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The Global Cleantech Innovation Index 2017

Global Cleantech Innovation Programme
(GCIP) Country Innovation Profiles

CATALYSING INNOVATION AND ENTREPRENEURSHIP IN CLEANTECH START-UPS
AND SMEs OF EMERGING ECONOMIES TO PROTECT THE GLOBAL COMMONS



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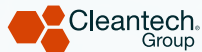
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EXECUTIVE SUMMARY

This report investigates the 8 partner countries of the Global Cleantech Innovation Programme (GCIP). The GCIP is an initiative of UNIDO and the Global Environment Facility conducted **Armenia, India, Malaysia, Morocco, Pakistan, South Africa, Thailand** and **Turkey**. The GCIP aims to foster innovation and entrepreneurship ecosystems, and to catalyze investment to support and accelerate start-up entrepreneurs towards the development and commercialisation of cleantech solutions to protect our global commons.

This report is a supplement to the 2017 Global Cleantech Innovation Index (GCII). The GCII aims to measure where clean technology companies are likely to emerge in the next 10 years and the reasons behind such expectations. The method of analysis used in developing this report follows the spirit of the GCII.

The GCII methodology was extended to include GCIP partner countries that were not already part of the GCII’s purview, namely Armenia, Malaysia, Morocco, Pakistan, and Thailand. In order to draw out an accurate assessment of each country’s cleantech ecosystem, a questionnaire was designed and submitted to experts in each of the 8 countries.

The result of incorporating GCIP countries into the GCII methodology are presented below in *figure 1*. In comparison to the forty advanced economies analysed in the GCII 2017 report, the GCIP partner countries are placed in the lower half of the ranking, with Armenia, Morocco and Pakistan forming the bottom three of the forty-five countries analysed. It should be noted that for Pakistan, data was not available to prescribe a score in either of the *input to innovation* indicator pillars.

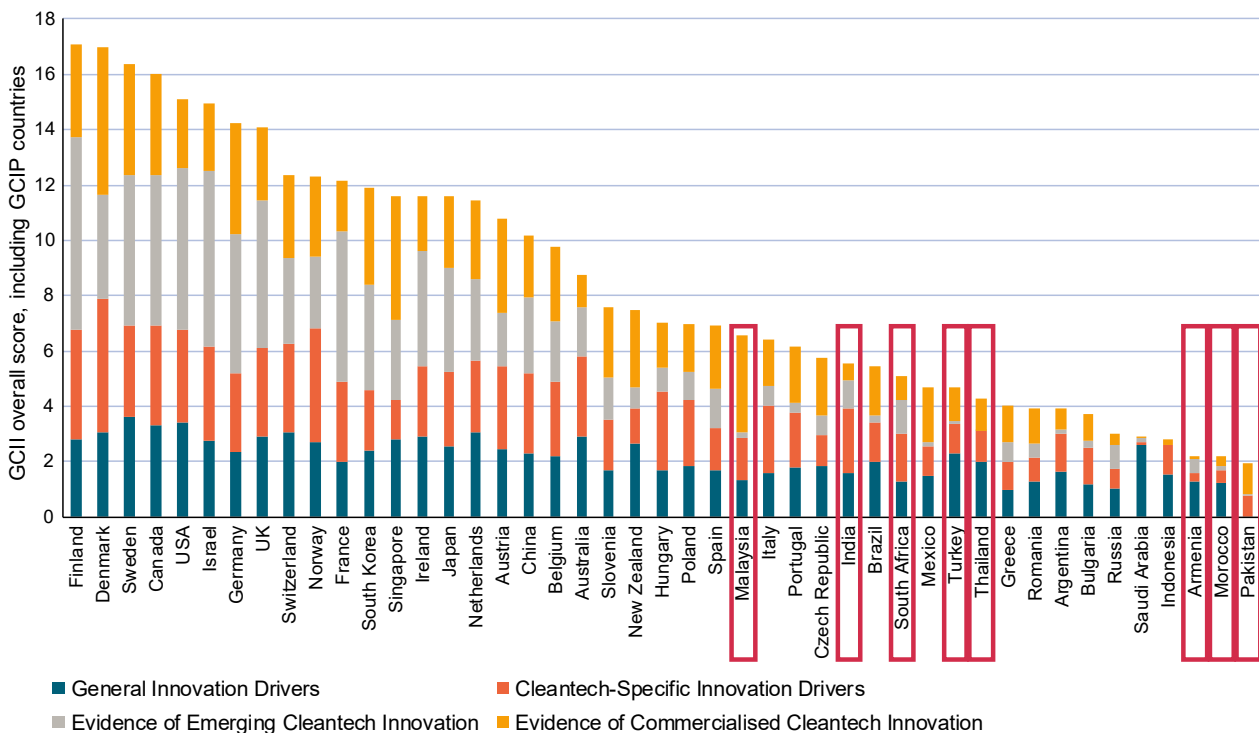


Figure 1 2017 Global Cleantech Innovation Index including GCIP countries

The appearance of the eight GCIP partner countries in the lower half of this ranking serves to highlight the need for improvements across the range of indicators measured in the GCII. Incubator programs and accelerators, such as the GCIP, are part of the solution, but in the country profiles that follow, the requirement for further incubation and coordination of the cleantech ecosystems is highlighted as needing more attention.

Figure 1 also breaks down a country’s score by the 4 indicator pillars used in the GCII methodology (for more details see *Methodology*). For instance, Turkey scores well on *General Innovation Drivers*, while Malaysia scores well on *evidence of cleantech commercialisation*.

Information in Figure 1 above is further analysed to focus on *inputs to innovation* and presented in Figure 2 below. **Turkey** and **Thailand** score strongly in *General Innovation Drivers*, and in *Cleantech-Specific Drivers* **India** and **South Africa** score strongly.

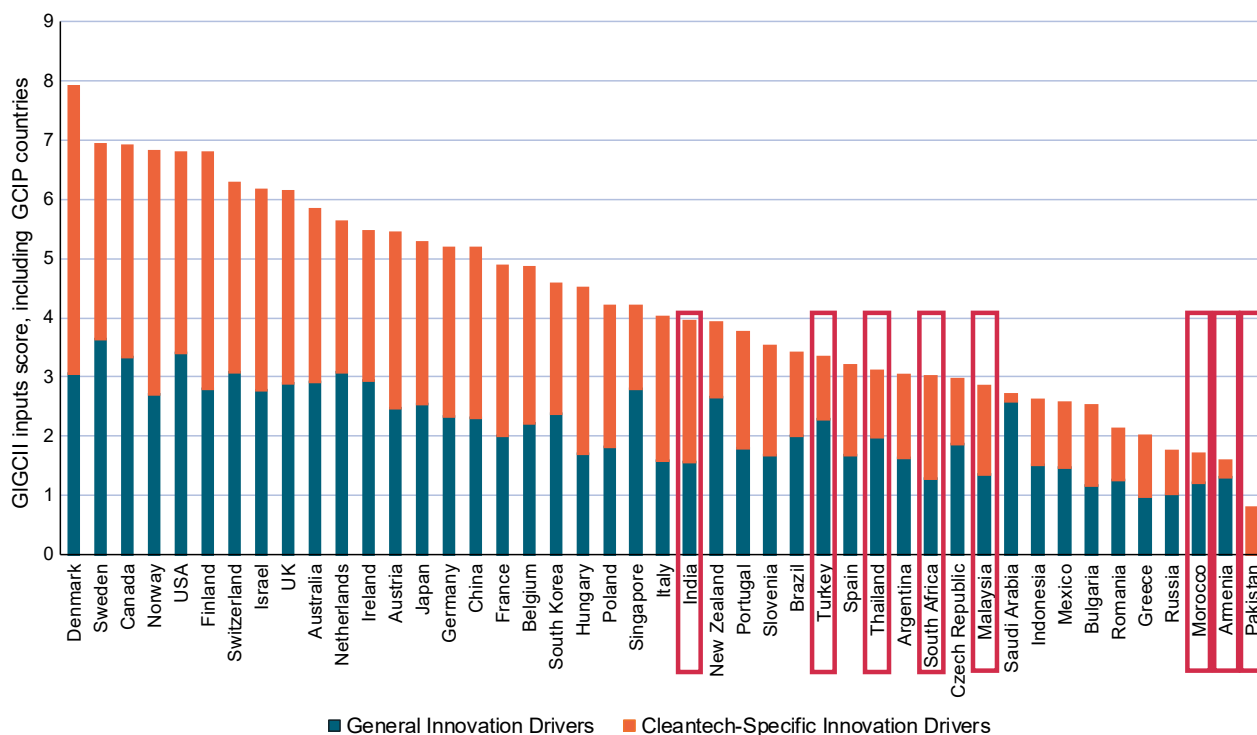


Figure 2 GCII and GCIP countries: Inputs to Innovation

Figure 3 zooms in on the outputs of innovation where **South Africa** and **India** again score strongly in Evidence of Emerging Cleantech, and in Evidence of Commercialised Cleantech **Malaysia** and **Turkey** score strongly.

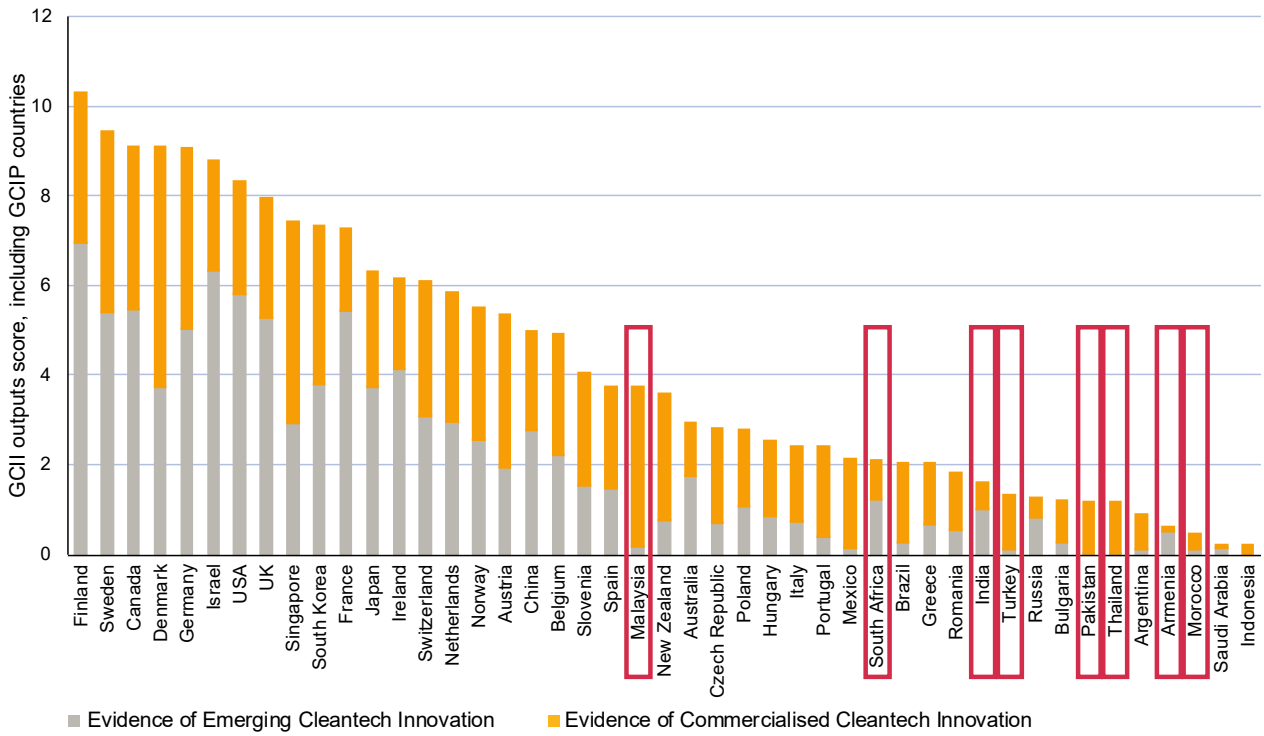


Figure 3 GCIIP and GCIP countries: Outputs of Innovation

Overall Observations

1. **Malaysia** leads the 8 GCIP partner countries, with particular strength in *evidence of Commercialised Cleantech*. This is caused by high levels of cleantech commodity exports and imports, in part due to the biomass pellet industry which is well established. This strong level of cleantech commercialisation is built on a foundation of leading levels of public cleantech R&D expenditure and domestic cleantech investors. However, despite relatively good access to finance and a promising number of cleantech incubators active in the country, there is currently very little *evidence of Emerging Cleantech*. Research and development, and promotion of cleantech start-ups from public and private sector, need to fill this gap in the country's cleantech innovation ecosystem.
2. **Pakistan, Armenia and Morocco** score below the minimum observed for the 40 global countries, largely due to a lack of significant cleantech innovation *outputs* which forms 50% of the score in our methodology. Innovation *inputs* are nascent, but growing, but suffer from limited private sector funding support across the three countries. These countries have nascent cleantech innovation ecosystems.
3. **South Africa and India** lead the group in showing *Emerging Cleantech* innovation, which, given the right support structures and market demand, could translate into significant *Commercialised Cleantech* in the near future.
4. Consistent with the main GCII findings, above-average cleantech innovation *outputs* require an above-average level of *inputs* (both *General, and Cleantech-Specific Innovation Drivers*)
5. All GCIP countries show some government support for the cleantech sector, but there is a wide gap between leader and laggard countries. Government support typically focuses on overarching cleantech-friendly policies. In some instances, direct financial support is available beyond cleantech R&D expenditure. Governments tend to focus on promoting renewable energy technologies and energy-efficiency enhancing technologies.
6. Access to finance for cleantech start-ups varies greatly, and is a major focus of our assessment throughout. However, accelerators & incubators as well as government funds and grant schemes play an important role, and tend to be present in countries showing *evidence of Commercialised Cleantech*.
7. The deployment of early-stage and late-stage private capital in the cleantech sector is low compared to a global average. A combination of a risk-averse investment culture, lack of information sharing, and a low supply of innovative companies contribute to varying degrees across the countries analysed.
8. Low levels of corporate engagement in the cleantech innovation sphere exist in all GCIP countries.

Recommendations

Overall, all GCIP countries can benefit from greater coordination between the entities that provide *inputs to innovation*. Coordination between government departments and agencies responsible for managing initiative and policies that promote innovation is just one level of coordination, but interaction with the private sector deserves much closer attention. This report often highlights the presence of good public policy that is not carried into strong private sector support.

Inputs to innovation

1. Cleantech-related research activities in universities are often detached from the private sector. For example, in **Malaysia** there is a good amount of research being funded, but this has not translated into early-stage entrepreneurial activity, and there is low evidence of environmentally-related IP protection. Furthermore, support programmes are required to match these prototype developments with business model developments, to carry innovation into commercial success.
2. **Armenia's** recent introduction of a course on Entrepreneurship at the American University of Armenia's Entrepreneurship & Product Innovation Centre could serve as an example on how to bridge the commercialisation gap between research facilities and start-up company origination.
3. All GCIP countries do not have significant numbers of cleantech-related industrial clusters. Organizations that seek to connect innovators with potential investors or industrial partners should be increased to facilitate the scale-up of cleantech start-ups.
4. Each of the countries analysed had an incomplete set of cleantech-friendly policies, as measured in the GCII indicator. The first recommendation would be to push towards a full set of supportive policies, which enable a base of legislation on which cleantech-targeted policies and support schemes can be built. For a summary of existing cleantech friendly policy, refer to the extended summaries in *appendix 2*.

Outputs of innovation

1. In countries where some forms of early-stage support is already present, such as **South Africa, India, Malaysia**, it would facilitate growth of *output* indicators if these early-stage grant and development funds were directed through public-private partnerships for incubator/accelerator/cluster models that draw on the strength of existing industry players within country.
2. For all countries covered in this report, it is important for governments to examine the role it can play in facilitating the transition from public to private sector funding. In all countries except **India** and **South Africa**, venture capital financing was either low or zero. In the responses by in-country experts, it is evident that there are pockets of innovation, but these companies and start-ups are finding it extremely difficult to attract private investors. Even in **South Africa** and **India**, where there are plenty of examples of early-stage venture capital in cleantech, our assessment shows that these are often provided with stringent de-risking terms. As in the example highlighted in **Thailand**, these terms are often based on asset-based collateral, which is often a prohibitive term in the cleantech ecosystems analysed in this report.



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INTRODUCTION

In today's economic landscape where resource constraints and climate concerns are no longer externalities, technology innovation has emerged as a key driver for economic growth. Today's clean technology innovations will fuel the next industrial revolution that will shape tomorrow's global economy and job market, and start-ups and small and medium-sized enterprises will play a vital role in catalyzing breakthrough technology innovations.

And as the world continues to globalize, the synergetic value of collaboration among developing countries and advanced economies are quickly leading to innovation linkages and receiving recognition as a catalyst for game changing solutions at the global scale.

Cognisant of these essential factors, the Global Cleantech Innovation Index (GCII) 2017 investigates where, relative to GDP, entrepreneurial clean technology companies are most likely to emerge from over the next 10 years – and why. Drawing on a wide range of factors and sources, the study seeks to answer the questions: which countries currently have the greatest potential to produce entrepreneurial cleantech start-up companies that will commercialise clean technology innovations over the next 10 years?

The changing nature of cleantech investment:

In the 2014 Global Cleantech Innovation Index Report, we reported on the rise of 'other cleantech' sectors gaining favour in a 'post-bubble landscape for renewables (especially solar), in which many venture capital investors have pulled out since the hype and height of stimulus spending in 2008'.¹ According to *Figure 1*, the update in 2017 would confirm the first assertion that there has been a proliferation of 'other cleantech' sectors receiving venture investment in substantial quantities, while sectors such as solar, which constituted a large part of the \$329 billion invested in renewable energy in 2015, have used venture capital investment to go mainstream, proving that the solar 'bubble' may have in fact led to the maturing of the solar market. The second comment on the decline of venture capital investor's participation, at the time measured by the decline of investment from the 2011 peak to the 2013 trough, seems to have been written at a turning point. On evidence of the last four years, venture capital is steadily returning to newly-defined cleantech.

¹ Cleantech Group, WWF, *Global Cleantech Innovation Index*, 2014

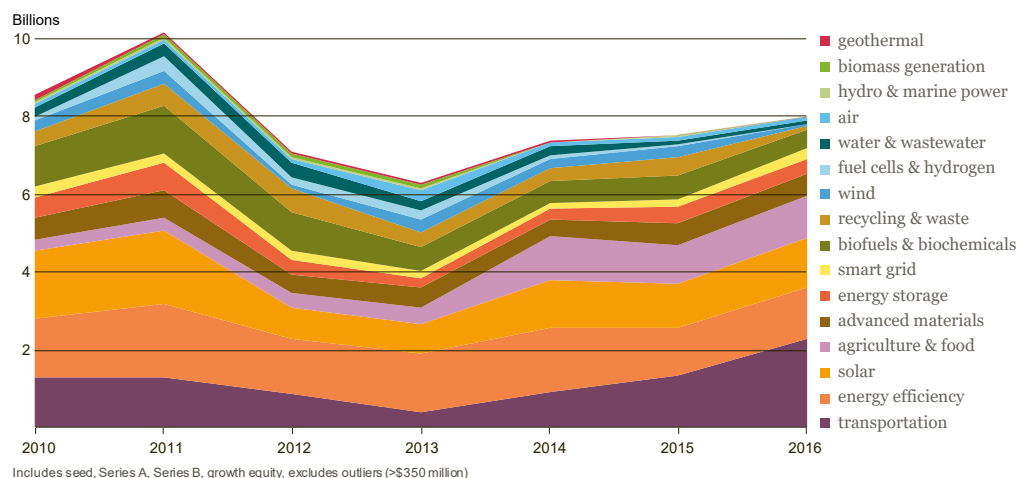


Figure 4 Global Venture and Growth Equity Investment in cleantech companies, 2010 - 2016

However, it is returning to a much-changed investment theme. While Renewable Energy and Energy Efficiency remains the bedrock of cleantech venture capital, there has been a significant rise in investment in Agriculture and Food, Advanced Materials, and Transportation, with the latter now a leading cleantech sector. We shall return to look at the impact of Energy Efficiency and Transportation on the cleantech investment theme later in this report.

One recent example of the growing strength of cleantech investment was announced at COP21 in Paris. A new Breakthrough Energy Coalition for early stage cleantech investment was launched. This new investment group committed to provide patient capital for clean energy innovation, starting with a \$2 billion pledge that is expected to reach \$20 billion by 2025. To follow this announcement, in December 2016 Breakthrough Energy Ventures was launched with \$1 billion, with the remaining 50% expected to be announced soon. This represents a welcome 12% addition to the \$8 billion in global venture and growth equity investment in cleantech companies.

Key results from the GCII report

The GCII 2017 analyzed 15 indicators of creation, commercialisation and growth of cleantech start-ups in 40 countries. The key trends identified in top performing countries are that they are

- a) addressing growing demand for renewable energy and other clean technologies;
- b) connecting start-ups with multiple support channels to increase their success rates and;
- c) increasing international engagement across the cleantech ecosystem.

As expected, and consistent with the 2014 Index, there is a positive correlation between *inputs to innovation* and *outputs of innovation*. Countries that are facilitating investment in innovation, either through public R&D, cleantech-friendly policy, or any other of the *inputs* measured, tend to also reap benefits from the commercialisation of cleantech companies.

The top three positions in the GCII 2017 are held by Denmark, Finland and Sweden. Denmark tops the 2017 Index, moving up from 5th place in 2014, based on strong scores in both *inputs to innovation* and *outputs of innovation*. The key contributing

cleantech specific drivers include the amount of capital raised by cleantech funds and the number of cleantech organizations. Denmark also shows strong *evidence of Commercialised Cleantech*, including cleantech exports, the number of public cleantech companies and the number of renewable energy jobs. Poland has displayed the biggest change from the 2014 Index, as it rose thirteen places to take 24th place. This is mainly due to three notable increases in *Cleantech-Specific Drivers*. Poland's public cleantech R&D expenditure now sits at the global average, having been in last place in the 2014 Index. The country also improved its score in the Renewable Energy Country Attractiveness Index, moving from 29th to 27th in that Index. These factors are combining to show increasing *evidence for Emerging Cleantech innovation*, as Poland moved up 16 places in our measurement of cleantech patent filings.

The Global Cleantech Innovation Programme (GCIP)

The Sustainable Development Goals and the Paris Agreement are the world's commitment to safeguarding the global commons. The United Nations Industrial Development Organization (UNIDO), with its unique mandate to support inclusive and sustainable industrial development, has partnered with the Global Environment Facility (GEF) to address the most pressing global environmental challenges of our time. Through fostering innovation and entrepreneurship ecosystems, UNIDO and GEF seek to promote affordable and scalable solutions enabling our partner countries to leapfrog to cleaner, more resilient economies.



Innovation Ecosystem

The GCIP promotes an innovation and entrepreneur ecosystem by identifying and nurturing cleantech innovators and entrepreneurs; by building capacity within national institutions and partner organizations for the sustainable implementation of the cleantech ecosystem and accelerator approach; and by supporting and working with national policy makers to strengthen the supportive policy framework for SMEs and entrepreneurs.

Entrepreneurship and innovation acceleration programmes can act as strong catalysts in creating and strengthening innovation ecosystems, as evidenced in the GCIP partner countries. The acceleration programmes are especially instrumental in carrying the inputs of innovation to result in cleantech-specific outputs of innovation, if emphasis on commercialisation and investment mobilization is adequately addressed.

