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The Global Cleantech Innovation Index 2014

NURTURING TOMORROW'S TRANSFORMATIVE ENTREPRENEURS

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Cleantech Group's clients – corporations, utilities, government agencies, and investors – recognize that innovating is crucial to business growth, yet can be challenging to pursue. The company partners with its clients to accelerate innovation. With more than a decade of experience covering 18 sectors of resource technologies, Cleantech Group is uniquely positioned to guide clients along their innovation journey through three lines of business. The i3 platform allows subscribers to discover and vet companies, as well as explore technology sector trends strategically using proprietary real-time data. Cleantech Forums, held around the globe, convene investors, entrepreneurs, and international policy makers to examine trends, develop innovation strategies, and make deals happen. The firm's Advisory Services help clients design and implement corporate strategies for sustainable growth and innovation sourcing, and then market the results.

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WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global network active in more than 100 countries. WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

The Global Climate and Energy Initiative (GCEI) is WWF's global programme addressing climate change and a move to 100 percent renewable energy through engagement with business, promoting renewable and sustainable energy, scaling green finance and working nationally and internationally on low carbon frameworks. The team is based over three hubs – Mexico, South Africa and Belgium.

www.panda.org/climateandenergy

About Tillväxtverket

The Swedish Agency for Economic and Regional Growth (Tillväxtverket) aims to strengthen the competitiveness of Swedish companies in the global economy by facilitating entrepreneurship and creating attractive environments for business in Swedish regions. Based on knowledge of the needs of businesses and regions, Tillväxtverket builds networks to facilitate cooperation and finance efforts to boost economic growth. One task for the Agency is to support small and medium sized enterprises with fully developed green goods and services in their business development. The aim of the financial support is to strengthen their competitiveness in domestic and international markets.

The Swedish Agency for Economic and Regional Growth *(Tillväxtverket)* is an agency of the Ministry of Enterprise, Energy and Communications.

For further information:
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EXECUTIVE SUMMARY

This report investigates the countries where 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 same question as the 2012 Global Cleantech Innovation Index, namely: *which countries currently have the greatest potential to produce entrepreneurial cleantech start-up companies which will commercialise clean technology innovations over the next 10 years?*

- 40 countries were evaluated on 15 indicators related to the creation, commercialisation and growth of cleantech start-ups.
- Israel topped the 2014 index, with its relative outperformance on the measure of start-up companies per capita being a key reason that it did so. The country generates the culture, education and 'chutzpah'[1] necessary to breed innovation, plus it has the survival instincts to manage a resource-constrained geography.
- Finland took second place in recognition of the clear efforts the country is making to mobilize its workforce towards sustainable innovation. Finland is also developing novel innovation approaches to access larger, cleantech hungry markets in other geographies.
- USA came in third place in the 2014 index, with its clean technology start-ups clearly attracting the most venture capital on an absolute basis. However, in the past few years, there have been more cleantech funds set up to invest in China than for any other part of the world, with capital inflows expecting to rival that of the U.S. in the years to come.
- All of the top 10 countries in the index are relatively good at early stage cleantech development but share a common challenge in increasing commercialisation rates. Denmark, however, stands out for producing a large number of mature, publicly-listed cleantech companies relative to the size of its economy.
- While China, India and Brazil currently fall outside of the top bracket of start-up generators in the index, their rank is likely to rise in the years to come as they possess a strong climate for growth and development, high levels of pollution, or resource drivers to commercialise cleantech innovation.
- Even the so called 'laggards' in the index (e.g. Russia, Saudi Arabia) are beginning to implement supporting structures for sustainable innovation – in order to hedge against the realities of limited conventional energy sources in the long-term.
- Overall, this index demonstrates that countries will get ahead if they 1) are able to adapt to growing demand for renewables (at home and abroad); 2) are connecting start-ups with multiple channels to increase their success rates and; 3) are increasing international engagement to spur widespread adoption of clean technologies.
- Overall the index shows countries that put significant resources into supporting cleantech innovation are rewarded with more emerging and commercialised cleantech companies, validating the approach many governments have taken to actively promote cleantech innovation nationally.

