> Permit processes could be streamlined in construction and operational areas, such as wind power development. Finally, private-sector funding is often tied to short-term projects, and investors expect rapid returns. Yet government can support academia and first movers in scaling emerging technologies and bringing them to the point of commercialization by sharing the risk in pilot and demonstration stages. Fertile areas for R&D funding include, e.g., industry electrification, energy use optimization, and circularity – especially in the emerging battery value chain.

## Catalyzing domestic green demand

To gain first-mover advantage and achieve economies of scale, sufficient demand for new offering is required. Often, companies scale abroad after first having conquered the home market. In the green transition, government can accelerate domestic demand through procurement policies, e.g., government can increase demand for zero-emission buildings and wooden construction by renovating existing public buildings and opting for wooden building materials in new public construction (e.g., schools). Government can also encourage private-sector demand and investments through incentives and policies. For example, zoning rules can promote wooden construction and net-zero living. With blending mandates, government can catalyze the development and adoption of new sustainable fuels. Furthermore, subsidies can enable Finnish solution

## GOVERNMENT HAS ALREADY TRIGGERED GREEN EXPORTS

The Finnish government and cities already have experience in successfully applying these levers to catalyze green exports. For example, in the 1970s, the city of Helsinki decided to publicly procure development of the metro line, which led ABB, Valmet and other industrial technology companies to co-develop the trains.<sup>44</sup> Through R&D investments, ABB became a global leader in driver technology, and continues to export drive technology to this date.

providers to pilot decarbonization technology and services domestically before scaling abroad.

## Ensuring prerequisites for growth

Any one of the five Moonshots will require expertise and R&D to successfully take off. For example, wooden construction requires architects specialized in building with wooden materials, such as cross-laminated timber, while bio-based products and materials will need increasing know-how and resources in bioeconomy across industrial use cases. Consequently, revised or new higher-level education pathways and degrees are required to address the emerging expertise needs driven by the green transition. In addition to educating its own workforce, Finland should attract international students and workforce.

Acknowledging that the full potential of the Moonshots will require national coordination and strategic planning across ministries and public institutions, the Finnish government can build on its existing National Climate and Energy Strategy. For example, it can provide planning support for green hydrogen efforts that need access to renewable energy and fresh water.

Finally, developing competitive green offerings requires co-development and collaboration among different value chain players. Ideally, universities and research institutions also contribute to the broader ecosystem. Centers of Excellence can significantly accelerate the exchange of ideas, drive innovation, and facilitate coordination among ecosystem players. These Centers can also support in attracting investment, talent, and partners. By placing the Centers outside the capital region, close to the relevant natural resources, Finland can create jobs and drive attractiveness of less populated areas in Finland.

*There will be significant amount of climate-aligned investments globally and it is important to attract some of these investments to Finland.*

*Also, Finland needs to shift its R&D funding increasingly to more disruptive green technologies – incremental improvements in productivity will not be enough*

**- Juha Majanen**

Permanent State Secretary, Ministry of Finance

Furthermore, the national biofuel blending obligations first introduced in 2008 and the bioeconomy strategy launched in 2014 catalyzed domestic demand for biofuels. Finnish players, such as Neste, started to invest early on in biofuel R&D, which gave them a first mover advantage and enabled them to become the world's leading renewable diesel and jet fuel provider.<sup>45 46</sup> More recently, government provided financial grants for growing the national EV charging infrastructure, enabling players, such as Kempower and Virta, to scale and successfully expand beyond the domestic market.<sup>47</sup>

**Positioning Finland as the forerunner in green solutions**  
 Finland can generate and channel green demand by positioning itself as a leader in green technologies. First, an easy-to-navigate **online platform** could showcase Finland's comprehensive offering in green tech and decarbonization solutions in one place (similar to the one Denmark has on its State of Green [website](#)). By structuring offering according to key sectors, global companies could learn about the latest green technology and solutions applicable to their businesses, and Finland's numerous green tech companies would get an effective go-to-market platform.

Second, Finland could organize an annual, world-leading **Green Tech event** in Finland (such as Slush) to gather green tech companies, foreign investors, and global companies looking for green solutions together. (See Exhibit 9). Finally, a **green growth PR strategy** promoting Finland's spearhead offering and key milestones – such as the first circular battery or the world's first net-positive high-rise building – would earn valuable presence in international media and attract further interest toward Finland's green offerings.

**The Nordics have an opportunity to create a 'Green Silicon Valley'. We have a strong reputation, but there is still unclarity on how to realize this**

**- Minna Aila**

EVP, Sustainability & Corporate Affairs, Neste

#### EXHIBIT 9



**Accelerating the green transition is integral for the Finnish economy, and innovation on its own is not enough – enabling scaling, ensuring talent and resources, and forming ecosystems is needed.”**

**-Pekka Ala-Pietilä**

CLC Board,  
 Chair, Huhtamäki and Sanoma

**We should have a Green Tech 'Slush' in Finland – an annual green tech expo to match tech providers, investors and companies that are looking for green solutions**

**- Antti Herlin**

Chair, KONE

Chair, Tiina and Antti Herlin Foundation



# Conclusion

The green transition provides significant new growth opportunities for Finland, whose economy needs healthy GDP growth for the coming decades to secure its welfare and balance fiscal deficit. Finland is particularly well-positioned to tap into green growth given its natural resources, export sectors that are focused on industrial processes and technology, and nationwide green ambition. Finland already has a vast number of green solutions and spearhead offerings to support decarbonization of the world's highest emitting value chains, including housing, food, travel, fashion, and consumer products.

From these green growth opportunities, five areas emerge as the Moonshots for Finland, the must-win-battles that Finland cannot afford to lose. These Moonshots lean on Finland's lasting competitive advantages – such as forests, mineral reserves, and growing renewable energy capacity – and ensure that established export sectors future-proof themselves. If fully realized, these Moonshots would lift Finland's exports, and thereby its GDP growth, to a permanently higher level. In total, the Moonshots have an export potential of €85 billion to €100 billion by 2035.

Finland's ultimate success in the green transition depends on actions taken now. There are several levers to catalyze green growth and unlock the full potential of the Moonshots, including removing bottlenecks for green investments, securing the required enablers for growth, accelerating domestic demand, and ensuring that existing subsidies and funding are aligned with green growth. In addition, Finland can position itself as the forerunner in green tech and channel green demand to Finland through collective go-to-market efforts. Through the Moonshots, Finland can simultaneously drive growth and thereby well-being, reach its own ambitious climate targets, and become greater than its size in solving the climate crisis.





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