Through this cleantech ecosystem and accelerator approach, the GCIP catalyzes investment to support and accelerate start-up entrepreneurs towards the development and commercialisation of their innovative ideas.

Innovation and Entrepreneurship Policy Frameworks

An integral part of GCIP is the development of an enabling environment for cleantech innovation and entrepreneurship, and GCIP employs a cross-sectoral and multi-tiered approach with a view to building a sustainable “ecosystem” for innovative entrepreneurship in small businesses. This entails supporting national partners to strengthen the institutional capacities of government agencies focused on small and medium-sized enterprises (SMEs) development, clean technology and innovation.

Through review of existing policies, regulations and guidelines relating to the promotion of clean technologies, innovation and entrepreneurship, GCIP also advises governments to focus on high-impact areas, especially from the perspective of encouraging and supporting increased engagement and participation of SMEs. Awareness raising and capacity building activities are also supported through regional stakeholder meetings and developing partnerships with leading institutions, agencies and universities.

Building on the experience accumulated in the past 7 years of supporting over 600 cleantech start-ups and SMEs, GCIP is planning to expand its geographical coverage, as well as impact across multiple environmental and social areas. GCIP is planning a transition to an impact-focused accelerator in order to leverage innovation and entrepreneurship to provide solutions to protect our global commons. Existing technology categories will evolve in to impact categories Further categories will be added in future Accelerator cycles to accelerate transformative clean technology solutions and integrated approaches for energy systems, sustainable cities, healthy oceans and sustainable fisheries, food systems, and landscape restoration.

GCIP also supports identification and development of demand-driven solutions that can address the most pressing environmental challenges at the national levels. Through National Innovation Challenges, innovators are invited to propose technology innovations that can address a particular problem with high-impact potential. This approach allows direct market access for the technologies, and ensuring efficiency and effectiveness in impact scaling.

METHODOLOGY

The Global Cleantech Innovation Index 2017

Under the policy component of the GCIP to enhance the enabling environment in partner countries, the GCII-GCIP report aims to further strengthen the ecosystem an enabling environment through national policies that promote innovation in clean technologies, and to serve as a valuable policy tool to stimulate a broader economic action plan including strategic support for cleantech solution providers.

The aim of this report is to review the existing environments related to the promotion of clean energy/cleantech innovation and support for entrepreneurial efforts in the 8 countries covered by the GCIP programme. In order to achieve this, the country analyses draw on two main sources of information.

1. The first is the 2017 Global Cleantech Innovation Index (GCII). The GCII was first created in 2012 to investigate this question: ‘Which countries currently have the greatest potential to produce entrepreneurial cleantech start-up companies and which will commercialize clean technology innovations over the next 10 years?’. South Africa, Turkey and India are featured in the GCII. The other countries were included in the indexing methodology for the purpose of this report only, illuminating their relative positioning in the global index, while accounting for the missing data-points in the required index indicator input.
2. The second is a customised questionnaire that was submitted to UNIDO in-country PMU’s². The questionnaire, including a quantitative and qualitative part, strongly follows the structural framework of the main GCII methodology but extends this to illuminate the particularities of the 8 national cleantech innovation ecosystems.

A short GCII methodology

The overall score for each country is based on the average between *inputs to innovation*, and *outputs of innovation*. By definition, *inputs* correspond to the creation of innovation (the development of technology supply) and *outputs* relate to the country’s ability to commercialise innovation. This analysis enables to capture the entire national cleantech innovation pipeline. Each of these *inputs* and *outputs* are determined by four equally weighted sets of indicators. The four pillars are built from a total of 15 indicators, drawn from both third-party research, public databases and Cleantech Group’s proprietary data³. The raw data for each indicator was normalised using a max-min scaling method to allow for comparisons on a common scale. Outliers were identified as those data points outside the upper and lower bounds, and then were attributed the value of the upper bound pre-normalisation of the data set. Where relevant, indicators were analysed from a ‘per GDP purchase power parity’ basis to account for relative accomplishment by size of economy, with the exception of renewable energy consumption (which we calculated as a percent of countries’ primary energy consumption) and employment (which is measured on a per total labour force basis).

The scope of the GCII main report study covered 40 countries, including all of the G20. In order to maintain comparability with the 2014 GCII, this report will not expand this selection in the 2017 Index. However, two additions have been made to the Global Cleantech Innovation Index programme. Firstly, a supplemental study of a number of Asian countries was conducted. In this report, data availability restricted a complete indexing of all of the Asian countries targeted, but their general position was

² Project Management Unit

³ See Appendix 1: Methodological framework of the GCII

determined relative to Asian countries that already appear in the GCII (Japan, India, Singapore, South Korea, and China). Secondly, using the GCII methodology as a guide, a cleantech innovation ecosystems assessment was conducted for partner countries of UNIDO’s Global Cleantech Innovation Programme (GCIP), which includes Armenia, India, Malaysia, Morocco, Pakistan, South Africa, Thailand, and Turkey. The current Once again, data restrictions and comparability prevented five of these countries being added to the main GCII, however for certain dimensions of the ecosystem in-depth analyses were possible for many of the countries, which will be captured in the supplement report. For the first time we are also launching a micro-site for the Index where you can click through country profiles and other data, see www.i3connect.com/gcii for more information.

The GCIP country analysis methodology

The countries were analysed for; *General Innovation Drivers*, *Cleantech-Specific Innovation Drivers*, *evidence of Emerging Cleantech Innovation*, and *evidence of Commercialised Cleantech Innovation* – which correspond to the four pillars of the GCII methodology.⁴

The Global context: South Africa, Turkey and India feature in the GCII, and their performances can therefore easily be put in a global perspective. Thailand, Pakistan, Malaysia, Armenia, and Morocco do not feature in the GCII, but for the purpose of this study only, the index methodology was applied to these countries too, having to account for their limited data availability by a weighting method. The questionnaire responses allowed to fill some data gaps with additional information. Based on these new cleantech innovation index scores, each country profile features a country peer grouping and a radar graph displaying its performance compared to a global average. *Figure 5* can be used to interpret each country’s performance.

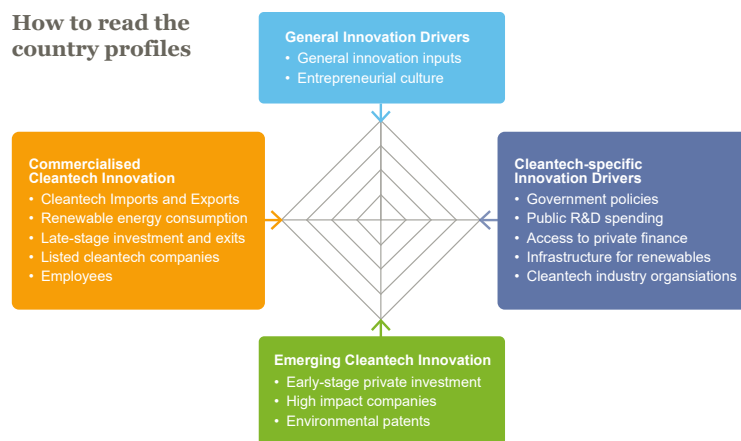


Figure 5 How to read a country profile radar chart

The country-specific cleantech innovation ecosystem: In the framework of the GCII, the two types of data *inputs* (1. and 2. above) informed a detailed assessment of a country’s key cleantech-innovation supporting mechanisms/policies, start-up access to finance, and its *General Innovation Drivers*, *Cleantech-Specific Innovation Drivers*, *evidence of Emerging Cleantech Innovation*, and *evidence of Commercialised Cleantech Innovation*. The findings of this analysis are firstly presented in a short country summary, followed by an extended country profile.

⁴ See Appendix 1: Methodological framework of the GCII

COUNTRY PROFILES

 **ARMENIA**

 **INDIA**

 **MALAYSIA**

 **MOROCCO**

 **PAKISTAN**

 **SOUTH AFRICA**

 **THAILAND**

 **TURKEY**

ARMENIA

While Armenia shows some evidence of a supportive cleantech policy environment, with a solar-to-grid enabling law and different renewable energy tariffs, the cleantech innovation sphere remains nascent. With the current government focus on building a strong IT start-up sphere, cleantech start-ups could thrive alongside.

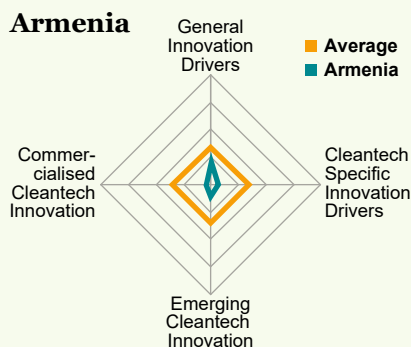


Figure 6 Armenia's performance in the indicator pillars, compared global average

Ranked in GCII	General Innovation Drivers	Cleantech-specific Innovation Drivers	Emerging Innovation	Commercialised Innovation
+1	Mexico (35th)	Russia (39th)	Romania (32nd)	Indonesia (39th)
Armenia	Armenia	Armenia	Armenia	Armenia
-1	Romania (36th)	Saudi Arabia (40th)	Portugal (33rd)	Saudi Arabia (40th)

Figure 7 Armenia's relative positioning in the GCII ranking based on its performance in GCII indicator pillars

Strengths	Weaknesses
Early-stage entrepreneurial activity: 1.5 new businesses per 1000 working age population/annum	INSEAD Global Innovation Index (60/128) ⁵
9th in WB's global assessment for the Ease of 'Starting a Business'	Ranked 113 out of 176 in the Corruption Perception Index ⁶
Tax privileges to start-ups in the IT-sphere, can apply to software-focused cleantech	Few cleantech-supportive government policies (2/8 measured in GCII)
Government-backed innovation accelerators and incubators with seed-stage finance availability; Government fund (SME DNC) for soft-loan provision	Access to private finance for start-ups is limited; lack of centralised network and risk-adverse investment culture
Good R&D expenditure in the university research sector	Start-ups fail to show commercial success due to a lack of domestic market demand

Figure 8 Armenia's strengths and weaknesses in key indicators

Key Support Mechanisms/Policies

The Armenian cleantech ecosystem is nascent due to low cleantech-specific policy and support in Armenia. Cleantech start-ups can thrive with further improvements made in the support of the general national innovation ecosystem.

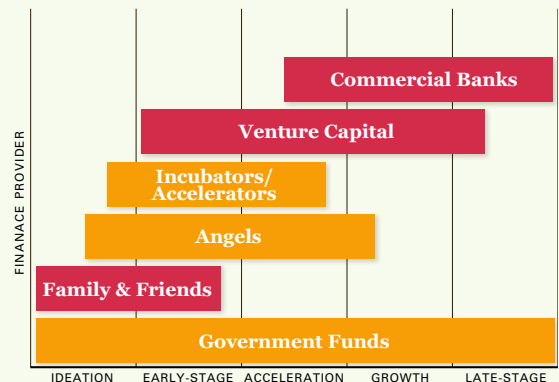
The Armenia '**SME Development National Centre**' provides soft-loans to entrepreneurs. Several start-up accelerator & incubator programmes provide mentoring, training courses, networking as well as small seed funding opportunities for prototype/product development. Many of these were established by the **Armenian Enterprise Incubation Foundation (EIF)**, including vital technology centres connecting university research to the market, but other independent accelerators/incubators also play a role. Few accelerators & incubators, however, run through universities. Private accelerators, such as the **Microsoft Innovation Center**, have an IT focus and, among other roles, help start-ups connect with corporates in the field. To address the gap between research and market deployment of innovation, the **American University of Armenia's Entrepreneurship & Product Innovation Centre** has recently opened to provide advanced courses in entrepreneurship, which is still only limited to students at the university. With the IT sector being the current focus of public support, the Armenian government recently passed a law giving tax

⁵ INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016
⁶ Transparency International, Corruption Perception Index, 2016

privileges to start-ups in the IT-sphere. As more cleantech start-ups move away from the traditional hardware focused model to the provision of software that enhances resource efficiencies, cleantech start-ups can benefit from this policy change too.

Access to Finance

- The Armenian governments has a few funds targeted at the start-up sphere but the total available capital is small, and preference is given to the IT sector
- Incubators and accelerators provide matching grants and seed grants
- There is no established angel network present, nor a centralised platform to connect investors and investment-seeking start-ups
- Commercial banks are risk adverse in lending to start-ups, and the VC market is underdeveloped with only 1 active firm, and 2 launching in 2017



- Loans to SMEs are provided by banks through the SME DNC programme

Pillar Analysis

Inputs

General Innovation Drivers

Armenia scores just above neighbouring Georgia in the GCII, outshining it in the level of entrepreneurial activity. Entrepreneurs are generally well-respected, pointing to a strong intrinsic entrepreneurial culture within Armenian society. New entrepreneurs benefit from the one-stop shop principle which is applied to setting up a new company in Armenia. The principle is proving to be effective, as the World Bank assigns the country the 9th rank in a global assessment for the Ease of 'Starting a Business'. The lack of education in entrepreneurship has recently been addressed by the opening of American University of Armenia's Entrepreneurship & Product Innovation Centre. However, there is a general lack of publicly available and centralised information about both investors and start-ups within the country, limiting the growth of the entrepreneurial ecosystem. Some public accelerators and incubators exist, and private ones with an IT-focus can involve the participation of corporates, e.g. in the Microsoft Innovation Center.

Cleantech-Specific Drivers

Armenia only has a few government policies in place that favour the cleantech industry, scoring 1/8 of selected cleantech-supportive policies. There is no renewable energy mandate, highlighting the lack of solid commitment to GHG emission reduction. However, the Armenian parliament passed a law allowing households that generate PV electricity to sell to the grid and, in cooperation with Armenian commercial banks, the EBRD's Energocredit programme has started providing companies with loans and a 10-15% cashback provision when investing in energy efficient equipment or construction.

Armenia's estimated public cleantech R&D expenditure comes close to the median of Asian countries, but well below the Global average. R&D expenditure is mainly funnelled into academic research, which to-date still lacks connection to the real market via technology transfer and spin-out offices.

Most public policy and investment support remains limited to the IT start-up sphere.

Outputs

Emerging Cleantech

Armenia has a high number of environmental patents, relative by GDP. This can be attributed to the significant university research funding that currently exists in cleantech-related fields. However, the lack of domestic market demand (related to low cleantech-supportive policy environment) and limited access to finance reduces the chances of successful commercialisation. Overall, inputs to cleantech innovation in Armenia at present do not provide the setting for successful founding of cleantech startups without the support of programmes such as GCIP, which can point to several examples of startups active in diverse fields of cleantech. For example, Black Solar focuses on developing high efficiency and low-cost silicon solar cells by using nanostructured "black silicon." In waste-to-energy, Am-Eska has found a way to convert used tires to diesel fuel through an emission-light refining process.

Commercialised Cleantech

Armenia does not show signs of cleantech innovation commercialisation and ranks lowest among all countries analysed in this indicator pillar. The only present clean technology are large-scale installed hydropower stations that use foreign technology and are often managed by multinational companies.

None of the Armenian Emerging Cleantech start-ups received outside funding and are still struggling to gain commercial traction. Some of the cleantech start-ups already have developed market-ready products and are on track to commercialize or license it to other companies. Those who have started production require more investment to expand a market outside the limits of Armenia, where the demand is higher and competitiveness can be tested.

Extended Summary

Inputs to cleantech innovation

General Innovation Drivers

Armenia scores just above neighbouring Georgia in the GCII, outshining it especially in the level of entrepreneurial activity⁷. Armenia’s entrepreneurial culture is built largely on the very strong maths and science foundation established during the Soviet era. Entrepreneurs are generally well-respected, pointing to a strong intrinsic entrepreneurial culture within Armenian society. However, Armenia has high levels of endemic corruption (the country is ranked 113 out of 176 in the corruption perceptions index)⁸, which may act to hinder the creation of a fair playing field in the innovation sphere.

New entrepreneurs benefit from the one-stop shop principle which is applied to setting up a new company in Armenia. The principle is proving to be effective, as the World Bank assigns the country the 9th rank in a global assessment for the Ease of ‘Starting a Business’⁹. The registration for a new business is immediate when made online, and only takes up to 2 working days in other cases.

The lack of education in entrepreneurship has recently been addressed by the opening of American University of Armenia’s Entrepreneurship & Product Innovation Centre. However, there is a general lack of publicly available information about both investors and start-ups within the country, limiting the growth of the entrepreneurial ecosystem. Foreign investors benefit from several tax incentives and administrative exemptions, although these incentives related primarily to physical investment and thus will not necessarily act to incentivise foreign start-up investments. No further direct policy incentives exist facilitating domestic investor interest in local start-ups.

Cleantech-Specific Innovation Drivers

Cleantech-friendly policy environment

Policy Area	
Carbon tax/carbon market	
Clean energy tax incentives; Tax incentives specifically for clean technology companies	
Green bonds; government-backed or -owned green investment banks; green investment funds.	
Government investment/loans/grants for climate-friendly and eco-friendly technology	
Transport obligation; Transportation efficiency or emissions standards	✓
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	✓
Government tendering/ green procurement	
Research institutes or government support university programs for clean technologies	

Armenia has some way to go before you could describe its policy environment as supportive of cleantech. There are renewable energy tariffs, which make a distinction

7 World Bank, *Fostering Entrepreneurship in Armenia*, 2013, <http://documents.worldbank.org/curated/en/462221468008429321/Fostering-entrepreneurship-in-Armenia>

8 <https://www.transparency.org/country/ARM>

9 <http://www.doingbusiness.org/data/exploreeconomies/armenia>

between different forms of renewable energy and are updated on an annual basis. Interestingly there is to-date no renewable energy mandate, highlighting the lack of solid commitment to GHG emission reduction. The country has vehicle emission standards which are in line with the UNECE requirements. Additionally, the Armenian parliament passed a law allowing households who generate PV electricity to sell their electricity to the grid.

The Armenian government recently passed a law giving tax privileges to start-ups in the IT-sphere. As more cleantech start-ups move away from the traditional hardware focused model to the provision of software that enhances resource efficiencies, cleantech start-ups can benefit from this policy change too. In cooperation with Armenian commercial banks, the EBRD's Energocredit programme has started providing companies with loans and a 10-15% cashback provision when investing in energy efficient equipment or construction, incentivising domestic demand for cleantech. However, these policies remain limited in their scope and the Armenian government thus fails to provide direct incentivising policies for the cleantech innovation system.

R&D and accelerator/incubator support

Armenia's estimated public cleantech R&D expenditure comes close to the median of Asian countries, however it is mainly funnelled into the academic research sphere. Government funded research projects within universities cover several cleantech-related fields. (While there are some university spin-offs, in-country experts point to the relative disconnect between the government-funded cleantech academic research and the market.)

Several start-up accelerator & incubator programmes provide mentoring, training courses, networking as well as small seed funding opportunities for prototype/product development. Many of these were established by the Armenian Enterprise Incubation Foundation (EIF), including vital technology centres connecting university research to the market, but other independent accelerators/incubators also play a role. Few accelerators & incubators, however, run through universities. Private accelerators, such as the Microsoft Innovation Center, have an IT focus and, among other roles, help start-ups connect with corporates in the field. Supported by the World Bank, newly built technology centres act as clusters and separate start-up accelerators in the two major cities of Armenia. The Armenia Renewable Energy and Energy Efficiency Fund is an independent NGO that promotes the use of sustainable energy in Armenia.

Access to finance for cleantech start-ups

Private sources of capital

1. Family & friends: Very little due to the risk-adverse investment culture and lack of investor education on the start-up sphere.
2. Angel networks: Angel investment in Armenia is not centralised and makes up a small proportion of available capital for start-ups. In-country experts see that a central platform with investor training and education could greatly enhance the capital available to start-ups from this source.
3. Private accelerators and incubators are scarce in Armenia. The only active examples is the Microsoft Innovation Centre, which also partly supported by public organisations of Armenia and USAID.
4. Venture capital investment in Armenia is underdeveloped. Granatus Ventures is the only venture capital firm in Armenia, but it tends to focus on IT development, with total funds valued at \$5 million (USD).

5. The private sector interest in Armenian cleantech is still low, and no evidence of corporate venturing exists.
6. Commercial Banks are risk-averse and tend not to grant loans without sufficient collateral, which is hard for cleantech start-ups to obtain.

Public sources of capital

1. There is good evidence of public accelerators and incubators that provide support as well as access to early-stage finance for Armenian start-ups, mostly in the \$1,000 to \$15,000 (USD) range. The European Investment Fund holds start-up competitions through an accelerator with grant provisions of up to \$50,000 USD.
2. The Armenian government, and international donor-backed “Small and Medium Entrepreneurship Development National Center” (SME DNC) Fund provides low-interest rate loans (max. 10,000 USD). Armenian Development Agency sources foreign funds for SME financing in Armenia, does not provide own access to finance.

The financing environment in Armenia is underdeveloped and presents a major limitation to successful entrepreneurship. There is not enough seed-stage risk capital available in the country in order to bring emerging research to the market.

Outputs of cleantech innovation

Emerging cleantech innovation

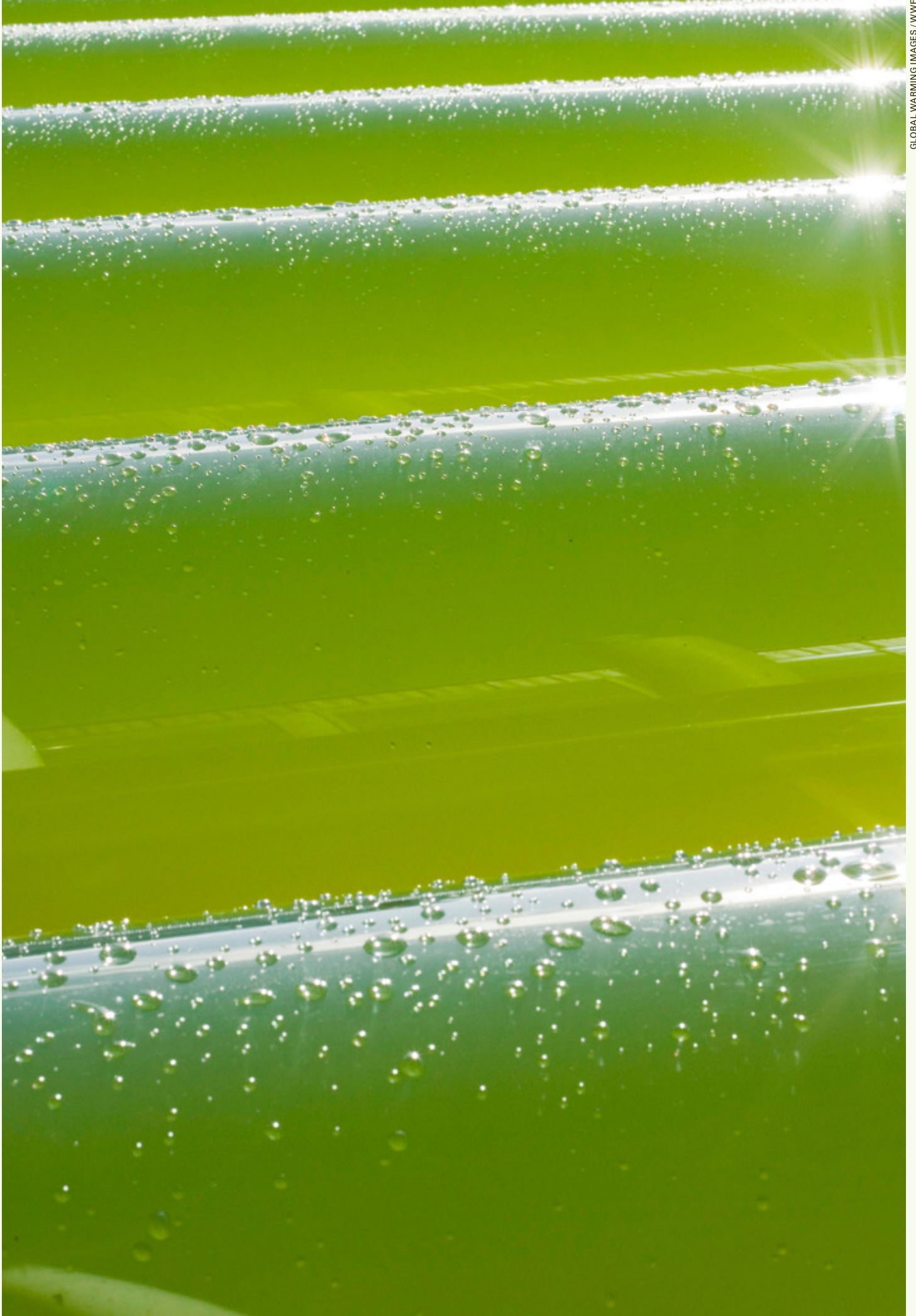
Armenia has a high number of environmental patents, relative by GDP. This can be attributed to the significant university research funding that currently exists in cleantech-related fields. However, the lack of domestic market demand (related to low cleantech-supportive policy environment) and limited access to finance reduces the chances of successful commercialisation. Overall, *inputs to cleantech innovation* in Armenia at present do not provide the setting for successful founding of cleantech start-ups without the support of programmes such as GCIP, which can point to several examples of start-ups active in diverse fields of cleantech.