1 Hebrew/Yiddish slang word to mean someone that is brave and takes risks

FOREWORD

The science is clear that, after two centuries of burning fossil fuels and emitting greenhouse gases at an exponentially increasing rate, the earth's climate is changing. Anthropogenic warming is disrupting a number of natural systems on which we depend, with predicted effects of temperature increases above 2°C to include more extreme weather events, sea level rises, precipitation changes, disappearing coral reefs and ocean acidification. International climate change negotiations are not delivering sufficiently on the challenge to avoid catastrophic climate change, which make accelerated investments in solutions by business, financial institutions, countries and cities even more crucial.

Current trends of energy investments fall well short of the amount needed to avoid dangerous global warming. And policies in place are insufficient to give guidance to investors. The private sector must start shifting investments from dirty fossil fuels into sustainable energy within the context of consistent policies needed to steer private financing for renewables and energy efficiency. Investments of about $U.S. 2 trillion annually by 2035, will be required for both energy efficiency and clean energy.[2] Currently, the world invests less than $U.S. 400 billion in clean energy while all fossil fuel investments have grown to around $U.S. 1.1 trillion in 2013,[3] and fossil fuel subsidies account for another $U.S. 2 trillion. In 2012 alone, the 200 largest publicly traded fossil fuel companies collectively spent an estimated $U.S. 674 billion on finding and developing new reserves – reserves that cannot be utilized without breaking the world's carbon budget and without becoming useless assets in a scenario where we avoid catastrophic climate change.[4]

It is becoming clear to investors that there is a lot of money backing up the problem that can be shifted to support the solutions. Moreover, it is increasingly clear that renewables must assume the full share of the global energy supply market fairly shortly in order to avoid 2°C global warming whilst preventing major water pollution, hazardous waste for generations, poor human health, proliferation of nuclear weapons and unnecessarily high costs.

Solutions do exist and can be enacted with the right combination of political, social and financial will. WWF's Energy Report shows that all of the world's energy needs could be provided cleanly and renewably by the year 2050, in ways that can be sustained by the global economy and the planet, and that such a transition is not only possible but cost-effective.[5] However, the major innovation challenges ahead include the acceleration of business models that take solutions to market and the continuous cost-cutting of key technologies.

2 World Energy Investment Outlook, IEA, 2014
3 World Energy Investment Outlook, IEA, 2014
4 Unburnable Carbon – Are the world's financial markets carrying a carbon bubble?, Carbon Tracker Initiative, 2011
5 The Energy Report – 100% Renewables by 2050, WWF, 2011

In order to accelerate progress we need to look at the conditions surrounding our large and small solution providers. We will need to see a wide range of innovative cleantech solutions quickly scale up over the next 10-30 years. Agencies, governments, investors and business need to proactively collaborate as forces for change in transitioning towards a sustainable energy future on a global level. Understanding these innovation processes is important in order to accelerate increase of the "good" as a complement to the establishment of national climate targets and carbon caps that address a more rapid decrease of the "bad."

Tracking the innovation activity of smaller cleantech disruptors that carry the hope of enabling a shift to more Good solutions is the impetus for this Global Cleantech Innovation Index. We must join hands in creating a more attractive future for all and be clear to decision-makers that we are ready and able to do so.

Samantha Smith

Leader, WWF Global
Climate and Energy Initiative

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INTRODUCTION

With the world's population projected to increase to over nine billion by 2040, sustainable innovation will surely continue to go mainstream in the upcoming years, in order to enable the world to re-use and share the earth's finite resources. 'Business-as-usual' scenarios of coal mining, oil production, air, land and water pollution, will only continue to result in security, health and ecological damage. As an illustrative example, it is estimated that 1.3 million people die every year from urban outdoor air pollution originated from air pollutants such as So2, NOx, heavy metals, or black carbon.[6] As such, global energy and environmental challenges of the next ten to fifty years will require multi-dimensional innovative solutions.