None of these examples received outside funding and are still struggling to gain commercial traction. Some of the cleantech start-ups already have developed market-ready products and are on track to commercialize or license it to other companies. Those who have started production require more investment to expand a market outside the limits of Armenia, where the demand is higher and competitiveness can be tested.

In renewable energy, for example, **Black Solar** focuses on developing high efficiency and low-cost silicon solar cells by using nanostructured “black silicon”.

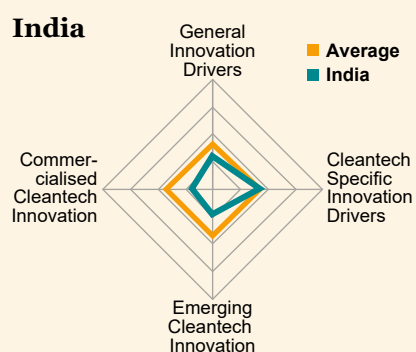
In waste-to-energy, **Am-Eska** has found a way to convert used tires to diesel fuel through an emission-light refining process.

In advanced materials, **NanoHi** has developed a process for the energy-efficient production of two-dimensional materials like graphene.



INDIA

India experienced a drop in its position in the Global Cleantech Innovation Index in 2017, dropping from 21st in 2014 to 29th position. While there is some evidence for this being due to a methodological change in the GCII, the new position also reflects some areas for improvement, especially in joining up the great diversity of entrepreneurship, support schemes, financing markets, and established industrial expertise. Combining our GCII findings with questionnaire results, and further conversations with in-country experts, we find the potential scale and pace of innovation in India is substantial.



Ranked In GCII	General Innovation Drivers	Cleantech-specific Drivers	Emerging Innovation	Commercialised Innovation
+1	Argentina (32 nd)	Poland (21 st)	Poland (24 th)	Argentina (36 th)
	India (33 rd)	India (22 nd)	India (25 th)	India (37 th)
-1	Indonesia (34 th)	South Korea (23 rd)	Hungary (26 th)	Russia (38 th)

Figure 10 India's relative positioning in the GCII ranking based on its performance in GCII indicator pillars

Figure 9 India's performance in the indicator pillars, compared global average

Relative Strengths	Relative Weaknesses
Strong culture of entrepreneurship	Low access to seed (and pre-seed) entrepreneurship support beyond friends and family network
Strong government entrepreneur support schemes	High barriers to entry in government-backed support schemes
Strong cleantech-specific government initiatives in support of startups	Lack of coordination between government-backed entrepreneur schemes at both state and federal level
Cleantech-friendly government policy agenda, with ambitious GHG emission targets and standards	Strong government support of a clean energy sector, but not as strong support for innovation in other clean technology sectors
Attractive destination for clean energy infrastructure investment	Risk averse growth capital investment market
Several innovation clusters and accelerators provide small loans and grants for start-ups	Start-ups fail to show commercial success due to a lack of domestic market demand

Figure 11 India's strengths and weaknesses in key indicators

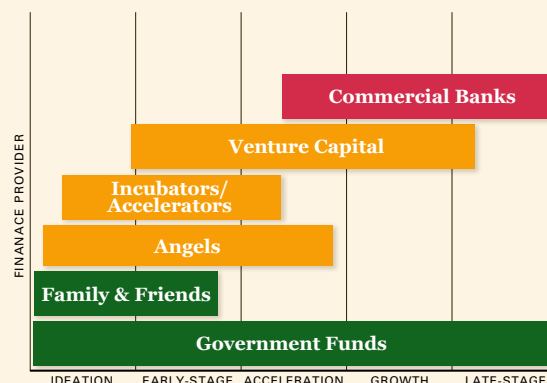
Key Support Mechanisms/Policies

While India has only a few policies focused on cleantech, there is a wealth of policies and initiatives aimed at promoting the development of start-ups. One example is **Startup India**, a program that will additionally introduce a tax exemption to start-ups for 3 years to provide additional incentives to entrepreneurs. The Department of Science and Technology (DST) has set up more than 100 **Technology Business Incubators (TBI)** and **Science & Technology Entrepreneurs Parks (STEPS)**, providing direct support structures to more than 2000 start-ups at one time.

Industrial energy efficiency is approached via a sophisticated '**Perform, Achieve and Trade**' (**PAT**) scheme, designed as a market-based mechanism to enhance efficiency in energy intensive industries and facilities via capping and trading on energy savings. The promotion of energy efficiency is further supported by policy incentives on green buildings (e.g. IGBC/GRIHA ratings), the agricultural sector and the promotion of demand-side management in utilities.

Access to Finance

- Family and friends are responsible for 30-50% of pre-seed and seed funding.
- There is a range of government funds and policies aimed at supporting start-ups in different stage of development.
 - Equity investment is well established but venture capital investment seems largely ineffective.
- There are incubators and accelerators, but these tend to focus on software industries, such as IT, data analytics, and fintech.
- Banks tend to be risk-averse, and start-ups often have trouble attracting early stage capital through financial institutions.



Pillar Analysis

Inputs

General Innovation Drivers

India scores low in the INSEAD Global Innovation Index,¹⁰ falling behind all BRICS nations except Brazil. Despite this relative weakness, indicators from the Global Entrepreneurship Monitor point to the evidence that the Indian population is optimistic about perceived entrepreneurial opportunities, with 44.34 % of population seeing good opportunities to starting a business¹¹ in their area. The government is supportive of entrepreneurship, and there are a large number of public and public-private initiatives that have formed to support the innovation ecosystem of India. However, with such a range and diversity of initiatives on offer there is often no clear way for a start-up to leverage benefits from interlinking schemes. Further weaknesses are found in the bureaucratic hurdles that limit the ‘recognition’ of a start-up as eligible for financial support by different agencies, as time is wasted by entrepreneurs trying to fulfil and certify for approval criteria.

Cleantech-Specific Drivers

Indian policy support focuses on renewable energy expansion and adoption, and it has a target of reaching 175GW installed renewable energy capacity by 2022. There are also subsidies available for renewable energy installation, renewable feed-in tariffs and renewable energy certificates, amongst other policy mechanisms. India’s first official dollar-denoted green bond was issued in 2015 by the Exim Bank of India. The National Clean Energy Fund (NCEF) was created in 2010 and is based on a the ‘polluter pays’ principle in an effort to reduce coal consumption and foster research and technology deployment in the renewable energy and environmental sector. In 2016-17, the fund will allocate more than \$767 million to the clean energy sector growth alone. India also launched the National Mission for Enhanced Energy Efficiency (NMEEE). Early-stage finance in India is quite developed, and there are several cleantech funds and investors active within the Indian cleantech ecosystem.

Outputs

Emerging Cleantech

According to our GCII indicators, cleantech-specific public R&D spending is low in India, relative to GDP, falling well below the global average. However, there are a large amount of funding initiatives, incubators, and support schemes for innovative solutions. The proportion of cleantech-focused companies participating in these programs remains very small.

CASE STUDY: Applied Solar Technologies Group, a developer of solar PV off-grid power solutions for telecom towers. The company has thrived through national policy incentivising both the extension of electricity services to the off-grid and renewable electricity sources. It featured in both the 2012 and 2014 Global Cleantech 100.

Commercialised Cleantech

India has some examples of late-stage equity finance, including private equity buyouts, late-stage financing, and IPO activity, but when weighted by GDP India falls behind other Asian countries. India has very low cleantech exports, and of the GCIP countries only Morocco and Pakistan score lower in this indicator of commercialised cleantech global competitiveness. However, this may reflect internal market demand. India’s levels of renewable energy consumption are in line with some developed countries, such as Australia and Belgium. For renewable energy jobs, the country falls further behind.

¹⁰ INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

¹¹ Global Entrepreneurship Monitor, Perceived Opportunities Indicator, 2016

Extended Summary

Inputs to cleantech innovation

General innovation drivers

India scores low in the Global Innovation Index¹², falling behind all BRICS nations except Brazil. As this indicator assesses the sophistication of government, market, and business, as well as educational system quality, to support the growth and maintenance of an innovation ecosystem, the result points to some areas of potential for improvement. Despite this relative weakness, indicators from the Global Entrepreneurship Monitor point to the fact that the Indian population is optimistic about perceived opportunities, with 44.34 % of population seeing good opportunities to starting a business¹³ in their area, leading to about 1,806,000 women and 17,940,000 men owning their own early-stage business today.¹⁴

Following a low ranking in the ‘ease of doing business’ indicator,¹⁵ the Indian government has since dedicated policy changes to reduce bureaucratic hurdles to entrepreneurship in India,¹⁶ including issues related to starting a business, paying taxes, enforcing contracts, and resolving insolvency. A new scheme, called Startup India, will additionally introduce a tax exemption to start-ups for 3 years to provide additional incentives to entrepreneurs. The impact of these changes are yet to be examined, but its early effects on cleantech-specific sectors is promising.

There are many public or public-private initiatives that have formed to support the innovation ecosystem of India. These provide soft loans, entrepreneurial and bureaucratic advice in physical innovation clusters, and accelerator and incubator programmes. The Department of Science and Technology (DST) has set up more than 100 Technology Business Incubators (TBI), built Science & Technology Entrepreneurs Parks (STEPs), providing direct support structures to more than 2000 start-ups at one time. Other large initiatives that shape the innovation ecosystem and provide start-up support include; the Innovative Ventures for Technology Development (INVENT) programme, the privately supported cluster the Global Innovation & Technology Alliance (GITA), the rural-focused Technological Advancement for Rural Areas (TARA), the National Science & Technology Entrepreneurship Development Board (NSTEDB) and the National Research Development Corporation (NRDC). Another government agency, the Department of Industrial Policy and Promotion (DIPP) is heavily involved in coordinating the Startup India program, which aims to attract venture capital investors to the sector and provide a platform of support and networking to further this goal. While these are mostly government or public-private partnership backed programmes, there are also many examples of private corporations partnering in incubators and accelerators, such as TATA Motors work with the DST’s ‘Indian Innovation Growth Programme’.

As mentioned in our opening comments on India, there is no shortage of support schemes available to start-ups. However, with such a range and diversity of initiatives on offer there is often no clear way for a start-up to leverage benefits from interlinking schemes. Further weaknesses are found in the bureaucratic hurdles that limit the ‘recognition’ of a start-up as eligible for financial support by different agencies, as time is wasted by entrepreneurs trying to fulfil and certify approval criteria.

¹² INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

¹³ Global Entrepreneurship Monitor, *Perceived Opportunities Indicator*, 2016

¹⁴ <https://data.gov.in/catalog/entrepreneurship-profile-enterprises-owned>

¹⁵ World Bank, Ease of doing business, 2016

¹⁶ Reforms towards Ease of Doing Business, DIPP http://dipp.nic.in/English/Investor/reforms_eodb.aspx

Cleantech Specific Drivers

India's performance for *Cleantech-Specific Innovation Drivers* in the GCII is above the global average.

Out of 8 important cleantech-supporting policies tracked in this indicator, India has 5 in place to-date. The country's strength lies in policy support for renewable energy expansion and adoption into the grid and it has a target of reaching 175GW installed renewable energy capacity by 2022.

Subsidies for cleantech installation, renewable feed-in tariffs, Renewable Purchase obligations (RPO) and Renewable energy certificates (REC) support the drive of demand for domestic clean-energy technology development in India.

Policy Area	
Carbon tax/carbon market	
Clean energy tax incentives; Tax incentives specifically for clean technology companies	✓
Green bonds; government-backed or -owned green investment banks; green investment funds.	✓
Government investment/loans/grants for climate-friendly and eco-friendly technology	
Transport obligation; Transportation efficiency or emissions standards	✓
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	✓
Government tendering/ green procurement	✓
Research institutes or government support university programs for clean technologies	

Some of these policies have played key roles in the growth of grid connected solar energy installations in the country and therefore serve as a prime example of policy-incentivised cleantech innovation.

While the Indian Renewable Energy Development Agency Ltd and Greenko have in the past issued bonds for financing renewable energy without the tag of green bonds, India's first official dollar-denoted green bond was issued in 2015 by the Exim Bank of India.

The National Clean Energy Fund (NCEF) was created in 2010 and is based on a the 'polluter pays' principle in an effort to reduce coal consumption and foster research and innovation in the renewable energy sector. The fund has steadily grown, with an increasing amount of expenditure going to projects like Grid Connected Rooftop Power Plants (40000 MW), Expansion of the 'Green Energy corridor' in different regions of India (incl. Rajasthan, Gujarat, Madhya Pradesh), installation of SPV water pumping systems and The Ministry of the Environ¹⁷ment's 'Climate Change Action Plan' and 'National Adaptation Fund'. The total spending of the fund was \$1269.7 million (USD) in 2016-17.

Under India's National Action Plan for Climate Change (NAPCC) launched in 2010, India promotes policies and incentives that fall under the Mission for Enhanced Energy Efficiency (NMEEE). Industrial energy efficiency is approached via a sophisticated 'Perform, Achieve and Trade' (PAT) scheme, designed as a market-based mechanism to enhance efficiency in energy intensive industries and facilities via

17 National Clean Energy Fund (NCEF) brief (2015), Annexure II

capping and trading on energy savings.¹⁸ The promotion of energy efficiency is further supported by policy incentives for green buildings (e.g. IGBC/GRIHA ratings), for the agricultural sector, and the promotion of demand-side management in utilities. In the commercial and residential sector, BEE's Star-labelling programme has been critical in creating awareness of energy efficient appliances and changing consumer behaviour in choosing energy efficiency white goods, thereby creating an opportunity for more efficient appliance and products in the market. If successful, these programmes serve as a valid driver for Indian cleantech innovation and commercialisation, but this has not been evaluated.

Access to Finance

Various forms of financing or funding options are available to support a startup or SME in India. Short term finance from financial institutions (bank credit in the form of loans, cash credit, overdraft and discounting of bills), venture capital, preference share capital, debentures and borrowings, long-term loans from special financial institutions (such as IDBI, IFCI, EXIM, SIDBI),¹⁹ state level institutions (State Financial Corporations (SFCs), State Industrial Development Corporations (SIDCs)),²⁰ non-banking finance companies (NBFCs), funding of LLP, trade credit, external commercial borrowing (commercial loans availed in foreign currency are termed as ECBs), listed debentures/bonds, and possibly more. However, looking across the spectrum of financing solutions, from the publicly- to privately- sourced, to the seed-to growth- stage, capital, there are particular challenges and access issues associated with startups and SMEs, and in particular cleantech companies.

Seed Stage Investment

Access to finance for cleantech start-ups and SME's is one of the key drivers of innovation. Most seed-stage funding in India is sourced from family and friends, making up approximately 30-50% of seed and pre-seed funding. More formalised and organised early stage private investment support is being developed, such as with Indian Angel Networks (IAN), which currently has investors from 10 countries invested in over 80 separate deals across 17 portfolio sectors. A study by the National Knowledge Commission (NKC) in India concluded that 63% of all early-stage start-ups were self-financed (including informal family and friends support), with the remaining 37% being made up of banks, angel investors, venture capitalists, and other formal sources of finance.²¹ The initiatives named above partly offer some funding support through their incubator and accelerator programmes, including grants and soft loans, but the number of cleantech start-ups affected is still very low. Due to the risk-averse nature of banks, access to loans from commercial banks often requires assets and/or evidence of start-up profits, and is thus a less accessible source of early-stage capital for clean-tech innovators in India. The new Startup India action plan will help provide start-ups with the skills to apply for credit and support a 'Credit Guarantee Fund for Startups' to overcome this credit access problem.

Early stage investment in 2016 amounted to 405 deals, worth \$1.04 billion in 2016, across all sectors.²² According to Cleantech Group data, only 21 of these were attributable to cleantech sectors.²³

Commercialisation Capital

Venture capital in India is well established, but shows signs of being relatively ineffective. In 2016, Seed stage investing remained steady, but Series A deal volume

18 <http://shaktifoundation.in/wp-content/uploads/2014/02/PAT-Pulse-Compendium-2016.pdf>

19 <http://www.idbi.com/index.asp>, <https://www.ifcilt.com>, <http://www.eximin.net/>, <http://www.sidbi.in/>

20 <http://sidbi.in/?q=state-financial-corporations> <http://sidbi.in/?q=sidcs-siics> https://www.rbi.org.in/scripts/BS_NBFCList.aspx

21 FICCI-Nathan Associates, *Nurturing Entrepreneurship in India*, August 2014

22 www.dealstreetasia.com/stories/10-venture-capital-dealmakers-to-watch-in-2017-62125

23 Cleantech Group data

dropped by 45% year-on-year, with as estimated \$3 billion of un-invested capital available in the market.²⁴ Despite having 146 active national cleantech investors, combined with an estimated \$9 billion in India-focused funds²⁵ between national and international investors, venture capital is not filtering down to early-stage entrepreneurs.²⁶

This relatively low level of early-stage investing is reflected in the low risk appetite seen in early-stage funding sourced from commercial banks. In a survey, 80% of entrepreneurs described obtaining finance from banks as ‘difficult’ or ‘average’, citing low levels of risk tolerance.²⁷

An overall problem facing the cleantech sector’s access to finance from any source is that the current national investor interest is largely based around IT-related start-ups and innovators, which usually require less starting capital and can enter profitability sooner. Longer lead times in cleantech, which is largely seen as a hardware-based industry, reduce investment attractiveness. However, software-based cleantech innovators may benefit from this specific focus. Cleantech startups in India are largely engineering enterprises or product companies, but some of them could be ICT-based solution providers to enhance these engineering solutions. Out of the 10,000+ startups in the country 57% are non-IT based (mostly engineering) startups that work on agri-products, textiles, printing, and others including a significant percentage in construction.

Incubators/Accelerators

Whilst there are many incubators and accelerators that offer start-up support, more can be done in this sector. Of the 4,000 business schools present in India, only a handful work with entrepreneurs in a formalised way. Similarly, despite many programmes being housed in universities and R&D facilities, very few have built sufficient linkages with both the research climate in the institution itself as well as partnerships with relevant corporations.²⁸

Looking specifically at cleantech, it is clear that incubator programmes have a similar focus to the venture investors. Private acceleration programmes are driven towards the latest developments in lean, software-based, innovation such as Data Analytics and Fintech. While there is potential for cleantech software start-ups to benefit from these programmes, there is a lack of focus on clean technology specifically.

Public source of funding and cleantech R&D

According to GCII indicators, cleantech-specific public R&D spending is low in India, with its estimated amount falling below the global average. However, with this figure being measured relative to GDP, and with the evidence of funding initiatives, incubators, and support schemes returned in our research, there may be significant funding sources not being accounted for.

The Startup India campaign is based on an action plan aimed at promoting bank financing for start-up ventures to boost entrepreneurship and encourage start-ups with jobs creation. As a government-backed incubator programme, it offers funding support and incentives alongside start up process ‘simplification and handholding’ and ‘Industry-Academia Partnership and Incubation’²⁹ across technology sectors including agriculture, manufacturing, and other relevant to the cleantech ecosystem.

²⁴ www.dealstreetasia.com/stories/10-venture-capital-dealmakers-to-watch-in-2017-62125

²⁵ Cleantech Group, WWF, *2017 Global Cleantech Innovation Index*, based on fully- and partially-focused cleantech investors naming India as a target investment geography

²⁶ Cleantech Group data

²⁷ FICCI-Nathan Associates, *Nurturing Entrepreneurship in India*, August 2014

²⁸ NITI Aayog, *Report of the Expert Committee on Innovation and Entrepreneurship*, August 2015

²⁹ <http://startupindia.gov.in/pdf/file.php?title=Startup%20India%20Action%20Plan&type=Action&q=Action%20Plan.pdf>

As part of the Startup India programme, a Rs12,000 crore (around USD\$1.875 billion) Fund of Funds was announced at the beginning of 2016. This capital will be divided between Rs 2,000-crore (USD\$312.5 million) India Aspiration Fund (IAF) and SIDBI Make In India Loan For Enterprises (SMILE) scheme with an investment size of Rs 10,000 crore (USD\$1.563 billion). The funds will aim to catalyze startups by providing venture debt assistance directly to start-ups up to the value of Rs crore (USD\$310k). Partnerships for start-up assistance will be provided via Indian Angel Network, The Indus Entrepreneurs (TiE), NASSCOM, ISPIRT, and other partners. So far, Rs.500 crore (USD\$78 million) was provided in 2016, with Rs.600 crore (USD\$93.75 million) earmarked for 2017.

The Make in India programme, set up to encourage multi-national, as well as national, companies to manufacture in India, was earmarked by SBG Cleantech, a joint venture between Softbank, Foxconn Technology Group, and Bharti Enterprises Limited, which will invest about \$20 billion over the next 10 years to generate 20 gigawatt (GW) of solar power and manufacture solar power equipment in India.³⁰ Other solar manufacturing commitments include a joint venture between Adani and RREC.

The Government funded Centre for Innovation, Incubation, and Entrepreneurship (CIIE) has opened the Indian Fund for Sustainable Energy (Infuse Ventures), through which a USD\$25 million cleantech-specific fund has been made available since. Foreign investors also play a role here, as Asian Development Bank backs the centre's cleantech boot camp and the German development agency GIZ supports CIIE to run its MentorEdge that engages local NGOs and government departments, to train entrepreneurs in the sphere. Under the India-US bilateral partnership, the Millennium Alliance was initiated by the TDB and the USAID to provide early-stage grant funding for accelerating the commercialisation of innovative off-grid clean energy access solutions. In addition, ClimateSolver was launched in partnership with the WWF to accelerate cleantech innovation for reducing GHG emissions and improve clean energy access in India.

While these initiatives are aimed at SME and start-up support are quite advanced in India, the proportion of cleantech-focused companies within these remains very small. For cleantech start-ups that could gain the benefits of the grant programmes and support within incubators and accelerators under the Department of Science and Technology (DST), access is often limited by harsh 'recognition criteria'. Additionally, the funding provided within these schemes does not match the high CAPEX required for many cleantech innovators. There is no means of risk-sharing for cleantech innovators, which inhibits the attractiveness of the sector to entrepreneurs.

Outputs of cleantech innovation

While India's score outputs score in the GCII fall below global average, the size of the internal market ensures that there are some examples of sectors, and specific companies, that highlight the level of cleantech innovation already present in the country. The reasons behind their relative success lies both within public policy incentives, domestic market demand and the good access to capital to the start-ups.

Renewable Energy Technology

The renewable energy sector is amongst the most developed cleantech sectors in the country. Supported by national and federal emissions targets, renewable consumption mandates, installation projects and funds directly targeted at the clean energy sector, innovation has been greatly incentivised. Most innovation thrives in the solar, wind, and biogas sub-sectors.

³⁰ <http://www.financialexpress.com/industry/make-in-india-looks-at-120-bn-investment-from-10-companies/181115/>

One of 68 active Indian solar start-ups tracked by Cleantech Group is **Applied Solar Technologies Group**, a developer of solar PV off-grid power solutions for telecom towers. The company has thrived through national policy incentivising both the extension of electricity services to the off-grid and renewable electricity sources. The company installs and manages hybrid energy systems using solar PV, batteries and diesel generators to power off-grid telecom towers leading to a range of savings for the telecom operator, reducing the industry's dependence on diesel. The innovative company has featured on the Global Cleantech 100 in 2012 and 2014 amidst top cleantech companies worldwide. Following funding from the International Finance Corporation (IFC), the company has attracted much private VC capital (e.g. Bessemer Venture Partners and Capricorn investment Group) to scale up its production and commercial viability.

Energy Efficiency

Energy efficiency is the second largest sub-sector of the Indian cleantech innovation system. Separate initiatives and policies under the Energy Conservation Act 2001 and National Action Plan for Climate Change (NAPCC) incentivise energy efficient application through market transformation. Additionally, separate sectors are approached individually: including Micro, Small and Medium Enterprises (MSMEs), the Agriculture Sector and the Municipalities and Demand Side Management (Utilities).

One of the most recent national start-up successes within the energy efficiency sector is **GIBSS**, who incorporates green building and energy efficiency. The success of **GIBSS**, a provider of energy efficiency products and solutions for net-zero building systems, has repeatedly been acknowledged through winning several awards. The company recently won in the Innovation for India Awards 2016 by the Marico Innovation Foundation (MIF) and received the first prize at the Vibrant Gujarat Startup Grand Challenge 2016. The start-up promotes a portfolio of geothermal cooling systems, hot water co-generation systems and lighting systems in order to reduce operating costs and carbon foot print in buildings by 60-80%. The company's success has been backed by both private and public sources of funding – with the most recent 2015 seed A round including investments by SustainAbility Ventures, Infuse Ventures, the Ministry of New and Renewable Energy (MNRE) and BP Ventures.

Green Building

There are Energy Conservation Building Codes (ECBC) in place across India, and the Indian Green Building Council (IGBC) promotes IGBC Green rating for new constructions and major renovations of existing commercial buildings, and supports the related green performance monitoring and certification. This is however not obligatory and only covers about 4,077 Green Buildings projects registered with the Indian Green Building Council (IGBC) to-date.

Waste to Energy (renamed as Waste Beneficiation)

The Waste to Energy innovation sphere in India is in its infancy. Indian Renewable Energy Development Agency (IREDA) estimates indicate that India has so far realized only about 2% of its waste-to-energy potential. Most current policy incentives are focused on the off-grid and thus do not yet seem to be on the policy agenda for a wider application in large urban environments. This results in a lack of incentive for cleantech innovators in the sphere.

ReNew Power is a developer and operator of renewable energy projects in India. Despite only being founded in 2011, the company has successfully scaled up to reach IPO. It has a history of strong private (Goldman Sachs, Global Environmental Fund) and public (Asian Development Bank) investment, allowing for the company to extend its service expertise across 6 states of the country. ReNew Power now has the largest portfolio of commissioned (2000 + MW) and in construction assets (1000 + MW) in the clean energy space in India, with a large presence in both solar (1400 MW, commissioned and in construction) and wind (over 1,000 MW, commissioned and in construction). After a recent PIPE investment by Tokyo Electric Corporation and JERA in early 2017, the post-money evaluation of the country hit \$2 billion.

Other successful companies in renewable energy sector that have commercialised and since been very active:

Suzlon: manufacturer of wind power turbines; developer of wind power projects. Public listed in National Stock Exchange of India since 2005.

Greenko: Owner and operator of clean power and greenhouse gas emissions reduction generating assets. Public listed company since 2007. Continued PIPE and follow-up investments received since. Greenko currently has over 2.5 GW of operating capacity and plans to achieve 3.0 GW capacity by year end of 2017.

Oorja Energy (pka First Energy Ltd), develops clean, energy efficient, biomass cooking stoves since 2005, and has managed to scale its business to a wide commercial scale. Holding multiple product patents and also offering own biofuel pellets, the company targeted low-income markets to reduce emissions from the domestic sector – but has now reached a scale large enough for its technologies to be implemented in the food processing, laundry, textile and pharmaceuticals industries. Thermax, a leader in heat transfer technologies and applications, has acquired a 33% stake in Oorja and now serves as a strategic partner helping the scaling of all products to reach a larger customer base.

MALAYSIA

Malaysia's government is strongly committed to incentivising its entrepreneurial ecosystem, specifically cleantech entrepreneurship focusing on green growth in the country. With public policy and funding commitments, the cleantech sphere has begun to thrive and attract private support, including venture capital and the creation of corporate-backed accelerators. Malaysia shows some evidence of these incentives translating into commercialised cleantech companies.

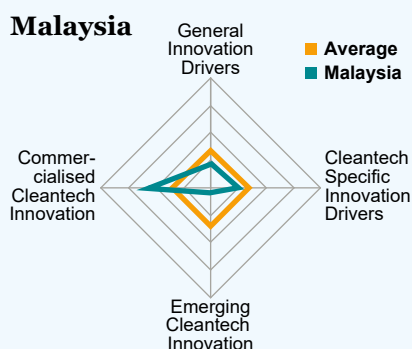


Figure 12: Malaysia's performance in the indicator pillars compared to a global average

Ranked in GCII	General Innovation Drivers	Cleantech-specific Innovation Drivers	Emerging Innovation	Commercialised Innovation
Below	Indonesia (34 th)	India (22 nd)	Bulgaria (34 th)	New Zealand (14 th)
Malaysia	Malaysia	Malaysia	Malaysia	Malaysia
Above	Mexico (35 th)	Indonesia (23 rd)	Saudi Arabia (36 th)	Japan (15 th)

Figure 13: Malaysia's relative positioning in the GCII ranking based on its performance in GCII indicator pillars

Relative Strengths	Relative Weaknesses
High Global Innovation Index rank of 35/128 ²⁸	Low early-stage entrepreneurial activity (4.7%)
Strong evidence of cleantech-supportive government policy; 6/8 policy set measured in the GCII were recorded	Few formally established cleantech industrial clusters – only Sarawak Corridor of Renewable Energy (SCORE), Sustainable City (previously Green City) in Melaka
Government-backed financing and policy support is high for the general innovation ecosystem.	Private investors are still reluctant to invest in cleantech due to bad reputation of the sector.
Strong R&D expenditure in the cleantech ecosystem and cleantech-specific government funding schemes, with strong research and academia in cleantech	Family & friends and angels are not incentivised to engage in early-stage start-up financing.
Evidence of the commercial success of the cleantech innovation; strong cleantech commodity trade indicators, especially in biomass	Policy incentives yet to show impact on growth of emerging and commercialised cleantech

Figure 14: Malaysia's strengths and weaknesses in key indicators

Key Support Mechanisms/Policies

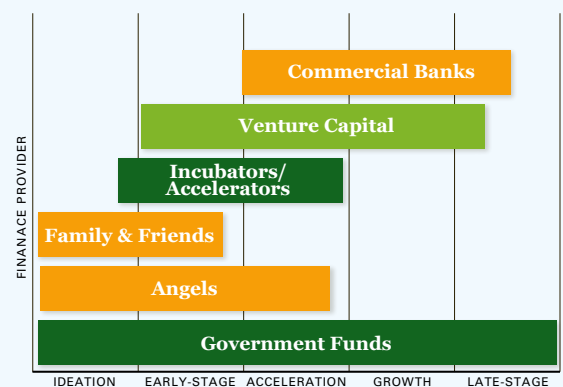
Malaysia shows evidence of making policy commitments to incentivise cleantech growth through entrepreneurship. The country is targeting the cleantech start-up ecosystem through the **National Green Technology Policy** (2009), implemented by the **Malaysian Greentech Corporation** (MGTC). Further examples of cleantech-promoting initiatives include the recently introduced tax exemption for hybrid and electric vehicles. The **Malaysian Investment Development Authority** (MIDA) also provides direct tax incentives for green technology industries, including those extending beyond the renewable energy sector, which in turn promotes domestic market demand. The government is also engaged in trying to turn government procurement, which amount to 15% of Malaysia's GDP, into green procurement. In addition, energy efficiency is directly incentivised by various programmes, including the **Malaysian Industrial Energy Efficiency Improvement Programme** (MIEEP) and the Green Building Index.

31 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

Large private accelerators like **MAGIC** (Malaysian Global Creativity & Innovation Centre), together with ten public accelerators and institutions such as **Institut Keusahawanan Negara** (INSKEN), work towards promoting and supporting entrepreneurship through training programmes and investor-start-up networking. They also provide sources of early-stage financing and promote commercial partnerships. The **Malaysian SME Masterplan** includes significant incentives for investors in the start-ups, including the introduction of an angel and a venture capital investor tax incentive.

Access to Finance

- Private accelerators and incubators provide an important part of start-up finance in Malaysia. Ten public accelerators are also active in the sector.
- Cleantech start-ups benefit from ‘green’ government funds as well as twenty-three other funds aimed at SME support.
- Friends & family and angel investment lack incentivisation, and thus do not make a significant contribution to cleantech start-up finance.
- Commercial banks have loan schemes, but cleantech start-ups need to meet difficult criteria, making this an ineffective funding source.



Pillar Analysis

Inputs

General Innovation Drivers

Malaysia scores high in the INSEAD Global Innovation Index,²⁹ outperforming the Asian country average (36.2) by some distance, indicating that the country supports the development of a streamlined innovation pipeline. However, the very low score for total early-stage entrepreneurial activity shows that there is a general lack of real entrepreneurial activity. Socially, the risk of failure that is inherently connected with a career in entrepreneurship is not well accepted in Malaysian society. The country has since approached this gap by developing multiple policy incentives, public accelerators and incubators (including MAGIC), and training agencies in its SME Masterplan aimed at nurturing the general national start-up sphere. 2017 has been named as the Start-up and SME Promotion Year by the Prime Minister.

Cleantech-Specific Drivers

Malaysia stands out with a score of 5/8 for selected cleantech-supportive policies, and the country targets the cleantech start-up system through the National Green Technology Policy (2009), implemented by the Malaysian Greentech Corporation (MGTC). The dedication to the cleantech space is reflected in Malaysia’s estimated cleantech R&D budget relative to GDP, which ranks much higher than Thailand, Vietnam, and India. While Malaysia lacks in formally established cleantech clusters, different cities in the country have evolved to specialise in certain aspects of the cleantech sphere, such as SCORE and Sustainable City in Melaka. Cleantech innovators benefit from generally good access to private capital, as well as public sources such as the Green Technology Financing Scheme (GTFS), which to-date has already approved green projects for a total of USD\$690 million.

Outputs

Emerging Cleantech

Malaysia shows some evidence for emerging cleantech innovation. The above Asian-average cleantech-related patent filings is related to the significant R&D expenditure in Malaysia. Some evidence of early-stage private venture capital investing points to the success of policy incentives aimed at growing the cleantech sector through private engagement. While there is no Malaysian representative company within CTG’s Global Cleantech 100’s shortlist in the last 3 years, there are some domestic cleantech start-ups that have shown remarkable evidence of emergence from the R&D phase, and successful commercialisation.

Commercialised Cleantech

Malaysia shows strong evidence of cleantech commodity trade, as it ranks 3rd among all analysed Asian countries for exports relative to GDP, trailing only Singapore and Hong Kong. However, the strong evidence for commercialised cleantech from commodity trade is not reflected in late-stage venture capital deals, highlighting that these commercial successes may not be the result of fully commercialised cleantech innovation companies. Policy-based incentives are having an impact on domestic cleantech innovation, with energy efficiency initiatives resulting in an RM 1.5 billion (USD\$350 million) contribution to Malaysian GDP in 2013. The GTFS has also created a total of 4,000 green jobs to-date, a good indicator for a successful emerging and commercialising cleantech innovation ecosystem.

32 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

Extended Summary

Malaysia's government is strongly committed to incentivising its entrepreneurial ecosystem, specifically cleantech entrepreneurship focusing on green growth in the country. With public policy and funding commitments, the cleantech sphere has begun to thrive and attract private support, including venture capital and the creation of corporate-backed accelerators. Malaysia shows some evidence of these incentives translating into commercialised cleantech companies.

Inputs to innovation

General Innovation Drivers

Malaysia is outperforming the Asian-average in the Global Innovation Index (36.2) by some distance,³³ indicating that the country supports the development of a streamlined general innovation pipeline. However, the very low score for total early-stage entrepreneurial activity shows that there is a general lack of real entrepreneurial activity. Socially, the risk of failure that is inherently connected with a career in entrepreneurship is not well accepted in Malaysian society. The country has since approached this gap by developing multiple policy incentives, public accelerators and incubators, and training agencies in its SME Masterplan aimed at nurturing the general national start-up sphere. 2017 has been named as the Start-up and SME Promotion Year by the Prime Minister.

Policy-based innovation incentives are supported by several agencies offering programmes for entrepreneurship, such as the Malaysian Global Creativity & Innovation Centre (MAGIC), Institut Keusahawanan Negara (INSKEN) and other public- and private-led initiatives, including the ten active public accelerators and incubators.³⁴ Additionally, the SME Masterplan includes significant policy incentives for investors, including an angel investor incentive, tax incentives for venture capital investors and investment tax allowances. Overall, social entrepreneurship is relatively newly incentivised in Malaysia,³⁵ with a first assessment of the SME Masterplan showing positive impacts on investment funding, but less so on labour productivity and wages.³⁶

In line with this governmental push for entrepreneurship since 2014, starting a business in Malaysia takes less than an hour. This is supported by the World Bank assigning Malaysia a score of 23 for 'ease of doing business' (for comparison India scores 130, with higher numbers meaning it is more difficult).

33 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), *Global Innovation Index*, 2016

34 MAGIC, Technology Park Malaysia, SIRIM, MTDC Symbiosis, BioNexus Partners, MDEC, Cyberview, SME Corp, MARA, TERAJU

35 State of social entrepreneurship in Malaysia 2014/2015, p. 25

36 <http://www.smecorp.gov.my/index.php/en/resources/2015-12-21-11-07-06/sme-masterplan/book/11/1?page>

Cleantech-Specific Innovation Drivers

Policy environment

Policy Area	
Carbon tax/carbon market	
Clean energy tax incentives; Tax incentives specifically for clean technology companies	
Green bonds; government-backed or -owned green investment banks; green investment funds.	
Government investment/loans/grants for climate-friendly and eco-friendly technology	✓
Transport obligation; Transportation efficiency or emissions standards	✓
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	✓
Government tendering/ green procurement	✓
Research institutes or government support university programs for clean technologies	✓

Malaysia stands out with a score of 6 out of 8 of selected cleantech-supportive policies, as well as ambitious carbon emissions reduction commitments to cut emission intensity by 45% by 2030, using 2005 as the baseline. Malaysia plans to reach 13% renewable energy consumption by 2050, with an estimated cost of USD\$4.5 billion to reach this target.

Malaysia shows evidence of making policy commitments to incentivise cleantech growth through entrepreneurship. The country targets the cleantech start-up ecosystem through the National Green Technology Policy (2009), implemented by the Malaysian Greentech Corporation (MGTC). Further examples of a cleantech-promoting initiatives include the recently introduced tax exemption for hybrid and electric vehicles. In addition, the Malaysian Investment Development Authority (MIDA) provides direct tax incentives for green technology industries, including those extending beyond the renewable energy sector, which in turn promotes domestic market demand.

The government is also engaged in trying to turn government procurement, which amount to 15% of Malaysia's GDP, into green procurement. Energy efficiency is also directly incentivised by various programmes including the Malaysian Industrial Energy Efficiency Improvement Programme (MIEEP) and the Green Building Index.

For transportation and auto-emissions, Malaysia has regulations set by the Road Authority Department (JPJ), which apply to fleet operators such as the taxis, logistics and transportation companies and transport operators, but to-date is limited in its real impact on vehicles owned by the population.

R&D and accelerator/incubator support

The government's commitment to the cleantech space is reflected in Malaysia's estimated cleantech R&D budget relative to GDP, which ranks much higher than Thailand, Vietnam and India. While Malaysia has relatively few established cleantech clusters – only Sarawak Corridor of Renewable Energy (SCORE) and Sustainable City (previously Green City) in Melaka – different cities in the country have evolved to specialise in certain aspects of the cleantech sphere, with Putrajaya and Cyberjaya embarking on the Smart and Sustainable City concepts, turning the city scape into a cluster as well as a space for technological application. While there is an extensive accelerator & incubator base, there are no cleantech-specific ones yet.

To extend current cleantech policy efforts to the start-up sphere, MGTC offers training courses to increase SMEs' capacity and capability to comply with the green standards established in Malaysia, in particular being certified as 'green' under eco-labelling. The Green Technology Financing Scheme (GTFS) has to-date approved and financially supported 237 green innovation projects in Malaysia.

A good number of university programmes are designed to produce talent specifically for the cleantech innovation sphere, and some technical universities play an important role in providing a general talent pool for cleantech start-ups. For example, the National University of Malaysia (UKM) has an established the Solar Energy Research Institute (SERI), and the University of Malaya (UM) has the Power Energy Dedicated Advanced Centre (UMPEDAC). More generally, the University of Technology Malaysia (UTM) has a Department of Environment & Green Technology, while the University of Science Malaysia (USM) has an Office of Sustainability that cuts across the faculties.

Access to Capital

Private sources of capital

1. Family & friends: There is little evidence for this type of funding, and it is not centralised or incentivised by the government.
2. Angel networks: In addition to the Malaysian Business Angels Network (MBAN), six licenses have been approved by the Securities Commission of Malaysia to operate crowdfunding platforms (P2P).
3. Private accelerators and incubators: These provide a significant proportion of finance, with examples including 1337 Accelerators, Cyberview Living Lab, Coach & Grow Programme, and MAGIC Global Accelerator Programme.
4. Venture capital investment: In Malaysia, venture capital is well developed, as various government agencies help support the setting up funds that focus on different 'needs of the community,' which also support start-ups in the field. Malaysia also attracts venture capital from foreign sources.
5. Corporate venture capital: Corporate financing for start-ups is supported by the Corporate Entrepreneurship Responsibility scheme of the government. While still in its infancy, some corporates are setting up their own accelerators, including AirAsia, Malaysia Airlines System, and TM.
6. Commercial Banks: Soft loans and credit services from commercial banks are available, and can be evaluated on a centralised information platform provided by MAGIC.

Public sources of capital

1. Malaysia shows good evidence of public accelerators and incubators that provide support as well as access to early-stage finance for start-ups, ten of which are very active.
2. The Malaysian government's policy focus on green growth is reflected in the number of funds directly related to cleantech. Twenty-three funds or financing schemes are set up with start-up access. In addition, the Green Technology Financing Scheme (GTFS) was invoked in 2010 to promote clean technology adoption – and has approved projects for a total of USD\$690 million.

As we have shown, start-up access to finance is more substantial than that of many other GCIP economies. Both the public and private sector are engaged in start-up support, even if cleantech start-ups are still inhibited by the risk-reputation of the sector, dating back to losses from investments in the palm oil-to-biodiesel innovators in the early 2000s.

Outputs to innovation

Emerging Cleantech innovation

Malaysia shows some evidence for emerging cleantech innovation. The above Asian-average number of cleantech-related patent filings can be related to the significant R&D expenditure in Malaysia. Some evidence of early-stage private venture capital spending points to the success of policy incentives in growing the cleantech sector through private engagement. While there is no Malaysian representative company within CTG's Global Cleantech 100's shortlist in the last 3 years, there are some domestic cleantech start-ups that have shown remarkable evidence of successful emergence and partial commercialisation.

Commercialising cleantech innovation

Malaysia shows strong evidence of cleantech commodity trade, as it ranks 3rd among all analysed Asian countries for exports relative to GDP, trailing only Singapore and Hong Kong. However, the strong evidence for commercialised cleantech from commodity trade is not reflected in late-stage venture capital deals, highlighting that these commercial successes may not be the result of fully commercialised cleantech innovation companies. Policy-based incentives are having an impact on domestic cleantech innovation, with energy efficiency initiatives resulting in an RM 1.5 billion (USD\$350 million) contribution to Malaysian GDP in 2013. The GTFS has also created a total of 4,000 green jobs to date, a good indicator for a successful emerging and commercialising cleantech innovation ecosystem. The country also scores high for clean energy-related jobs as a proportion of labour force, despite having a below-average proportion of renewable energy consumption. This can indicate that many of these jobs are related to the planning and construction of future renewable energy technology that isn't yet included in the grid, or alternatively, a labour-intensive sector that lacks the efficiency of, for example, European renewable energy sectors.

CatchThatBus, a Malaysian-based bus mobility service and ticketing app provider, was only founded in 2011 but has now scaled its business using two rounds of seed investments in preparation for a series A funding round. The company is aiming to extend its service provisions across South-East Asia.

Grab (formerly known as MyTeksi) is a Malaysian company that migrated to Singapore. The ride hailing company is now a regional company with presence in Singapore, Indonesia, Myanmar, Vietnam and The Philippines. The company has raised multiple rounds of investment to date.

Dah Makan, a delivery service start-up for healthy food based in Kuala Lumpur, has recently raised USD\$1.3 million from high profile Asian VCs including Asia venture Group and NFO Capital, alongside an angel investment from a former Nestle CEO. The funding is helping the cleantech start-up focus on improving their tech-routing, clustering, and rider allocation learning. The expansion of Dah Makan has been so rapid that it is already looking to expand overseas before the end of this year.

Pipeline Network is a developer of an Internet of Things (IoT) cellular network. The Malaysian start-up sourced USD\$1 million in seed funding in 2016 from the US-based venture capital investor Helios Investment Partners. The firm offers different tailored applications of its IoT network, with examples of industrial applications including empowering data in the agricultural sector to improve farming efficiency, and using its 'Pipeline Cloud' to enable companies to improve their transport logistics, lower their OPEX and also improve road safety.

MOROCCO

Despite a significant effort by the Moroccan government to become the North African leader in renewable technology commercialisation, the country still lags behind in providing the necessary incentives and support structures for a thriving domestic cleantech innovation pipeline. While the government is dedicating significant funds to renewable energy projects, a centralised system to support the financing of cleantech start-ups and SMEs is lacking.