Policy makers and large enterprises alike are aware of the potential benefits of curating clean technology start-ups, and are viewing sustainable innovation as an additional source of employment and revenue growth. The investor community has also been a driving force - investing over $41 billion of venture capital into cleantech start-ups in the last five years[7] – almost double the amount of the previous five years. However, the next wave of cleantech businesses will require more than just capital and policy backing to grow – the industry will need to build relationships with local and international partners to bring them to desirable scale.

The Global Cleantech Innovation Index explores the question of where sustainable innovation companies are being created across the globe, as well as how well their products are being commercialised. This index, first produced in 2012, remains the only study (we know of) seeking to look at why entrepreneurial companies developing sustainable innovations, seem to spring up in certain geographies, and which economic, social and environmental conditions cultivate hotbeds for such innovation. All countries can do the workout needed to improve their conditions in the decades to come, especially if they can emulate and learn from the strengths of other countries in generating and commercialising innovation. Several countries are on the right track, landing 'above the curve' compared to others, but it is clear that even the top performers still need to address their weaknesses, in order to effectively support cleantech companies right through their later stages of development.

It is worth telling the tale of countries that are disproportionately producing innovative start-ups compared to their economic size, at a time when technological breakthroughs are difficult to size to true multi-national scale (with only a few such case studies today). This report can provide valuable insight for policy makers, entrepreneurs, investors and industry actors alike who are interested to understand the global landscape of cleantech innovation, and to gain inspiration from various archetypes in different parts of the world. We hope that this study will challenge you to facilitate discussion on supporting the next stage of cleantech innovation in your respective countries.

We hope you find it thought provoking.

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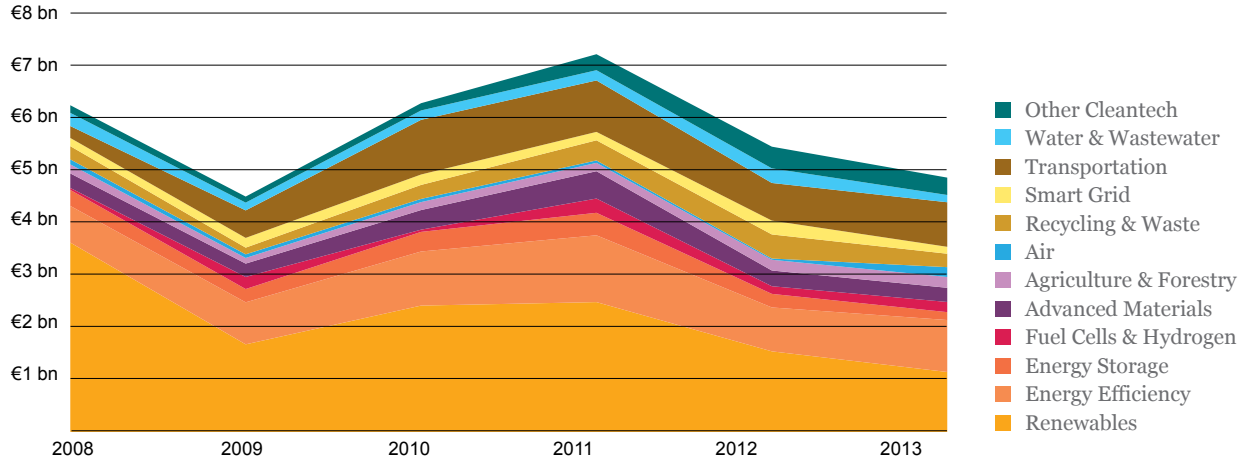
June 2014