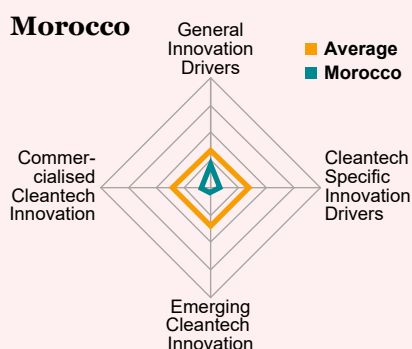


Figure 15: Morocco's performance in the indicator pillars compared to the global average

Ranked In GCI	General Innovation Drivers	Cleantech-specific Innovation Drivers	Emerging Innovation	Commercialised Innovation
+1	Bulgaria (38 th)	Russia (39 th)	Mexico (37 th)	Russia (38 th)
	Morocco	Morocco	Morocco	Morocco
-1	Russia (39 th)	Saudi Arabia (40 th)	Turkey (38 th)	Indonesia (39 th)

Figure 16: Morocco's relative positioning in the GCI ranking based on its performance in the GCI indicator pillars

Relative Strengths	Relative Weaknesses
Perceived entrepreneurial opportunities: 45% of population recognised entrepreneurial opportunities in their area of residence	INSEAD Global Innovation Index rank of 72/128; ³⁴ Total early-stage business activity: 6% of working-age population
Legal status of 'Independent entrepreneur'; 'One-stop-shop' principle officially applied to setting up a new business	It can take up to 5 weeks to formalise the start of a new business
Cleantech-specific clusters (2 public, 1 private); Cleantech-specific accelerators (2)	Little evidence of cleantech-supportive government policy; scores 0/8 based on GCI cleantech-friendly policy measurements
First Moroccan green bond issued March 2017	Access to private finance for start-ups is very limited
Several innovation clusters and accelerators provide small loans and grants for start-ups	Low evidence of cleantech start-up commercial success due to a lack of domestic market demand

Figure 17: Morocco's strengths and weaknesses in key indicators

Key Support Mechanisms/Policies

Masen, Morocco's leading renewable energy agency that primarily manages large integrated renewable energy projects in the country, also works to support in-country innovation in the cleantech sphere through industrial clusters and incubators. **Cluster Solaire** brings together entrepreneurs working on solar technology innovations, and is complemented by the **Climate Innovation Centre of Morocco (MCIC)**, which provides training, global networking and financing services for Moroccan entrepreneurs working on climate change-mitigating technologies. Morocco's **EMC** provides an industrial cluster for start-ups innovating in the energy efficiency sphere.

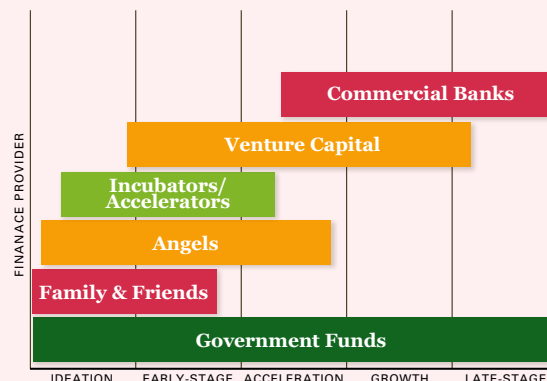
The city of Casablanca also opened its own smart city cluster, **E-Madina**, in 2013, a first for North Africa. The cluster is a private-public partnership, providing a space for innovation and networking to enable partnerships with corporates. Private accelerators provide the most accessible source of early-stage financing for start-ups in Morocco, and they make this investment valuable through additional training and business model support. The biggest examples are **NUMA/Impact Lab** (for loans

37 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

and seed investment), **DARE Inc**, supported by the Moroccan Centre for Innovation and Social Entrepreneurship (MCISE), and **CEED Morocco**.

Access to Finance

- Government funding is strongest in the early stages via R&D, and in the latest stages of deploying commercialised cleantech in large renewables/energy efficiency projects.
- Incubators and accelerators (generic and cleantech-specific) provide soft-loans and grants for early-stage start-ups, but are limited in number and in evidence of successfully accelerated companies.
- Due to the weak entrepreneurial culture and entrepreneurial status, family & friends and angel investors do not provide much financial support for start-ups (there is only one angel network).
- The venture capital market in Morocco is underdeveloped, and interest in cleantech is inhibited by risk-adverse investment mentality.



Pillar Analysis

Inputs

General Innovation Drivers

Morocco scores low in the INSEAD Global Innovation Index,³⁴ ranking 72nd place of 128 countries analysed due to the quality of the underlying parameters of a successful innovation ecosystem, including an assessment of the sophistication of institutions, policy, educational system, markets and business networks. Despite this inherent lack of a streamlined innovation support system, Morocco scores above global average for the perceived entrepreneurial opportunities within the country. The low proportion of the Moroccan workforce that is to-date involved in setting up or owning an early-stage business (only 5.56 %) indicates a lack of a strong national entrepreneurial culture. Indeed, entrepreneurship is not highly regarded within Moroccan society, due to its risk-prone nature and fear of failure.

Cleantech-Specific Drivers

Morocco lags behind the world average in the count of key policy areas that support the cleantech innovation sphere. Despite an ambitious renewable energy consumption target (52% by 2020) and a newly launched Green Bond by MASEN, the country does not provide sufficient in-country drivers to promote significant domestic cleantech innovation. While total public R&D spend on cleantech is still estimated to be very low, some early-stage funds are now cleantech-focused such as IRESEN and 4C Maroc. Start-up support through incubators, accelerators and clusters are focused on clean energy and energy efficiency innovation, with Cluster Solaire and MCIC being two public examples. Cleantech start-ups struggle to access early-stage investment outside these few cleantech-specific entities, and targeted financing options like the MORCEFF (by the EBRD) are limited.

Outputs

Emerging Cleantech

With only 16 cleantech-related patents issued in 2013, Morocco still lacks significant evidence of successful research results. With more university courses being offered in cleantech-related fields, and the creation of cleantech-specific clusters, some positive growth is expected. However, there is currently still a lack of success stories in Morocco's cleantech innovation pipeline. Start-ups are early-stage and struggle to gain commercial traction due to limited demand in the domestic market and lack of investor interest to provide means to scale up their products.

CASE STUDY: Kilimanjaro won the first prize in GCIP Morocco's cleantech start-up competition. The company produces biodiesel from discarded cooking oil, and has piloted its product, but is struggling to scale up the business due to a lack of investor interest.

Commercialised Cleantech

Evidence of commercialised cleantech innovation in Morocco exists in the form of large deployment of renewable energy technologies (e.g. the planned "Noor Complex"). While Morocco is clearly setting renewable expansion as a focus of policy and public funding, these projects show little evidence of contributing to domestic innovation to-date. Most renewable energy projects are joint ventures with the relevant government agencies and funds, domestic contractors and foreign expertise. Besides the acquisition of domestic solar-installer Nova Power Group in 2015, there has not been much evolution in the mature Moroccan cleantech sphere. Morocco's cleantech-related commodity trade (imports and exports) ranks lower than most countries analysed in the GCII, except for Saudi Arabia.

38 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

Extended Summary

Despite a significant effort by the Moroccan government to become the North African leader in renewable technology commercialisation, the country still lags behind in providing the necessary incentives and support structures for a thriving domestic cleantech innovation pipeline. While the government is dedicating significant funds to renewable energy projects, a centralised system to support the financing of cleantech start-ups and SMEs is lacking.

Inputs to innovation

General Innovation Drivers

Morocco scores low in the Global Innovation Index,³⁹ ranking 72nd of 128 countries analysed due to the quality of the underlying parameters of a successful innovation ecosystem – including an assessment of the sophistication of institutions, policy, educational system, markets and business networks. Despite this lack of a streamlined innovation support system, Morocco scores above global average for the perceived entrepreneurial opportunities within the country. The low proportion of the Moroccan workforce that is to-date involved in setting up or owning an early-stage business (only 5.56 %⁴⁰) points to the lack of a strong national entrepreneurial culture. Indeed, entrepreneurship is not highly regarded within Moroccan society due to its risk-prone nature, and an individual is far more inclined to choose a position within an established large business instead of an entrepreneurial career path.

In order to lift some of the barriers to entrepreneurial activity in the country, Morocco has introduced the ‘one-stop shop’ principle to setting up a business, aiming to dramatically reduce the time and bureaucratic obstacles involved in start-up creation. While it officially takes five days to set up a new business, experience from in-country experts shows that this can take up to five weeks. Additionally, the Moroccan government introduced a new legal status for start-up founders to be recognized as an ‘independent entrepreneur’, providing more administrative clarity than before. To promote employment in local SMEs, the Moroccan government issues tax benefits for young companies that are actively hiring.

Cleantech specific innovation drivers

Policy environment

Policy Area	
Carbon tax/carbon market	
Clean energy tax incentives; Tax incentives specifically for clean technology companies	✓
Green bonds; government-backed or -owned green investment banks; green investment funds.	✓
Government investment/loans/grants for climate-friendly and eco-friendly technology	
Transport obligation; Transportation efficiency or emissions standards	
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	
Government tendering/ green procurement	
Research institutes or government support university programs for clean technologies	✓

³⁹ INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), *Global Innovation Index*, 2016

⁴⁰ GEM Total early-stage entrepreneurial activity score 2016

Morocco lags behind the world average in the number of active cleantech-friendly policies, failing to produce effective demand-side pull on domestic cleantech innovation. Morocco nevertheless has a very ambitious renewable energy target – 52% by 2020⁴¹ – with new large government-backed solar infrastructure projects like the “Noor complex” currently under construction. Masen, Morocco’s highly active renewable energy agency, issued Morocco’s first Green Bond in March 2017. The Société d’Investissement Energétique (SIE) acts as the financial arm of the State for the execution of energy targets, investing in renewable and energy efficiency projects, and also sourcing investment from private entities.

R&D and accelerator/incubator support

While there is a large emphasis on renewable project finance, there is growing support for early stages of venture capital. IRESEN (renewables-focused) and 4C Maroc (climate change mitigation-focused) were set up by the government to help focus R&D funds and act as capacity-building and information sharing platforms,⁴² but the total public spend on cleantech-related R&D is still estimated to be very low.⁴³

Also in coordination with government agencies, a cluster was set up to support innovation in the solar technology sphere (Cluster Solaire) and another focused on energy efficiency innovation (EMC). In addition, the Morocco Climate Innovation Centre (MCIC) was launched in 2014, providing incubator and support services for cleantech entrepreneurs. The accelerator and award competition led by UNIDO’s GCIP programme provides unique start-up support, investor networking and cash awards as well.

While other cleantech sectors are still relatively low on Morocco’s public interest profile, there is some evidence of private engagement. The cement giant LafargeHolcim Maroc has recently launched North Africa’s first “Smart Construction Lab” in Casablanca that will house a cluster of smart building start-ups.

Access to finance

Private sources of capital

1. Family and friends: In Morocco, decentralised family & friends and angel investing can play an important part in seed-stage financing of start-ups due to the difficulty in accessing formalised capital without assets or profits.
2. Angel investors: The only centralised angel network, MNF Angels, was set up in 2016 and hasn’t shown much activity since its inception.
3. Incubators & accelerators: There are few private accelerators and incubators set up by foundations and international accelerator programmes that are focused on general innovation and provide small loans and grants. These include NUMA/ Impact lab, CEED Morocco, Emerging Business Factory, and social-environmental start-up incubator Espace Bidaya.
4. Venture capital investors: While Maroc Numeric Fund has previously been the only active venture capital firm based in Morocco, this year will see an increase in the number of active early-stage VCs to six, partly aided by World Bank capital deployment setting up three of them. World Bank approved VCs include Azur Partners and Seaf Morocco Capital Partners.⁴⁴ Africa-wide VC firms that are headquartered in Morocco include the new OUTLIERZ (early-stage) and Africinvest (late-stage).

⁴¹ <https://www.theguardian.com/global-development/2016/nov/17/cop22-host-morocco-lights-way-africa-renewable-energy-2020>

⁴² <http://www.ocppc.ma/publications/morocco%E2%80%99s-green-energy-opportunity-0#.WP88e9rl2w>

⁴³ Global Cleantech Innovation Index methodology using a percentage of total R&D expenditure figures

⁴⁴ <http://www.ccg.ma/fr/espace-media/actualites/resultat-de-lami-pour-la-selection-des-societes-de-gestion-de-fonds-public>

5. Corporate Venture Capital: Corporate venture is underdeveloped in Morocco, despite large corporates working in the cleantech space around renewable energy.
6. Commercial Banks: Commercial bank loans are hard to access pre-profit, but the BMCE African Entrepreneurship Awards is an example of an African program organised by a Moroccan bank that facilitates this process for start-ups.

Public sources of capital

1. Incubators & accelerators: There is good evidence of general innovation incubators & accelerators, including Dare. Inc. supported by MCISE. Morocco also has cleantech-specific options for such funding, like the government-backed clusters MCIC and Cluster Solaire that provide small grants and a fast-track to market through capital. UNIDO's global cleantech innovation programme also provides cash prizes as well as investor networking for Moroccan cleantech start-ups.
2. Government funds & initiatives: MORSEFF provides several financing solutions for cleantech SME projects, set up through the EBRD. The SIE acts as the financial arm of the State for the execution of energy targets, investing in renewable and energy efficiency projects, and also sourcing investment from private entities. The OCP Innovation Fund For Agriculture provides capital for cleantech-related innovation in the food & agriculture sector.

Kilimanjaro, who won the first prize issued in GCIP Morocco's cleantech start-up competition, works in the area of waste beneficiation. The company collects used cooking oil (UCO) from restaurants and hotels, which it filters, treats, and resells to biodiesel manufacturers. It also resells fatty acid products to both biodiesel and feedstock production plants. These plants utilize a feedstock of second generation biofuel made from waste, rather than food products, which both encourages sustainable waste disposal and reduces pressure on food production. The company has piloted its product, but is struggling to scale up the business due to a lack of investor interest.

Meolink, a software provider that helps manage energy and fluid consumption, has previously achieved USD\$400,000 in grants from the VC Maroc Numeric Fund (2012). While the start-up is still active, it has not managed to scale to a significant commercial level yet.

Elum is a provider and developer of an industrial energy management software-as-service, utilizing artificial intelligence to help manage both on-grid and off-grid energy costs. Founded in 2016, the company aims to expand to the wider African market to help optimize the growing renewable energy market. The company is self-funded, and has also received grants from cleantech players like MCIC.

Although there is evidence for some capital availability, it is still difficult for start-ups and SMEs to access it to-date. The current focus of cleantech finance in Morocco is on large-scale development projects, such as the renewable energy complexes. Additionally, due to the risk-averse Moroccan culture, individual investors prefer to invest in traditional sectors.

Outputs to innovation

Emerging Cleantech Innovation

With only sixteen cleantech-related patents issued in 2013, Morocco still lacks significant evidence of successful research results. With more university courses being offered in cleantech-related fields, and the creation of cleantech-specific clusters, some positive growth is expected. However, there is currently still a lack of success stories in Morocco's clean tech innovation pipeline. Start-ups are early-stage and struggle to gain commercial traction due to limited demand in the domestic market and lack of investor interest to provide means to scale up their products.

Commercialised Cleantech innovation

Evidence of commercialised cleantech innovation in Morocco exists in the form of large deployment of renewable energy technologies (e.g. the planned "Noor Complex"). While Morocco is clearly setting renewable expansion as a focus of policy and public funding, these projects show little evidence of contributing to domestic innovation to-date. Most renewable energy projects are joint ventures with the relevant government agencies and funds, domestic contractors and foreign expertise. Besides the acquisition of domestic solar-installer Nova Power Group in 2015, there has not been much evolution in the mature Moroccan cleantech sphere. Morocco's cleantech-related commodity trade (imports and exports) ranks lower than most countries analysed in the GCII, except for Saudi Arabia.



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PAKISTAN

The cleantech innovation landscape in Pakistan is underdeveloped, with early signs that this is likely to change. This is mainly due to ineffective and disconnected government agencies. However, the entrepreneurial culture in Pakistan is picking up, resulting in Pakistan having the largest number of applicants to the Global Cleantech Innovation Programme (GCIP) in 2016.

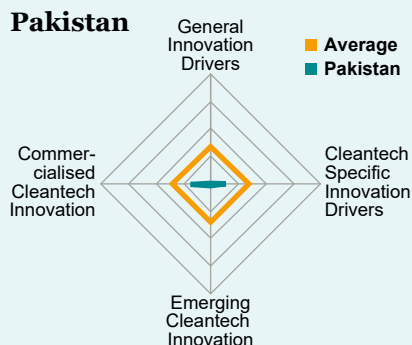


Figure 18: Pakistan's performance in the indicator pillars compared to the global average

Ranked In GCI	General Innovation Drivers	Cleantech-specific Innovation Drivers	Emerging Innovation	Commercialised Innovation
+1	Greece (40 th)	Romania (38 th)	Argentina (39 th)	Australia (33 rd)
	Pakistan	Pakistan	Pakistan	Pakistan
-1	N/a	Russia (39 th)	Indonesia (40 th)	Bulgaria (35 th)

Figure 19: Pakistan's relative positioning in the GCI ranking based on its performance in GCI indicator pillars

Relative Strengths	Relative Weaknesses
Presence of incubators and accelerators is growing	Historically weak entrepreneurial culture due to planned economy policies
Government support is starting to become available for entrepreneurs. The country's large middle class provides additional opportunity to increase early-stage business activity.	Difficulty for entrepreneurs and investors to connect due to lack of cleantech clusters
Pakistan has a large potential for solar energy, and the first solar parks are being installed.	Government support is mainly aimed at IT start-ups and applications, with few programs aimed at cleantech specifically.
The country has put some cleantech-friendly policies in place (including renewable energy tax incentives), which serve as a market demand driver for cleantech innovation.	Cleantech commodities are almost entirely imported; there do not seem to be any Pakistani firms active in the local cleantech industries.

Figure 20: Pakistan's strengths and weaknesses in key indicators

Key Support Mechanisms/Policies

IT-focused venture capital firms and government initiatives

Pakistan does not yet focus greatly on cleantech, and there does not seem to be evidence of any government initiatives aimed at supporting cleantech start-ups specifically. However, Pakistan does invest a lot in support for the IT sector. Cleantech companies that have an IT dimension might be able to benefit from these measures. One example is the **National ICT R&D fund**, which offers research grants and commercialisation grants primarily to the IT sector. There are also some accelerators and incubators focused on IT, such as **Nest i/o**, supported by Google, the **Microsoft Innovation Centre**, and **Tech Valley Abbottabad**.

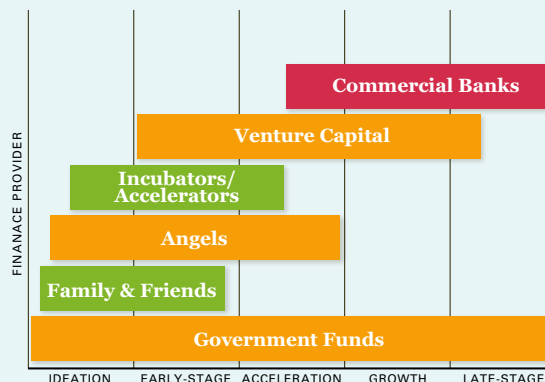
GCIP has created a first cleantech platform, through which the government sector, private sector, universities and financial sector organizations can directly interact. By improving Pakistan's institutional capacity related to cleantech and incentivising angel and risk-capital investors, cleantech is now starting to become a preferred choice for many innovators. **GCIP Pakistan** received the largest number of applicants out of all eight countries last year.

Investment in solar power

Pakistan has a large potential for solar power, and despite the fact that the overall renewable energy use in Pakistan is still quite low, the government has shown an interest in developing these renewable energy resources. The flagship project is the **Quaid-e-Azam Solar Park**, which opened in 2015 and is one of the world’s largest grid-connected solar plants. Several extensions to the project are already planned.

Access to Finance

- Family & friends and informal angel investing are the main sources of early-stage finance for Pakistani entrepreneurs.
- The number of organised angel funds in Pakistan remains low but has been notably increasing since 2014, with five angel funds now actively investing.
- Private accelerators and incubators provide some funding for start-ups, but most remain a space for innovation with no guaranteed funding provision. Public incubators do exist at universities. There are some highly successful public accelerators such as Plan 9, set up by the Punjab Information Technology Board.
- Venture capital investment in Pakistan is underdeveloped, with only one venture capital investor making regular start-up investments (Acumen).
- Pakistan’s banks are risk-averse to early-stage businesses, due to high numbers of non-repayment on loans in depressed economic conditions.



Pillar Analysis

Inputs	
<p>General Innovation Drivers</p> <p>Pakistan does not have a strong entrepreneurial culture. It ranks 119th out of the 128 countries surveyed in the INSEAD Global Innovation Index.⁴¹ The country has weak institutions and suffers from political instability. This impacts the regulatory certainty that entrepreneurs need for investment. Furthermore, the levels of education are insufficient to deliver the skills required for an innovation ecosystem, and many people do not have the financial literacy to successfully start and run a business. The Small and Medium Enterprise Development Authority (SMEDA) promotes job creation through entrepreneurship. However, Pakistan is betting heavily on its IT innovation, and most of the programs supporting entrepreneurship and innovation have a focus on the IT sector.</p>	<p>Cleantech-Specific Drivers</p> <p>Early-stage finance in Pakistan is low, and there does not seem to be evidence of the presence of cleantech investors, funds or clusters. This lack of early-stage investment is remediated to a small extent by the presence of incubators and accelerators. The Pakistani Green Building Council, a private-sector organisation, is promoting the development and implementation of green building laws and regulations in Pakistan. It is part of the World Green Building Council, which gathers similar groups from different countries into a global body. R&D expenditure in Pakistan is low. In 2015, the country allocated a mere 0.29% of GDP to R&D. Continued under-investment in R&D and innovation has led to poor research infrastructure. However, there are plans to gradually increase the investment in R&D to 2% of GDP by the year 2023.</p>
Outputs	
<p>Emerging Cleantech</p> <p>Pakistan has a very low patent activity, certainly compared to the patent activity weighted by GDP of neighbouring country India. The country does not have any companies that featured in CTG’s Global Cleantech 100 shortlist in the past three years. However, there are some start-ups that are gathering international attention, which is promising for the future.</p> <p>CASE STUDY 1: Capture Mobility, one of the semi-finalists of the GCIP 2014, developed a system that captures electricity from the kinetic energy of moving vehicles along highways, feeding it back into electric cars that are using the highway. The company successfully installed its prototype in several places in the UK.</p>	<p>Commercialised Cleantech</p> <p>Pakistan has relatively high levels of cleantech commodity imports. This is explained to a large extent by the recent increase in solar power capacity. There are a large number of private sector project developers, especially in solar. The Quaid-e-Azam Solar Park, which opened in 2015, is one of the world’s largest grid-connected solar plants. Further additions to the plant are planned, which would ultimately make it the largest solar power plant in the world.</p> <p>Cleantech commodity exports, on the other hand, are very low. This shows that although there are some cleantech start-ups active in Pakistan, they are either too small or are aimed at the domestic market to really make an impact in export figures.</p>

45 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

Extended Summary

The cleantech innovation landscape in Pakistan is underdeveloped, with early signs that this is likely to change. This is mainly due to ineffective and unstable government agencies and a low level of education. However, things seem to be changing fast, and the entrepreneurial culture in Pakistan is picking up. If this trend continues, Pakistan's current rather weak score should start to improve over the coming years.