6 WHO. "Air Quality and Health." Media Centre, September 2011.
7 Data from Cleantech Group's i3 connect platform

The Global Cleantech Story: Evolution

Originally thought of as a venture capital investment niche theme, cleantech is growing up – and now permeates all realms of the economy, impacting industries as diverse as ICT, Healthcare, Food, Electronics, Chemicals and Retail. The term has been used interchangeably with 'resource innovation', 'industrial efficiency', 'sustainable technology', but all essentially have the same meaning – doing more with less (e.g. fewer materials, less energy expenditure, reduced water availability), while making money doing so.[8] For a time, it seemed like cleantech was associated almost exclusively with the energy realm (renewable energy, energy efficiency), but its true and wider meaning is now proliferating, increasingly linked to solving ever more prominent world challenges – such as clean water availability, sustainable food sourcing, land and air pollution, and low carbon transportation. Cleantech venture capital is still primarily made up of energy-related technologies (51 percent in 2013), though much less so compared to 77 percent in 2010, and much more of the energy element is around efficiencies, as opposed to renewables generation. This is partially explained by other cleantech sectors gaining favour (as shown in Figure 1 below), as well as 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, in addition to some high-profile bankruptcies in the U.S. and Europe.

Figure 1: Global Venture and Growth Equity Investment in Cleantech companies, 2008 - 2013



*Includes seed, series A, series B, growth equity

SOURCE: CLEANTECH GROUP'S I3 CONNECT PLATFORM

The other clear explanation for less venture stage investment in renewable areas like solar and wind is simply that they have 'grown up.' Production costs have decreased to an unprecedented level, making unsubsidized grid parity a very real prospect for a number of countries (already 19 countries have reached grid parity). For this reason, the better measure of renewables' growth trajectory is in deployment statistics: for example, renewable energy accounted for over half of the new electricity-generating capacity added globally in 2012[9] and by 2021, global cumulative installed solar PV capacity is forecasted to surpass 700GW; 7 times today's capacity.[10] Just like the

8 Nuclear and fossil fuels have been excluded from any calculations in the index.
9 IPCC WGIII on Mitigation, April 2014
10 CleanEdge Clean Energy Trends Report 2014

electronics industry, solar and wind power companies are driving prices sharply downwards, and will make conventional fuels a less attractive proposition in the future. For this reason, annual global project finance investment in renewables is projected to reach $400 to $500 billion by 2020.[11] Some sovereign wealth funds, university endowments and other institutional investors are already divesting from fossil fuel stocks, citing both moral (the danger they place on rising CO2 levels), and financial reasons, given their potential to be over-valued assets in the long run.[12] The medium to long term risks of only holding coal, oil, gas and nuclear in global energy portfolios are no longer being ignored, as over 119 countries across the globe have enacted targets for renewables supply by 2020, 2030, and 2050.[13] Further, several countries are considering reducing public expenditure on subsidized fossil fuels to 'level the playing field.' High renewables scenarios have also gained credibility over recent years (with projections of 50-95 percent energy share of renewables by 2050 not uncommon), with Denmark the early pioneer, setting a 100 percent renewables target by 2050.[14]

Just a decade ago, cleantech was primarily associated with small startups. Now, sales of products from across the aggregated clean technology portfolio will rival the oil and gas equipment market by 2015, by which time the market size is forecast to be between $330 and $390 billion.[15] Already, we see evidence of emergent, well-branded, companies seeking to lock in dominant positions in the changing energy world – pioneers today include Tesla (the U.S. luxury electric vehicle maker), Hanergy (the Chinese developer of hydro, solar and wind power projects) and Suzlon (Indian manufacturer of wind power turbines). Though they have had their fair share of ups and downs, public markets have also opened up to clean technology funds, with an increasing presence of clean energy and water indices (e.g. Cleantech Group's Cleantech Index (CTIUS), S&P Global Clean Energy Index (ICLN), China Cleantech Index (CCTI), WilderHill New Energy Global Innovation Index (NEX), Powershares Global Water (PIO)).