Inputs to innovation

General Innovation Drivers

Pakistan does not have a strong entrepreneurial culture. It ranks 119th out of the 128 countries surveyed in the Global Innovation Index.⁴⁶ The country has weak institutions and suffers from political instability. This impacts the regulatory certainty that entrepreneurs need for investment. Furthermore, the levels of education are insufficient to deliver the skills required for an innovation ecosystem, and many people do not have the financial literacy to successfully start and run a business. This is exemplified by the 'new business density' metric included in the Global Innovation Index report, which indicates that new business activity in Pakistan is close to zero.

Low levels of entrepreneurship could also be attributed to the centrally-planned and governed economy that existed in Pakistan for years. Inherently, there is little room for entrepreneurship in such a system. Economic problems had to be solved through policy-based structures, rather than offering the tools with which entrepreneurs could create solutions on their own. The centrally-planned economy meant that an entrepreneurial culture was all but absent in Pakistan. However, the past few years have seen a reinvigoration of an entrepreneurial spirit.

Pakistan has a few government agencies active in the field of innovation and entrepreneurship. The Small and Medium Enterprise Development Authority (SMEDA) promotes job creation through entrepreneurship. The National Productivity Organisation (NPO), which operates under the Ministry of Industries, is focused on continuous productivity and quality improvement in all sectors of the national economy. The NPO has an important mandate in developing human capital in order to transform the Pakistani economy into a knowledge economy. The organisation also represents Pakistan in the Asian Productivity Organisation (APO) and the World Network of Productivity Organisations (WNPO).

Setting up a company in Pakistan takes around 7-10 days, which is longer than most countries, but by no means prohibitive. Additionally, Pakistan does allow the setting up of single-person companies, which is in line with recent developments in international company law.⁴⁷

Pakistan is betting heavily on its IT innovation. Most of the programs supporting entrepreneurship and innovation have a focus on the IT sector. For example, the National ICT R&D fund offers research grants and commercialisation grants primarily to IT sector.

There are also several incubator and accelerator programs in Pakistan.⁴⁸ Some of the programs are linked to universities, both private and public, while others are fully private creations. There are also divisions of international incubator networks, such as the Founder Institute and the Microsoft Innovation Centre.

46 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

47 <https://www.secp.gov.pk/company-formation/starting-a-company/start-your-company/>

48 <https://www.techinasia.com/13-startup-incubators-accelerators-coworking-spaces-pakistan> ; <https://www.techjuice.pk/incubators/>

Cleantech specific innovation drivers

Policy Area	
Carbon tax/carbon market	
Clean energy tax incentives; Tax incentives specifically for clean technology companies	✓
Green bonds; government-backed or -owned green investment banks; green investment funds.	
Government investment/loans/grants for climate-friendly and eco-friendly technology	
Transport obligation; Transportation efficiency or emissions standards	✓
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	✓
Government tendering/ green procurement	
Research institutes or government support university programs for clean technologies	

Pakistan has very few government policies that relate to cleantech. For some of those policies, such as green building and emissions standards, the relevant actors are voluntarily adhering to international standards or other standards created outside of government.

Renewable energy use in Pakistan is quite high compared to other Asian countries, with Pakistan using a higher percentage of renewable energy than India or Japan, for example. Initially, the target was to have 5% of energy from renewable sources by 2030. However, the government is considering revising these targets upwards to between 15-20%. Two government agencies have been created to set the standards for renewable energy: the Alternate Energy Development Board (AEDB) and the National Energy Efficiency Conversation Authority (NEECA). NEECA's activities shall cover the identification of:

- energy efficiency,
- conservation opportunities and technology demonstrations,
- undertaking pilot projects,
- information and outreach,
- training and education,
- and development of plans and policies for promoting mitigation, energy efficiency and conservation best practices.

Furthermore, a feed-in tariff has been introduced for some types of renewable energy, such as solar and wind energy. There are also tax incentives for renewable energy projects being developed.

Even though there are no specific emissions standards for road vehicles, some local car manufacturers are complying with the Euro 6 emissions standard and other international standards on a voluntary basis. A government policy regarding trucking and transportation is being developed by the Planning Commission of Pakistan.

A government sector project for efficiency in the agriculture sector in the province of Punjab is also under way. The project, called Punjab Irrigated-Agriculture Productivity Improvement Project (PIPIP), focuses on water use and efficient irrigation, and is supported by the World Bank.⁴⁹

⁴⁹ <http://www.worldbank.org/en/news/feature/2014/04/18/improving-punjab-irrigation-more-crops-from-every-drop>

The Pakistani Green Building Council, a private-sector organisation, is promoting the development and implementation of green building laws and regulations in Pakistan. It is part of the World Green Building Council, which gathers similar groups from different countries into a global body.

While there are some policies in place, R&D expenditure in Pakistan is low. In 2015, the country allocated a mere 0.29% of GDP to R&D. Continued under-investment in R&D and innovation has led to poor research infrastructure and signs of a brain drain. However, there are plans to gradually increase the investment in R&D to 2% of GDP by the year 2023.⁵⁰

Pakistan has been able to attract Chinese and Turkish professionals in cleantech and related sectors. Cleantech in Pakistan is the domain of multinational corporations and start-ups, and there are only very few family businesses active in cleantech.

Access to finance

Even though sources of finance exist in Pakistan, such as a fund a clean technology fund that The Ministry of Industries is in the process of launching in cooperation with UNIDO. the main issue seems to be connectivity and availability of information. Start-ups and investors are having trouble finding out about each other, keeping up to speed and remaining aware of each other's needs. For that reason, there is first and foremost a need for a common platform through which information between start-ups and investors can flow.

There is no notable private or public capital devoted specifically to the cleantech sector.

Private sources of capital

Family & friends: Alongside informal angel investing, informal investing is the main source of early-stage finance for Pakistani entrepreneurs. In 2014, 76% of entrepreneurs surveyed said they used personal funds to start their business, and 37% said they received funding from family and friends.

Angel investment: The number of organised angel funds in Pakistan remains low but has been notably increasing since 2014, with five angel funds (DotZero Ventures, CresVentures, Arpatech Ventures, Fatima Ventures and Planet N) active in various technology innovation financing.⁵¹

Private Accelerators & Incubators: While some private accelerators & incubators provide funding for start-ups, most remain a space for innovation and act as a supportive entity with no guaranteed funding provision. Some private incubators include: Nest i/o (supported by Google and P@SHA), Tech Valley Abbottabad, SEED, NSPIRE (launched by NetSol). Some private accelerators include: Telenor Velocity (by telecom company Telenor) and 10xC (offers seed funding up to USD\$10,000 for a 20% equity stake in the start-up).⁵²

Venture capital investment: Venture capital in Pakistan is not widely available but has recently made large improvements. The active venture capital investors include Acumen, Karandaaz, Indus Basin, and Cyan Capital. Other regional venture capital funds (like Insitor Management and Aavishkaar) are also a future option for some start-ups as the country promotes foreign investment.

Corporate Venture Capital: Corporate interest in financing start-ups is still low in Pakistan. The only support is provided through related accelerators or incubators (Telenor, Mobilink, Samsung), or through traditional CSR activities in general

⁵⁰ <https://www.dawn.com/news/1244723>

⁵¹ Pakistan entrepreneurship ecosystem report, 2016

⁵² Pakistan entrepreneurship ecosystem report 2016, p. 34-38

education and innovation competitions (e.g. Islamabad Startup Week, PIF's Open Innovation Challenge). International corporations like Unilever and Coca Cola offer partnerships to local entrepreneurs on occasion.

Commercial banks: It is difficult for start-ups and SMEs to receive loans from local banks. Pakistan's banks have become more risk-averse, due to high numbers of non-repayment on loans in depressed economic conditions.⁵³

Public sources of capital

Public incubators & accelerators: Pakistan shows good evidence of public accelerators and incubators that provide support as well as access to early-stage finance for start-ups. Many accelerators are at least in part supported by the Pakistani government or a public initiative. Examples are the highly successful Plan 9, set up by the Punjab Information Technology Board, and forms of competitions or awards focused on particular sectors (like the Grand National ICT R&D Awards and DICE (Digital Innovation Competition and Exhibition)).

Government funds: Besides the publicly funded initiatives and accelerators, there is no direct government funding made available to start-ups. The Higher Education Commission (HEC) has played an important role in establishing incubators within public universities (e.g. Technology Incubation Center (TIC), University of Engineering & Technology Peshawar), which provide a source of public capital for start-ups, and thus are important spaces for emerging innovation. However, this is still not a widespread occurrence.

Outputs to innovation

Emerging Cleantech innovation

Pakistan has a low environmental patent activity. Amongst the Asian countries, it finishes under Thailand and the Lao PDR, but ahead of Bangladesh and Afghanistan. Larger neighbour India is far ahead in the ranking for patents. However, Pakistan does have several successful cleantech start-ups.

Energy efficiency

Zaheen (Intelligent) Machines Pvt. Ltd. is an Internet of Things (IoT) start-up in Pakistan that produces resource optimisation devices for the national market. Its first product is Jal Bujh, an automated gas-fired hot water tank retrofit that has the potential to save Pakistan USD\$50 million per year in natural gas. Jal Bujh has won the 1st prize in the Pakistan national competition, and the company is currently rolling out its second product, e-Jal Bujh, which allows users to operate any electrical load according to a time schedule.

Transportation

Capture Mobility, one of the semi-finalists of the GCIP 2014, developed a system that captures electricity from the kinetic energy of moving vehicles along highways, feeding it back into electric cars that are using the highway. The company successfully installed its prototype in several places in the UK.

Water efficiency

Team Watersense also competed in the GCIP competition. The company aims to ensure that water is safe for human consumption. Their product sits on water tanks and periodically releases disinfectants so that the water is free of any impurities hazardous to human health. It eliminates diarrhoea-causing bacteria, keeping water safe to drink.

⁵³ Pakistan entrepreneurship ecosystem report 2016, p. 56

Green building

Project RASAAI is promoting the use of hempcrete, a building product based on the widely available hemp plantain, as an insulation material for building construction. The use of hempcrete not only brings down costs but also provides up to 10 times better insulation compared to the conventionally used bricks. The team has already acquired contracts to build model houses in Rawalpindi.

Waste-to-Energy

Tawanai Solutions has developed a crop waste gasifier that is mounted onto a tractor, reducing the tractor operating cost by an average of 50% with much less emissions than the conventional diesel set-up. This not only eliminates the cost of buying diesel fuel, but also enables the farmer to get rid of the biomass economically.

Commercialised Cleantech innovation

Pakistan has relatively high levels of cleantech commodity imports. This is explained to a large extent by the recent increase in solar power capacity, with a large number of private sector project developers particularly in the area of solar. The Quaid-e-Azam Solar Park, which opened in 2015, is one of the world's largest grid-connected solar plants. Further additions to the plant are planned, which would make it the largest solar power plant in the world.⁵⁴

Cleantech commodity imports in Pakistan are very low. This shows that although there are some active cleantech start-ups in Pakistan, they are either too small or are aimed at the domestic market to really make an impact in export figures.

Muhammad Saleem, a 23-year-old gin worker, works in a ginning unit at the Mian Cotton Factory - part of the Better Cotton project - in Bahawalpur, Punjab, Pakistan.

The Better Cotton Initiative (BCI) was founded by WWF and a number of like-minded retailers to improve the way cotton is grown and processed - and create a more sustainable future for cotton. BCI strives to mainstream 'Better Cotton' that is more energy-efficient, uses resources such as water more wisely, reduces the use of pesticides and is healthier for people and the environment.

54 <https://www.dawn.com/news/1205484>



SOUTH AFRICA

South Africa has an extensive cleantech-supportive policy environment, and provides incentives directed at specific cleantech subsector innovations. Despite these incentives and the funding provided by the government, the real entrepreneurial activity remains limited. A lack of coordination between government agencies as well as bureaucratic obstacles to starting and running a business are part of the problem. South Africa shows little evidence of commercial cleantech successes yet, but the improving cleantech-specific innovation drivers show some emerging start-ups in the sphere.

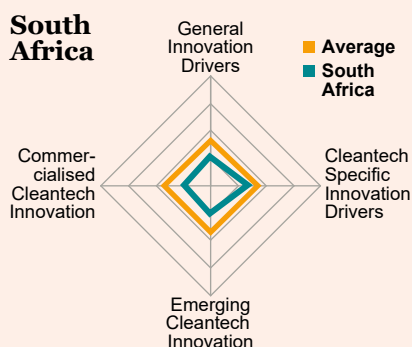


Figure 21: South Africa's performance in the indicator pillars compared to the global average

Ranked In GCI	General Innovation Drivers	Cleantech-specific Innovation Drivers	Emerging Innovation	Commercialised Innovation
+1	Romania (36 th)	Slovenia (25 th)	Spain (22 nd)	Bulgaria (37 th)
	South Africa (37 th)	South Africa (26 th)	South Africa (23 rd)	South Africa (38 th)
-1	Bulgaria (38 th)	Spain (27 th)	Poland (24 th)	Argentina (39 th)

Figure 22: South Africa's relative positioning in the GCI ranking based on its performance in GCI indicator pillars

Strengths	Weaknesses
The perceived entrepreneurial opportunities have been rising, and the government is supporting minority groups to increase their business activity.	Entrepreneurship remains low despite chronic unemployment. Large racial inequality persists in propensity to start and run a business.
There is an overarching cleantech-supportive policy environment, with all 8 policies tracked in the GCI indicator in place.	Cleantech-supportive policy, institutions and support programmes are fragmented and lack necessary coordination.
There is direct incentivisation of innovation and technology implementation in different cleantech subsectors via R&D and innovation roadmaps.	South Africa shows low evidence of cleantech-related patent filings, ranking 36 th out of 40.
Government funds and public financing schemes form a large part of start-ups' access to early-stage finance (e.g. National Treasury Green Fund of USD\$172 million).	Renewable energy consumption is still low, and ambitious roadmaps have not yet shown real success.
South Africa has good evidence of venture capital investment in cleantech start-ups.	Private equity investors are risk-averse and usually only invest in cleantech start-ups if the risk is shared with a public entity.
	South Africa shows low commercial success of cleantech start-ups, and less-than-average cleantech commodity exports.

Figure 23: South Africa's strengths and weaknesses in key indicators'

Key Support Mechanisms/Policies

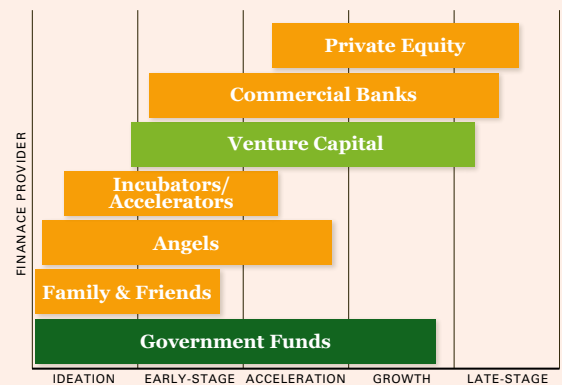
South African national and regional public finance provides the majority of risk capital at the early stages in the form of large Green Funds (e.g. **Department of Environmental Affairs' Green Fund**), regional funds (e.g. **Cape Capital Funds**) and general SME support schemes. The funds offer a variety of loans, grants, seed- and growth-stage investments to cleantech start-ups. The USD\$172 million **National Treasury Green Fund** channels funds through various government departments and agencies to offer financial support in the form of grants and loans, with the most active ones being the **Department of Trade & Industry, Small Business**

Development Agency and the Renewable Energy and Energy Efficiency Partnership. The scope of these grants and loans can be large, with the DEA's Green Fund having contributed directly to 2355 jobs being created in 55 projects, ranging from the R&D stage to active projects and start-ups.

Access to Finance

Government funding is the largest and most developed source of finance available to start-ups at all levels (regional, national, international).

- Venture capital and private equity interest is developed, but often requires risk-sharing with a public entity.
- Family & friends and angel capital is available, but access is highly uneven among the population.
- Commercial bank loans are available for SMEs, but there is a need for significant collateral to access credit services.



Pillar Analysis

Inputs

General Innovation Drivers

South Africa ranks 37th out of 40 countries in the *General Innovation Drivers* pillar, highlighting that the underlying parameters of the national innovation ecosystem are lagging behind the global average. While perceived entrepreneurial opportunities have been consistently rising over the years, early-stage activity is still highly correlated with historical wealth distribution patterns and institutional privilege. Entrepreneurial intentions have been dropping over the last 10 years despite chronic unemployment and improved entrepreneurial support structures, with early-stage activity ranking 31st out of 40. The government has approached this problem by introducing policy, and making funding available, aimed at helping disadvantaged groups. However, among the remaining limiting factors are the inefficient bureaucratic systems and highly fragmented nature of SME support structures and initiatives.

Cleantech-Specific Drivers

South Africa has all eight important cleantech-supporting policies in place, highlighting the country's particularly strong policy approach to promoting cleantech. Strategy plans for different cleantech-subsectors (energy efficiency, water, renewables, transportation) further incentivise innovation and attract significant funds. Access to finance is primarily provided by the public sphere, also targeting cleantech directly via specialised funds, but international organisations also play a vital role. The private sector is still risk-averse, but venture capital and private equity can be enhanced by risk-sharing with a public entity during technology commercialisation. Estimated R&D expenditure is still limited, and university research lacks a pathway to the market. Incubators and accelerators like SAREBI act less as funding sources, but rather provide training and networking support.

Outputs

Emerging Cleantech

South Africa shows low evidence of cleantech-related patent filings, ranking only 36th out of 40 in the GCII, presenting a failure to effectively turn the national policy incentives and funding provisions into emerging cleantech innovation. The country ranks 20th out of 40 in producing successful cleantech start-ups, measured by the number of companies in CTG's GCT100 shortlist. This shows that while the country does not present significant emerging innovation, some start-ups are managing to scale despite the multiple institutional, bureaucratic and market obstacles. The GCIP programme has so far attracted 404 entries, and finalists have shown significant growth impact.

Commercialised Cleantech

South Africa shows limited evidence of *Commercialised Cleantech*. The country ranks 18th out of 40 for cleantech commodity imports, indicating that there is domestic demand for clean technologies. Ranking 28th out of 40 for cleantech exports shows limited evidence of the presence of domestic, commercialised production of clean technologies that are internationally competitive. In our GCII measurements, South Africa shows no evidence of late-stage private equity investments into cleantech, no IPOs in the sector, or public companies in major cleantech indices. The country also scores low on renewable energy consumption and related clean energy jobs, despite the latest efforts to increase the share of renewables.

Extended Summary

Inputs to Cleantech Innovation

General Innovation Drivers

South Africa ranks 37th out of 40 countries in the *General Innovation Drivers* pillar, highlighting that the underlying parameters of the national innovation ecosystem are lagging behind the global average. While perceived entrepreneurial opportunities have been consistently rising over the years, early-stage activity is still highly correlated with historical wealth distribution patterns and institutional privileging. The large majority of SME funding applications and GCIP applicants come from the three most economically developed regions. In fact, entrepreneurial intentions have been dropping over the last 10 years despite chronic unemployment and improved entrepreneurial support structures, with early-stage activity ranking 31st out of 40 globally.

This contradiction is now targeted by South African public policy, aimed at reducing multiple inhibiting factors including unfavourable administrative steps, corruption, lack of technical assistance, and more. The Department of Small Business Development is still in its infancy, but is expected to incentivise the starting of, and improve the ease of, maintaining a small business. The existing entrepreneurship support schemes, delivered by a fragmented set of government institutions, did not show significant progress on the goals they had set.

A number of public South African funding and support institutions for SMEs have been set up, focusing on different disadvantaged areas in the national innovation pipeline. These range from the Technology Innovation Agency (DST) providing seed to commercialisation funding to high-CAPEX/high-risk innovators, to funds directed at women (IDC) or youth (NYDA) entrepreneurship. The Black Economic Empowerment Policies have so far played an important part in shifting minorities towards entrepreneurship, which are also supported by the National Empowerment Fund and Black Business Supplier Development Programme.

Bureaucratic processes in the set-up and running of a new business in South Africa are considered a part of the barriers to increasing start-up activity. Although the official duration of company registration is 48 hours, it usually takes up to three months for registration to be completed, which can only be sped up by utilizing a third-party, paying an extra fee. The need for legislative approvals and licenses from the government can delay or prevent new cleantech innovation investments and implementations, and thus the running of new businesses. Overall, South Africa's new businesses have a 70% failure rate in the first year of registering.

Cleantech-Specific Drivers

South Africa displays the largest relative score in this Index pillar as shown in Figure 2, indicating that the country is relatively strong at providing *Cleantech-Specific Drivers* to innovation.

Policy environment

Green growth forms part of six overarching national development strategies, including The New Growth Path (2010). South Africa has all eight important cleantech-supporting policies in place, highlighting the country's particularly strong policy approach to promoting cleantech. Renewable energy feed-in tariffs (REFIT), and the Renewable Energy Independent Power Producers Procurement Programme (REI4P) helped stimulate private sector investors' interest. In line with South Africa's greenhouse gas emissions reduction goals (34% by 2020 and 42% by 2025), a carbon

tax was introduced in 2013 to provide the necessary price signals to change consumer behaviour and stimulate investor appetite to shift towards low carbon options. Incentives for energy efficiency and conservation are provided by standard electricity tariffs and tax allowances, filed under the Income Tax Act of 1962 and 12L Tax incentive policy. South Africa also joined in on the recent boom of green bonds in 2017, with its first bond launching a USD\$389 million investment to fund the growth of green and energy efficient industries. Additionally, the National Treasury has multiple financial instruments in place (including tax reforms, incentives and subsidies) that support the growth of different aspects of green industry and green technologies. The Green Energy Efficiency Fund (IDC) enables businesses to reduce energy consumption and invest in energy efficient technology, hence driving domestic demand in the cleantech sphere.

In addition, the National Treasury Green Fund of USD\$172 million provides support across the cleantech R&D value chain, and provides key innovation support at high-risk stages of development.

Policy Area	
Carbon tax/carbon market	✓
Clean energy tax incentives; Tax incentives specifically for clean technology companies	✓
Green bonds; government-backed or -owned green investment banks; green investment funds.	✓
Government investment/loans/grants for climate-friendly and eco-friendly technology	✓
Transport obligation; Transportation efficiency or emissions standards	✓
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	✓
Government tendering/ green procurement	✓
Research institutes or government support university programs for clean technologies	✓

South Africa scores highly on the Renewable Energy Country Attractiveness Index,⁵⁵ occupying the 12th position in the GCII ranking for this indicator. REI4P, with more than USD\$15 billion in investment, of which USD\$4.1 billion is foreign capital, has been a significant success in creating drivers for the expansion of the renewables sector and related clean energy jobs in formerly disadvantaged, rural areas.

It can be concluded that South Africa provides a favourable policy environment for the cleantech innovation ecosystem. However, to produce successful results, a greater effort in the effective coordination between legislation, institutions and supporting programmes is required.

R&D and accelerator/incubator support

The country’s estimated cleantech R&D budget is very low relative to GDP, and the number of funds targeting South Africa as an investment destination is below global average. Universities and related science councils play a key part of cleantech research and development; however, the South African institutional infrastructure and processes have been largely inefficient at moving R&D and innovations into the marketplace. The recent set-up of the Technology Stations Programme has aided university R&D-funded innovations to spin-off into the market, but this programme is new and progress is slow.

55 EY, *Renewable Energy Country Attractiveness Index*, 2016

The South African approach to aiding cleantech innovation is highly focused on policy design, implementation, and providing the necessary funding support. However, much more technical and business expertise and assistance is required to succeed in scaling up a business. Generalist incubators are numerous, both private and public, but many entrepreneurs are unaware of the agencies that could be approached for support. A positive example is the South African Renewable Energy Business Incubation (SAREBI) in Cape Town, which has seen a number of small businesses commercialise due to effective support and technical business competence.

Additionally, the South African Renewable Energy Technology Centre (SARTEC) offers specialized industry-related training programmes to young individuals to increase their employability and expertise in the entire cleantech sphere. The Centre has been so successful that individuals have been hired to work abroad.

Access to finance

As part of the agenda of enabling green growth, and with it, cleantech innovation, various forms of financing have been made available to cleantech start-ups and SMEs. Investment interest into clean technologies has been steadily growing, partly due to the successful incentives provided by the multiple cleantech-supportive policies that are in place. To date, 214 organizations offer support in the South African entrepreneurial ecosystem. Of the direct finance providers, 30% are international and 70% are South African. Similar to the propensity to open a business, the propensity to attract investment or succeed in a funding application is still greatly influenced by the legacy of the Apartheid regime. Individuals that were denied property rights, and thus lack collateral, are limited in their access to loans and credit facilities. A change to the current credit market regulations and funding criteria is necessary to increase equality of opportunities.

Public finance

South African national and regional public finance provides the majority of risk capital at the early stages in the form of large Green Funds (e.g. Department of Environmental Affairs' Green Fund), regional funds (e.g. Cape Capital Funds) and general SME support schemes described earlier. These offer a variety of loans, grants, seed- and growth-stage investments to cleantech start-ups. The USD\$172 million National Treasury Green Fund offers financial support in the form of grants and loans through various government departments and agencies, with the most active being the Department of Trade & Industry, the Small Business Development Agency and the Renewable Energy and Energy Efficiency Partnership. The scope of these can be large, with the DEA's Green Fund having contributed directly to 2355 jobs being created in 55 projects, ranging from R&D stage to active projects and start-ups.

Development finance institutions (national and international) and foreign sovereign funds also form a large part of financial support in South Africa, with examples being the Global Environmental Facility (GEF) providing business loans to environmental entrepreneurs, and the International Climate Initiative (IKI) by the German Federal Ministry for Environment, Nature and Conservation.

Private financing

South African private investors are generally risk-averse, and require some evidence of commercialisation and business scale-up strategy before showing interest in the cleantech sector. Thus, cleantech start-ups risk falling into the gap between early-stage (public) funding and growth capital.

South Africa scores 23rd out of 40 for the presence of domestic cleantech investors, and 26th out of 40 for cleantech-targeted funds, in GCII rankings. While this does not indicate a particular strength, it shows that the country has a relatively well

developed private investment landscape relative to GDP, outshining other emerging GCI countries like India and Brazil.

Venture capital investors tend to abstain from investing in clean technologies that require high CAPEX risk, and have long development timelines. However, venture capital activity is still present in South Africa, with some domestic investors in the cleantech sphere including 4Di Capital, Edge Growth and Persistent Energy Capital. The angel network, AngelHub Ventures, also offers small seed-stage investment opportunities for cleantech start-ups. Indeed, South Africa shows strength in cleantech venture capital investment received in the last four years, ranking 15th out of 40 countries in this indicator.

Private support services are also provided by commercial banks offering special start-up loan services, or even schemes targeting cleantech entrepreneurs. Nedbank/WWF's Green Trust gives grants to supporting cleantech innovations with strong a community and conservation focus.

Little evidence of larger private equity deals is apparent in South Africa, and where they do occur, they usually tend to form joint investments with a public entity like the IDC in order to share the risk of commercializing cleantech innovation. Examples of these later stage private equity investors include Inspired Evolution, Adlevo Capital and Triumph Venture Capital.

Outputs of cleantech innovation

Emerging Cleantech

South Africa shows low evidence of cleantech-related patent filings, ranking only 36th out of 40, presenting a failure to effectively turn the national policy incentives and funding provisions into emerging cleantech innovations. The country ranks 20th out of 40 in producing successful cleantech start-ups, as measured by the number of shortlisted companies in CTG's GCT100 in the last three years. This shows that while the country does not demonstrate significant emerging innovation, some start-ups manage to scale despite the multiple institutional, bureaucratic and market obstacles. In addition, the GCIP programme has so far attracted 404 entries, and finalists have shown significant growth.

Commercialised Cleantech

South Africa shows limited evidence of commercialising cleantech. The country ranks 18th out of 40 in cleantech commodity imports, an indication of domestic demand for clean technologies. Ranking 28th out of 40 in cleantech exports shows some evidence of the presence of domestic, commercialised production of clean technologies that are internationally competitive. In our GCI measurements, South Africa shows little evidence of late-stage private equity investments in cleantech, and no IPOs in the sector or public companies in publicly traded cleantech indices. The country also scores low on renewable energy consumption and related clean energy jobs, despite the recent efforts to increase the share of renewables.

Renewable Energy Technology

While the Renewable Energy White Paper (2003) alone had little effect on national energy diversification efforts, the introduction of the renewable energy feed-in tariffs (2009) and the introduction of Independent Power Producers (IPP) competitive bidding process showed successful results in promoting investment and thus installation in the renewables sector. Following this, the Integrated Resource Plan for Electricity (2011) opened up further significant opportunities for foreign investment into renewable energy, and the development of a local renewable energy industry, but the actual binding targets are perceived to be too unambitious. To help the renewables

sector commercialise and expand, the South African Renewables Initiative (2011) has been set up to increase the renewables in the energy mix above the IRP target by leveraging international and domestic finance.

The Solar & Wind Sector Development Strategy (2012) targets investment into these specific technologies, and also offers support to the successful commercialisation of domestic technology in this subsector.

The Biofuels Industrial Strategy (2007) was originally aimed at supporting the development of the South African biofuels sector to cover 50% of renewable energy targets, but has not yielded the expected results. Implementation has now been delayed to 2017. The Strategy will instead fund research and improve the regulatory environment conducive to commercialisation efforts.

A good example of emerging innovation can be found among GCIP alumni that have gained significant market traction.

Solar Turtle develops and produces its mobile power station that provides instant electrification off-grid. Housed in a shipping container, the solar panels are folded out easily, and charge the batteries inside recycled bottles. Users take a bottle home and plug it into their home system, and then exchange it at the Solar Turtle when depleted for a small fee. This off-grid electrification technology additionally contributes 10722 tonnes of CO₂ equivalent of projected GHG savings in 2017 and has added six clean energy jobs to the South African market.

Energy efficiency technology

Technological innovations in the energy efficiency sphere have also been incentivised by the South African government. The National Energy Efficiency Strategy (2005) set a national target for energy efficiency improvement of 12% by 2015, and the related Industrial Energy Efficiency Improvement Project in South Africa (IEE Project) has assisted industry to save over R 1.54 billion in energy savings from large and SME businesses in South Africa.

Transportation

Only recently has the transportation and automotive sector been a target of cleantech policy, with the creation of the National Transport Policy Green Paper and 5-year Green Transport Strategy. Additionally, the Electric Vehicle Industry Roadmap Initiative was started in 2013 to stimulate the electric vehicle industry in South Africa through various incentives. The results of will be known in the next 1-3 years.

Ducere Holdings, a start-up company specialising in product development specific to energy recovery systems for the automotive sector, has successfully produced its pilot MISER Hydraulic Hybrid Transmission System. The company raised USD\$77.600 and now has a revenue projection of USD\$10.6 million in 2017, creating 375 direct jobs.

Water

On top of the general National Water Act and policies guarding universal access to water, the National Water Resource Strategy (2004) highlights the sustainable management of water, and thus drives innovation in the sector. With its consequences of climate change on water resource distribution already being felt, the new Water RDI Roadmap (2015) focuses funds, supports water-related R&D, and strengthens the innovation pipeline in the water cleantech subsector over the next 10 years.

Eco-V combines off-grid electric solar technology with efficient freshwater services. The company's GreenTower hybrid solar technology saves 90% in electricity for water heating, and supports micro-grids that supplement the utility or operate off-grid

by efficiently harnessing energy from the environment. The solution also includes smart LED lighting and greywater recycling while using an IoT approach to enhance performance and improve end-user experience. The company has raised USD\$400.000 for developing their technology further and scaling up to commercialisation.

Waste beneficiation

The National Waste Management Strategy (2011) and accompanying Waste Research Development and Innovation Roadmap have delivered significant contributions to the strengthening of a sustainable, regional secondary resources economy in South Africa.

Thevia manufactures roof tiles made from 99% waste materials (crusher discard and recycled HDPE) that are 25% lighter than concrete tiles and save 8-15% on costs compared to competitors' concrete tiles. The company now employs 85 people, and has revenue projections of more than USD\$800.000 for 2017 due to its commercial success.

THAILAND

Thailand scores below the global average for its cleantech innovation landscape. The main issues prohibiting the development of a thriving cleantech innovation ecosystem appear to be a disconnect between academic research and industry, and an underdeveloped financial landscape.

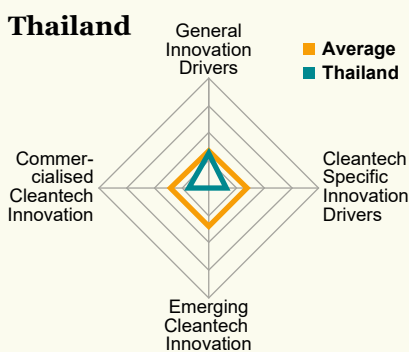


Figure 24: Thailand's performance in the indicator pillars compared to the global average

Ranked In GCII	General Innovation Drivers	Cleantech-specific Innovation Drivers	Emerging Innovation	Commercialised Innovation
+1	France (23 rd)	New Zealand (32 nd)	Argentina (39 th)	Australia (33 rd)
	Thailand	Thailand	Thailand	Thailand
-1	Czech Republic (24 th)	Mexico (33 rd)	Indonesia (40 th)	Bulgaria (35 th)

Figure 25: Thailand's relative positioning in the GCII ranking based on its performance in GCII indicator pillars

Relative Strengths	Relative Weaknesses
Strong early-stage entrepreneurial activity (ranked 11 th of the GEM report)	Low institutional stability and regulatory certainty; difficulty in accessing early-stage finance
Several tax benefits for SMEs and start-ups	Few programs specifically aimed at cleantech start-ups
Government support for R&D projects through grants and tax exemptions	Public cleantech R&D expenditure (0.37% of GDP) is low compared to other Asian nations
Strong academic research culture	Disconnect between academia and the needs of the industry

Figure 26: Thailand's strengths and weaknesses in key indicators

Key Support Mechanisms/Policies

Government funds investing in cleantech

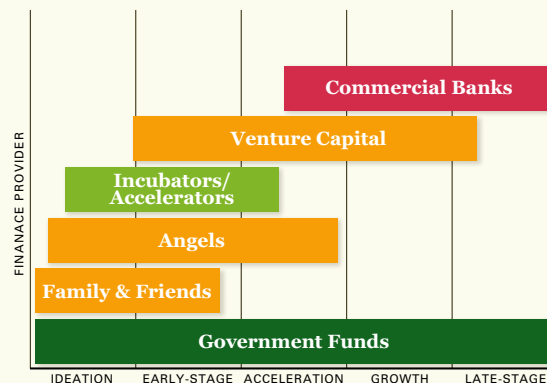
The Thai government has several government investment funds that focus on the development of energy infrastructure and energy conservation measures. The most important ones are the **Energy Conservation Fund** and the **Power Development Fund**. Besides these focused funds, there are also more general public funds that may invest in cleantech applications or cleantech start-ups, such as **Thailand Research Fund**, the **National Science and Technology Development Agency (NTSDA)**, and the **SME Development Fund**.

Science park dedicated to sustainable agriculture and food production

With the opening of the food research cluster, **FoodInnopolis**, Thailand builds on its expertise as an exporter of agricultural products. In particular, Thailand is the world's largest exporter of cassava, and the second largest exporter of sugar. A specific focus of FoodInnopolis is the development of automation and smart farming. FoodInnopolis is located in the Thailand Science Park, located north of Bangkok.

Access to Finance

- The venture capital sphere is present but not well documented. There are around 50 active venture capital investors with a general investment scope in Thailand. There are also some angel investors, including the participating investors in the Delta Angel Fund platform, Bangkok Venture Club, and the Thai Venture Capital Association.
- The NSTDA has set up Business Incubation programs targeting start-ups founded by university graduates. In addition, the accelerator run by the GCIP programme provides the first cleantech-focused support initiative with prize money.
- Government grants, tax exemptions, funds, and loans are available under NSTDA, with an example being the iTAP-Innovation Technology Assistance Program. Thailand’s green funds include the Energy Conservation Fund and Power Development Fund. In addition to those, there are government investment funds with a broader scope, such as the Thailand Research Fund and the SME Development Fund.
- A soft loan facility has been developed between large banks and the government, which aims at bridging the risk-averse culture of commercial banks (e.g. ‘SME revolution’ by SME Bank).



Pillar Analysis

Inputs	
<p>General Innovation Drivers</p> <p>For General Innovation Drivers, Thailand scores just below the the global average, showing a relative strength. Thailand’s performance in the INSEAD Global Innovation Index⁵² is underpinned by high levels of market sophistication, but it gets a low score for its regulatory environment and institutional stability. Thailand has a high early-stage entrepreneurial activity, with most small and medium enterprises operating in established and mature markets. However, Thailand faces issues with perceived opportunities for entrepreneurship. This is mainly due to the difficulties faced by entrepreneurs in securing early-stage financing. The government does provide tax benefits to start-ups. For example, a tax deduction was offered of up to 10% of the net profits for fiscal years 2015 and 2016, and there is a tax deduction specifically for start-ups in the ‘New Growth Engine’ group.</p>	<p>Cleantech-Specific Drivers</p> <p>The Thai policy landscape for cleantech innovation is dominated by the National Science and Technology Development Agency (NSTDA). Thailand only dedicates a small portion of its GDP to cleantech R&D (only 0.37% of GDP in 2011). However, there are several government initiatives that aim to promote private sector R&D. For example, there are improved government procurement procedures for innovative technologies. The government also invests in brick-and-mortar projects, such as the Thailand Science Park and the research cluster FoodInnopolis, which aims to build on Thailand’s expertise as an exporter of agricultural products. Although there are some cleantech investment funds active in Thailand, the amount raised by these funds was small, and they are not as prominently present in the investment landscape as they are in other countries.</p>
Outputs	
<p>Emerging Cleantech</p> <p>The strength of Thailand’s Emerging Cleantech innovation can be illustrated by the number of cleantech-related patents filed in a year. Weighted by GDP, Thai cleantech-related patent activity is low, falling below Armenia and Malaysia.</p> <p>While there is a small amount of early-stage venture capital activity, there are few successful Thai start-ups in the cleantech field, and no Thai company has so far featured on Cleantech Group’s GCT100 shortlist. The GCIP programme and other accelerators provide examples of some Thai cleantech start-ups.</p>	<p>Commercialised Cleantech</p> <p>Thailand’s performance in creating cleantech innovation outputs lies below the global average. There is only limited evidence of late-stage finance activity in the cleantech sector (M&A, IPO and PE activity), indicating the low supply of cleantech start-ups scaling up to commercial levels. Nevertheless, Thailand has some cleantech companies listed in global cleantech indices, like ‘Energy Absolute PCL’, which is evidence of a commercial success. The high renewable energy jobs compared to renewable consumption could be related to current clean energy technology constructions planned through the ambitious national Alternative Energy Development Plan (AEDP).</p>

56 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

Extended Summary

Thailand scores below the global average for its cleantech innovation landscape. The main issues seem to be the disconnect between academic research and the needs of the industry, and an underdeveloped finance landscape.

Inputs to cleantech innovation

General Innovation Drivers

For *General Innovation Drivers*, Thailand scores slightly below the global average. For *General Innovation Drivers*, Thailand scores just below the global average, showing a relative strength. Thailand's performance in the Global Innovation Index⁵⁷ is underpinned by high levels of market sophistication, but it gets a low score for its regulatory environment and institutional stability. Indeed, Thailand's recent political turmoil has had a toll on the Thai business climate. The passing of King Bhumibol Adulyadej, who for many years was a force of stability, is also likely to have an impact.

On the other hand, the country shows high early-stage entrepreneurial activity, with most small and medium enterprises operating in established and mature markets. Still, Thailand faces issues with perceived opportunities for entrepreneurship. This is mainly due to the difficulties faced by entrepreneurs in securing early-stage financing.

Banks are very hesitant to lend to start-ups, as they consider the risk of failure too high. A successful proof-of-concept is often not enough to convince banks to grant the loan, and banks tend to ask for collateral, which many asset-light start-ups are unable to provide. The government has implemented a policy to try to ease the access to private financing. Loans granted to start-ups under the soft loan programme, developed by the NSTDA, are partly underwritten by the government, which de-risks the loan. Several Thai banks participate in this scheme, notably the Government Saving Bank, the SME Bank and the Kasikorn Thai Bank. In another bid to improve access to early-stage finance, there is a tax exemption for investments by certified venture capital firms who invest in the government-defined 'new growth engines'.

The government does provide tax benefits to start-ups. For example, a tax deduction was offered of up to 10% of the net profits for fiscal years 2015 and 2016, and there is a tax deduction specifically for start-ups in the 'New Growth Engine' group. Furthermore, there are exemptions for companies and venture capital investment in some of the ten nationally identified focus groups. These groups include the food and agriculture industry, the clean and renewable energy industry and the advanced materials industry, amongst others. The same benefits apply for R&D and innovation. Given the broad definition of these focus groups, it is likely that many cleantech companies could benefit from these fiscal offerings.

The National Science and Technology Development Agency (NSTDA) gives out start-up vouchers to help start-ups scale up domestically and internationally. The government has also set up a scheme whereby SMEs can deduct R&D expenses for 300%, thereby reducing their revenue tax. Last of all, the National Innovation Agency can grant an 'innovation coupon', which is used specifically for feasibility studies and the first stages of implementation for SMEs.

Cleantech specific innovation drivers

Policy environment

Thailand has some significant overarching cleantech-friendly policies in place. More specific, market-incentivising policies are focused on renewable energy integration,

⁵⁷ INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), *Global Innovation Index*, 2016

of which a renewable feed-in tariff is the most impactful.⁵⁸ In 2016, the government announced plans to set up a national carbon market, specifically with Thailand’s emission reduction targets in the context of the Paris Agreement in mind. This carbon market would only be up-and-running in 2020 at the earliest.⁵⁹ Although there is no current formalised carbon market, there is some over-the counter trading of carbon credits.

Policy Area	
Carbon tax/carbon market	
Clean energy tax incentives; Tax incentives specifically for clean technology companies	✓
Green bonds; government-backed or -owned green investment banks; green investment funds.	
Government investment/loans/grants for climate-friendly and eco-friendly technology	✓
Transport obligation; Transportation efficiency or emissions standards	✓
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	✓
Government tendering/ green procurement	✓
Research institutes or government support university programs for clean technologies	✓

The Thai policy landscape for cleantech innovation is dominated by the National Science and Technology Development Agency (NSTDA). A recent project (2017) has directly approached the cleantech sphere, aiming at developing more direct incentives promoting Thailand’s cleantech innovation ecosystem, which results are still to be shown. The National Innovation Agency is involved with innovation on a more general level.

Thailand only dedicates a small portion of its GDP to cleantech R&D (only 0.37% of GDP in 2011).⁶⁰ However, there are several government initiatives that aim to promote private sector R&D. For example, there are improved government procurement procedures for innovative technologies. The NSTDA has also put in place a Business Incubator Centre (BIC) that targets university students and recent graduates. The BIC can guide start-ups through three different stages, namely pre-incubation, incubation and post-incubation. The Centre organises university roadshows and start-up weekends in order to attract new talent. However, cleantech-specific accelerator and incubators are still lacking. Government funds that deal specifically with renewable energy are the Energy Conservation Fund and the Power Development Fund.

The NSTDA also runs the Innovation Technology Assistance Program (ITAP), which targets majority Thai-owned enterprises that focus on the development of production technologies. The ITAP provides consulting services to Thai SMEs on issues such as recruiting, project tracking and business development.⁶¹ Furthermore, the ITAP has grants for specific projects, and can fund up to 50% of project costs.

Finally, the government also invests in brick-and-mortar projects, such as the Thailand Science Park and the food research cluster FoodInnopolis, which aims to build on Thailand’s expertise as an exporter of agricultural products. Both projects are located north of Bangkok.

⁵⁸ For an overview of Thailand’s renewable energy policies, see: <https://www.iea.org/policiesandmeasures/renewableenergy/?country=Thailand>.

⁵⁹ <https://carbon-pulse.com/18021/>

⁶⁰ <http://www.sti.or.th/apnisforum/download/THAILAND-STI-Profile-2014.pdf>

⁶¹ <http://www.sciencepark.or.th/index.php/en/innovation-technology-assistance-program-itap>

The mobility of skilled labour and researchers is crucial in an effective innovation ecosystem, as it prevents the development of silos and ensures that the right people are in the right place. However, there is an inherent mismatch in Thailand between the placement of highly skilled academics and where they are needed. Eighty-three percent of research personnel work in higher education institutions or governmental agencies, leaving seventeen percent to work in the private sector. The industry has little links to academia and the government and is unable to attract this talent. Moreover, many researchers lack the incentive to make the switch to the industry, because of less stable employment conditions in the industry.⁶² To combat this mismatch, the Thai government has developed the ‘talent mobility’ program, whereby researchers can move into the industry for a dedicated period of time.

Access to finance

Private sources of capital

Angel investors: There are some angel investors, including the participating investors in the Delta Angel Fund platform. The major angel investor networks are the Bangkok Venture Club and the Thai Venture Capital Association.

Venture Capital: The private venture capital sphere is present but not well documented. One active regional fund in the cleantech sphere is East Ventures, with more than 50 other general Thai VC firms also present.⁶³

Corporate venture capital: Private sector funds (corporate finance) aimed at financing R&D and early-stage SMEs include the Dtac innovation fund and accelerator and the SCG Innovation fund.

Public sources of capital

Public incubators & accelerators: The NSTDA has set up a Business Incubator Centre targeting start-ups formed by university graduates. Another accelerator run by the UNIDO GCIP programme provides the first cleantech-focused support initiative with prize money.

Public Venture Capital Funds: There is a large government VC Fund, managed by three private banks.

Corporate Venture Capital: Corporate involvement in start-up financing is not common and has potential for growth.

Government finance: There are grants available under the ITAP program. Thailand has several green investment funds like the Energy Conservation Fund and Power Development Fund. In addition to this, there are government investment funds with a broader scope, such as the Thailand Research Fund, the NSTDA, and the SME Development Fund. These provide a significant source of capital for cleantech start-ups, compared to the private sector.

Commercial banks and government: A soft loan facility has been developed between Government Saving Bank, SME Bank and Kasikorn Thai Bank, as well as the NSTDA.

Outputs of cleantech innovation

Emerging Cleantech innovation

The strength of Thailand’s *Emerging Cleantech* innovation can be illustrated by the number of cleantech-related patents filed in a year (2013). Weighted by GDP, Thai cleantech-related patent activity is low, falling below Armenia and Malaysia. While there is a small amount of early-stage venture capital activity, there are few successful

⁶² http://mddb.apec.org/documents/2012/ISTWG/DIA2/12_istwg43_dia_004.pdf

⁶³ <http://pugnatorius.com/vc/>

Thai start-ups in the cleantech field, and no Thai company has so far featured on the GCT100 shortlist.

The GCIP programme and other accelerators provide examples of some Thai cleantech start-ups.

Commercialised Cleantech innovation

Thailand's performance in creating *cleantech innovation outputs* lies below the global average. There is only limited evidence of late-stage finance activity in the cleantech sector (M&A, IPO and private equity activity), indicating the low supply of cleantech start-ups scaling up to commercial levels. As a net-cleantech-importer by our calculations, Thailand shows some significant cleantech commodity demand from abroad that isn't met by domestic production. This supports the observation that most clean technology at present does not originate from scaled-up domestic innovation, but rather is imported (and partly managed) by other countries that have a more mature cleantech sector.

Nevertheless, Thailand has some cleantech companies listed in global cleantech indices like 'Energy Absolute PCL', 'SPCG PCL' and 'Superblock PCL', which is evidence of some commercial success of cleantech in the country. This is, however, limited to these few large corporations and does not mirror Thailand's wider cleantech ecosystem.

The high renewable energy jobs compared to renewable consumption figures (2016) could be related to current clean energy technology constructions planned through the ambitious national **Alternative Energy Development Plan (AEDP 2015)**.

Cellenium has developed an innovative form of battery storage based on vanadium, and has raised over USD\$10 million in investment. With the market for energy storage starting to take off, Cellenium has good growth prospects. The company has been nicknamed 'the Tesla of Thailand' and has garnered significant media attention, featuring in the Financial Times amongst others.

TURKEY

The Turkish government has identified cleantech as one of the core areas of innovation for the coming years. However, the current innovation environment is not in good shape, with low levels of emerging cleantech innovation in particular. The amount of early-stage finance is relatively low, despite the presence of several venture capital funds and corporate venture capital investors. Turkey has a large and decentralised R&D infrastructure, but so far the effectiveness of this R&D has remained limited.

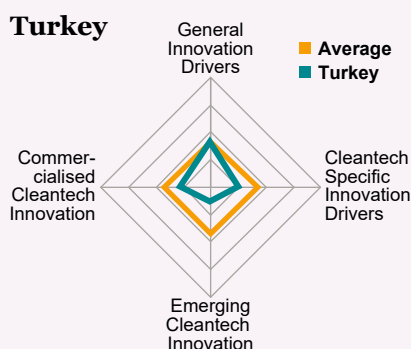


Figure 27: Turkey's performance in the indicator pillars, compared to the global average

Ranked In GCII	General Innovation Drivers	Cleantech-specific Innovation Drivers	Emerging Innovation	Commercialised Innovation
+1	Belgium (21 st)	Czech Republic (35 th)	Mexico (37 th)	Romania (31 st)
	Turkey (22 nd)	Turkey (36 th)	Turkey (38 th)	Turkey (32 nd)
-1	France (23 rd)	Greece (37 th)	Argentina (39 th)	Australia (33 rd)

Figure 28: Turkey's relative positioning in the GCII ranking based on its performance in GCII indicator pillars

Relative Strengths	Relative Weaknesses
Perceived entrepreneurial opportunities: 49.6% of population in their area of residence	INSEAD Global Innovation Index: rank 42/128, ⁶¹ mainly due to political and economic instability and low innovation linkages
Large network of support organisations for entrepreneurs (e.g. Chambers of Commerce)	Turkish culture discourages risk-taking
Decentralised R&D network with large geographical spread	Low R&D effectiveness; low patent registrations and start-up activity
Relatively large presence of VCs and corporate ventures	Amount invested by VCs and corporate ventures is quite low

Figure 29: Turkey's strengths and weaknesses in key indicators

Key Support Mechanisms/Policies

Turkey has 63 **science parks** scattered around the country. The main cluster is the **OSTIM** renewable energy and environmental technologies cluster, which gathers 50 companies on a campus located in the outskirts of Ankara. Turkey also has a wide network of 59 **Technology Transfer Offices (TTO)** that assist universities and public research organizations in managing their intellectual property in order to facilitate the conversion of these discoveries into real-life innovations.

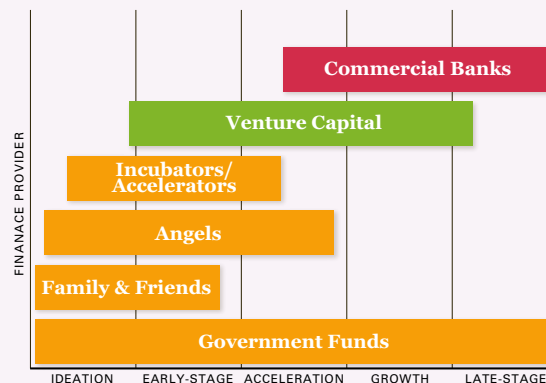
Incubators and accelerators driving the cleantech ecosystem in Turkey

Private accelerators and incubators are not as common to the Turkish start-up finance sphere, but **Viveka** and **e-tohum**, **StartersHub**, **Kworks**, **Startupbooth Camp** and **Stage-Co** can be cited as successful private incubators. Twenty of the 59 **TTOs** mentioned above also run incubator programs.

64 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), Global Innovation Index, 2016

Access to Finance

- There are 16 official active angel networks in Turkey, with the most active being Galata Business Angels, BIC Angels and Keiretsu Turkey.
- Private accelerators and incubators exist, but are not widespread.
- Venture capital investment in Turkey is available, but there is no focus on cleantech start-ups. There are 21 venture capital investors, combining both domestic and international investors targeting Turkey.
- Corporate interest in financing start-ups exists, with 16 active corporate venture capital arms based in Turkey.
- TEB bank has an SME financing division; however, banks are risk-averse and thus cleantech start-up access to finance is inhibited by unrealistic credit criteria.
- Some TTOs in Turkey also act as public incubators or accelerators, providing small opportunities for funding and general support. The GCIP programme also provides support and prize funding for cleantech start-ups in Turkey.
- Additionally, the Turkey Technology Development Foundation (TTGV) has interest-free payback credits for environmentally-related projects of a maximum of USD\$1 million, and the Ministry of Science, Industry and Technology gives grants to aspiring entrepreneurs.



Pillar Analysis

Inputs	
<p>General Innovation Drivers</p> <p>Turkey has a relatively poor innovation ecosystem. This is mainly due to political and economic instability, regulatory uncertainty, and a disconnect between research institutions and the industry. Despite these adverse conditions, Turkey has a lot of early-stage entrepreneurship and high perceived opportunities for entrepreneurship. The concept of risk-taking and the possibility of failure, which are inherent to the concept of entrepreneurship, are not well accepted in Turkish society. Stability and the guarantee of a steady income are still the preferred way of life. While setting up a business can be hard, Turkey has an extensive network of business organisations and industry clusters.</p>	<p>Cleantech-Specific Drivers</p> <p>The Ministry of Science, Industry and Innovation has outlined innovation in cleantech as one of the focus points of the industrial strategy, and TÜB TAK, the Scientific and Technical Research Council, also treats it as a core innovation track. In 2015, R&D expenditure represented 1.06% of GDP, a 17% increase compared to the 2014 budget. Turkey has a highly decentralised R&D network, with 63 science parks scattered around the country. Turkey also has a wide network of Technology Transfer Offices (TTOs), whose common core role is to assist public research organizations in managing their intellectual assets in ways that facilitate their conversion into benefits for society.</p>
Outputs	
<p>Emerging Cleantech</p> <p>Despite its extensive research network, Turkey has low environmental patent activity, finishing below Saudi Arabia on a global comparison. There are only a few successful Turkish cleantech start-ups that have advanced past the early-funding stage. No Turkish companies were included in CTG's Global Cleantech 100 shortlist over the past three years. Despite the relatively high presence of venture capital firms, the amount invested in cleantech start-ups by these investors, compared to the GDP, remains low.</p>	<p>Commercialised Cleantech</p> <p>Whilst still well under the global average, the country shows some evidence for commercialised cleantech innovation, mainly attributable to its cleantech commodity imports. These imports are most likely explained by the increase in renewable energy capacity that Turkey is experiencing.</p> <p>Turkey's very low export figures for cleantech commodities are another indication that the country faces difficulties in transforming its innovation inputs into commercialised products. Late-stage financing in Turkey, such as M&A, IPO and PE activity, is low and has been falling for two years, due to political and economic instability. There are no Turkish public companies that are listed in any of the major international cleantech indices, an indication that commercialisation of Turkey's cleantech innovations is nascent.</p>

Extended Summary

The Turkish government has identified cleantech as one of the core areas of innovation for the coming years. However, the current innovation environment is not in good shape, with low levels of emerging cleantech innovation in particular. The amount of early-stage finance is relatively low, despite the presence of several venture capital funds and corporate venture capital investors. Turkey has a large and decentralised R&D infrastructure, but so far the effectiveness of this R&D has remained limited.

Inputs to innovation

General Innovation Drivers

Turkey has a relatively low Global Innovation Index score.⁶⁵ This is mainly due to political and economic instability, regulatory uncertainty, and the disconnect between research institutions and the industry. Despite these adverse conditions, Turkey has a lot of early-stage entrepreneurship and high perceived opportunities for entrepreneurship. The Ministry of National Education has developed courses on education and innovation, and some universities have centres on entrepreneurship. The Small and Medium Enterprises Development Organization of Turkey (KOSGEB) provides a whole range of services to SMEs and start-ups.

The concept of risk-taking and the possibility of failure, which are inherent to the concept of entrepreneurship, are not well accepted in Turkish society. Stability and the guarantee of a steady income are still the preferred way of life. The main concern of Turkish entrepreneurs is more government aid for the training of entrepreneurs and the strengthening of entrepreneurial culture. Turkey ranked 69th out of the 190 countries surveyed in the World Bank 'Ease of Business' report. Setting up a company in Turkey takes 6.5 days, which is quite long compared to the other UNIDO countries.

While setting up a business can be hard, Turkey has an extensive network of business organisations and industry gatherings to fall back on. Examples are the Turkish Foundation for Small and Medium Businesses (TOSYOV), the Union of Chambers and Commodity Exchanges of Turkey (TOBB), Endeavour Turkey, the Turkish Entrepreneurship Foundation (Girvak), KAGİDER (The Women Entrepreneurs Association of Turkey), TEPAV (The Economic Policy Research Foundation of Turkey), TİM (Turkish Exporters Assembly), and TÜSİAD (Turkish Industry and Business Association).

65 INSEAD, Cornell University, World Intellectual Property Organisation (WIPO), *Global Innovation Index*, 2016

Cleantech-Specific Drivers

Policy Area	
Carbon tax/carbon market	
Clean energy tax incentives; Tax incentives specifically for clean technology companies	
Green bonds; government-backed or -owned green investment banks; green investment funds.	
Government investment/loans/grants for climate-friendly and eco-friendly technology	
Transport obligation; Transportation efficiency or emissions standards	✓
Renewable energy standard and/or feed-in tariffs; Electric utility quota obligation	✓
Government tendering/ green procurement	✓
Research institutes or government support university programs for clean technologies	

The Ministry of Science, Industry and Innovation has outlined innovation in cleantech as one of the focus points in the industrial strategy, and TÜBİTAK, the Scientific and Technical Research Council, also treats it as a core innovation track. The government has a few policies in place that favour cleantech innovation. This includes an umbrella law on energy efficiency, which deals with the certification and support of renewable energy resources. However, the effectiveness of this law is debated, as Turkey still relies heavily on cheap, imported fossil fuels for its energy needs. Further cleantech-policy adoption has occurred with the introduction of European Emission Standards for road vehicles 4 and 5 on a voluntary basis. In commodity markets, The Exporters Union offers environment-related certification. For market-based emissions policy, in 2011 the Ministry of the Environment and Urbanization commissioned some studies on the development of a carbon market in Turkey, with the goal to have a functioning carbon market in 2015. However, as of April 2017, there is no carbon market in Turkey.

In 2015, R&D expenditure represented 1.06% of GDP, a 17% increase compared to the 2014 budget. Turkey has a highly decentralised R&D network, with 63 science parks scattered around the country. The main cluster is the OSTIM renewable energy and environmental technologies cluster, which gathers 50 companies on a campus located in the outskirts of Ankara. Turkey also has a wide network of Technology Transfer Offices (TTOs), whose common role is to assist public research organizations in managing their intellectual assets in ways that facilitate conversion into benefits for society. There are 59 TTOs in Turkey, of which 41 are supported by TÜBİTAK. Twenty of those TTOs also run incubator programs.

Major Turkish universities, such as the Middle East Technical University (METU) and the Istanbul Technical University (İTÜ), have research institutes that are dedicated to renewable energy. However, there is a disconnect between academia and the industry, and academic breakthroughs are not easily commercialised.

The national R&D support law includes some tax exemptions for innovative companies, such as the possibility to deduct R&D and design expenditures and the exemption from stamp duty for R&D activities.

Volt, a ride sharing service focused on Istanbul, has raised over USD\$1 million. Volt has received funding from Turkish as well as Middle-Eastern investors. In its home market of Istanbul, it will compete with Careem, a Dubai-based ride sharing company that is the market leader in the wider MENA region.

Promatech, a spin off from the Istanbul Technical University ARI Teknokent in 2010, started as a R&D company focused on improving efficiencies in the maritime and shipping industry, and has since developed its CLEANWAVE and VPARS products. CLEANWAVE is a patented wave energy convertor, and VPARS is shipping route performance analysis service that helps track vessel routes' fuel consumption to improve efficiencies. The product development so far has involved funding from the Technological Research Council of Turkey (TUBITAK) and small/ medium enterprise partners, but no private investment.

NG Biyoteknoloji (Biotechnology) develops, manufactures and sells microbial products for bioremediation of organic pollutants in land and water. This product has been tested and launched to agricultural farmers, allowing their certification as 'best practices' farming. As a finalist of GCIP Turkey in 2016, the company is still in the early stage of its financing. However, since its founding in 2014, the company has raised USD\$160,000 by TUBITAK and an additional USD\$300,000 in personal/family & friends funds.

Positive Enerji (Positive Energy), a developer of IoT devices and software to optimize the functional efficiency of industrial buildings and smart homes, won the GCIP 2015 competition in Turkey. The company is commercialising its products and has partnered with WEMS international and AERECO to help accelerate its scale-up.

Kodeco is the developer of Ecotour, an emissions-free, solar-self-powered passenger car that does not need to attach itself to any charging stations. The company also featured among the GCIP Turkey finalists in 2015. At the moment, its applications range from vacation villages to factories to nature parks.

Access to finance

Private sources of capital

1. **Friends & family:** This may exist in early-stage, but is not centralised nor incentivised by the government
2. **Angel investors:** There are 16 active angel networks in Turkey, with the most active being Galata Business Angels, BIC Angels and Keiretsu Turkey.
3. **Accelerators & Incubators:** Private accelerators and incubators are not as common to the Turkish start-up finance sphere. Viveka and e-tohum are two good examples of the few that exist.
4. **Venture capital:** Venture capital investment in Turkey is available, but limited for cleantech start-ups. There are 21 VCs, both Turkish and international, operating in Turkey.
5. **Corporate venture capital:** Corporate interest in financing start-ups is carried out mainly via established corporate venture arms. Sixteen of those are active in the start-up sphere in Turkey.
6. **Commercial banks:** TEB bank has an SME financing division; however, banks are risk-averse and thus cleantech start-up access to finance is inhibited by unrealistic credit criteria.

Public sources of capital

1. **Accelerators & Incubators:** Some TTOs in Turkey also act as public incubators and/or accelerators, providing small opportunities for funding and general support. The GCIP programme also provides support and prize funding for cleantech start-ups in Turkey.
2. **Government Programs:** The Turkey Technology Development Foundation (TTGV) has interest-free payback credits for environment-related projects of a maximum of USD\$1 million, and the Ministry of Science, Industry and Technology gives out grants to aspiring entrepreneurs.

Outputs to innovation

Emerging Cleantech innovation

Despite its extensive research network, Turkey has low environmental patent activity, finishing below Saudi Arabia when compared globally. There are a small number of successful Turkish cleantech start-ups that have advanced past the early-funding stage.

Commercialised Cleantech innovation

Whilst still well under the global average, Turkey shows some evidence for *Commercialised Cleantech innovation*, mainly attributable to its cleantech commodity imports. These imports are most likely explained by the increase in renewable energy capacity that Turkey is experiencing. The country has a large potential for wind energy in particular. If this shift towards renewable energy continues, we can expect to see a parallel increase in Turkey's imports of cleantech commodities.

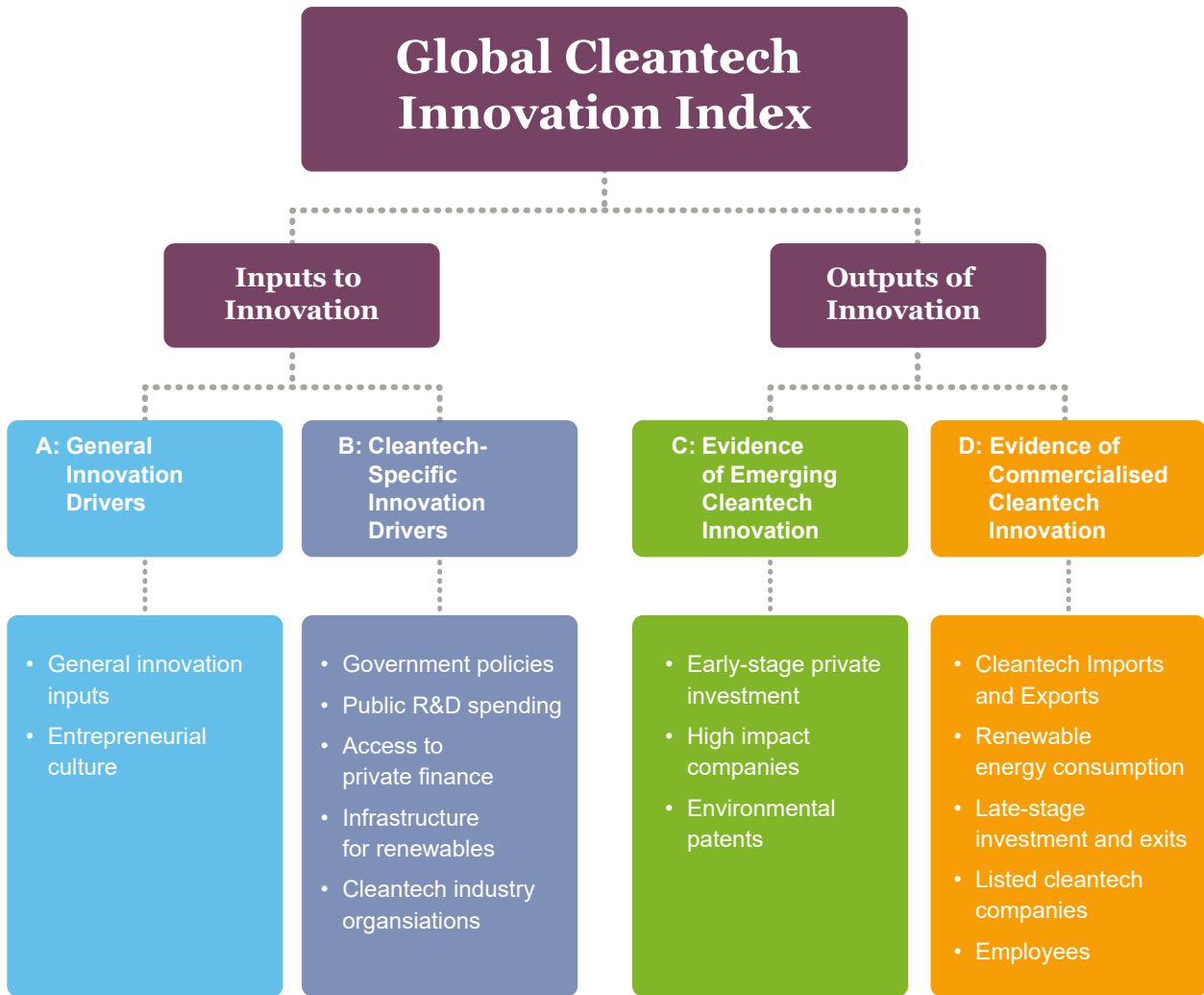
Turkey's very low export figures for cleantech commodities are another indication that the country faces difficulties in transforming its innovation inputs into commercialised companies and products. Late-stage financing in Turkey, such as M&A, IPO and PE activity, is low and has been falling for two years, due to political and economic instability.⁶⁶ There are no Turkish public companies that are listed in any of the major publicly-traded international cleantech indices, an indication that the commercialisation of Turkey's cleantech innovations is largely nascent.

⁶⁶ Deloitte Annual Turkish M&A review, <https://www2.deloitte.com/content/dam/Deloitte/tr/Documents/mergers-acquisitions/annual-turkish-ma-review-january-2017-final.pdf>

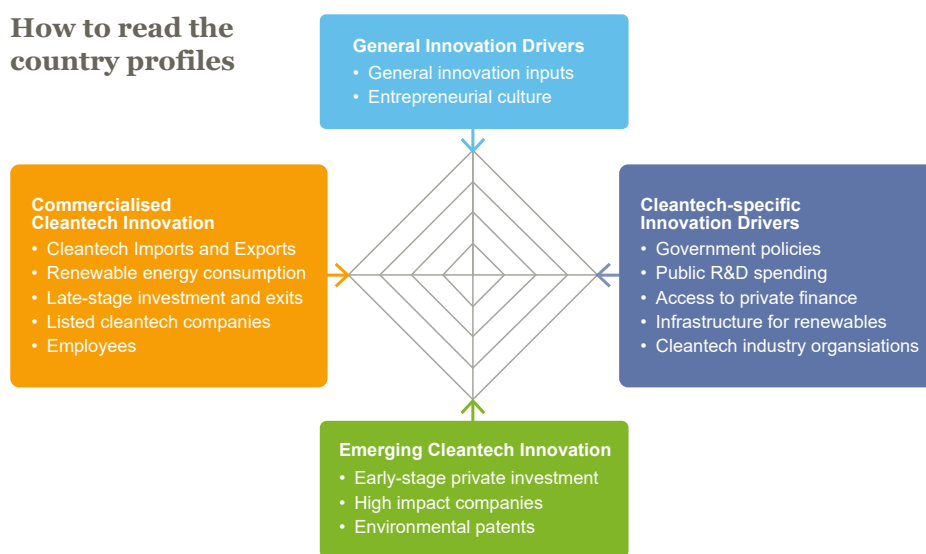


A solar cooker being used to cook food at the offices of WWF India, in Delhi, India.

APPENDIX – METHODOLOGICAL FRAMEWORK OF THE GCII



How to read the country profiles



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The Global Cleantech Innovation Index 2017

Global Cleantech Innovation Programme (GCIP) Country Innovation Profiles

**CATALYSING INNOVATION AND ENTREPRENEURSHIP
IN CLEANTECH START-UPS AND SMES OF EMERGING
ECONOMIES TO PROTECT THE GLOBAL COMMONS**

This report investigates the 8 partner countries of the Global Cleantech Innovation Programme (GCIP). The GCIP is an initiative of UNIDO and the Global Environment Facility conducted Armenia, India, Malaysia, Morocco, Pakistan, South Africa, Thailand and Turkey. The GCIP aims to foster innovation and entrepreneurship ecosystems, and to catalyze investment to support and accelerate start-up entrepreneurs towards the development and commercialisation of cleantech solutions to protect our global commons.

The report uses the Global Cleantech Innovation Index ecosystem framework that has been published 2012, 2014 and 2017.

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