Large multinational corporations are paying attention too – both in watching for signals of future threat from upcoming SME's, and in investigating potential technology synergies, or licensing, outsourcing, and supply relationships which they can leverage with some of these innovative cleantech SMEs. Corporations that are eager to keep their product offering up to date with the latest innovation are also making a number of acquisitions. Recent headlines (from 2013-14) in this regard include Samsung's acquisition of NovaLED (the developer of organic LEDs and organic solar cells), Google's acquisition of Nest (the smart thermostat company) and LG Chem's acquisition of NanoH2O (the developer of reverse-osmosis membranes for desalination). A distinctive trend of the past three years, has been the increase of Asian corporations making international acquisitions; examples include Hanwha's acquisition of Qcells, Wanxiang Group's acquisitions of Fisker Automotive and A123 systems, and Hanergy's buying spree of thin-film solar companies Alta Devices, MiaSole and Solibro to name a few.

11 Global Trends in Renewable Energy Investment, BNEF and UNEP, 2013
12 Carbon Tracker Initiative, "Unburnable Carbon: Are the Worlds's Financial Markets Carrying a Carbon Bubble?," 2012
13 Ren21, Renewables Global Future Report 2013, p17
14 Danish Climate and Energy Policy (http://www.ens.dk/en/policy/danish-climate-energy-policy)
15 Roland Berger & WWF, Clean Energy Living Planet 2012

Research Context

Like other innovation areas, cleantech seeks to disrupt status quo business models and leverage on-going global and local trends in order to better the lives of millions. However, the reality remains that a very small percentage of companies succeed with approximately 75 percent of start-ups failing.[16] Success is hard to come by, given that there are many complex factors which must coalesce at the right time. Today's entrepreneurs are often hindered by a lack of access to the resources essential to move beyond 'the valley of death' - the point just before a company's product or service reaches market commercialisation and the company runs out of cash. Entrepreneurs are affected by the dynamics attributable to the country or region in which they reside, for example, 1) individuals' knowledge and credentials for starting a business - depending upon education and training available; 2) market openness, regulation, and available financial support and; 3) cultural norms and prestige of an entrepreneurial career (does the media pay attention to entrepreneurs? how does a society perceive failure?).[17]

Moreover, start-ups cannot achieve their goals without the help of private and public actors, and the right mix of market forces, environmental and innovation policies, and access to key networks. Investors are attracted almost exclusively to opportunity sets in specific geographies, where start-ups have access to all the aforementioned resources as well as favourable market conditions - a self-fulfilling cycle. Cleantech start-ups that require large amounts of capital to scale will need to settle in geographies that are known to attract private and public capital and where they can access knowledge centers like universities, business accelerators, or open-innovation labs at an early stage of development, or channel partners and access to customers at a later stage. Countries that understand this reality and are able to act on it by facilitating systems that connect start-ups with multiple avenues for growth will likely increase the success rates of their local start-ups and spur economic growth.

The Global Cleantech Innovation Index seeks to measure, as closely as possible, the involvement of various actors to not only 'push' technology supply but promote the 'pull' of market demand.[18] This report provides a framework to assess the entire lifecycle of cleantech innovation (from the lab to mass production), so that it can serve as a useful provider of lead signals for years to come.

Measuring the drivers of cleantech innovation is certainly not straightforward, given that regulatory frameworks can wax and wane, outside market and geopolitical forces can vary, and unexpected competition can blindside progress made in a particular geography. We must consider, for example, that the global macroeconomic picture presented in the 2012 index (which was based on data from 2008 – 2011), is different from that of 2014 (where the data sets are from 2010 – 2013) in which the knock-on effects of the financial crisis and other developments (the discovery of more shale gas hubs, for example) have played a more prominent role. On the other hand, some countries have proven to be more resilient to adverse conditions, either substituting capital 'holes' with public support, or fostering momentum for cleantech such that local investors and support groups have come together more than ever. Other countries have benefited from different players that have taken part in their local ecosystem – i.e. private wealth, sovereign wealth funds, government backed ventures or incubators/accelerators which are able to fill in financial gaps.

16 According to research by Harvard Business School professor Shikhar Ghosh
17 Global Entrepreneurship Monitor 2013
18 See Cleantech Innovation Index 2012, p11

The Global Cleantech Innovation Index Methodology

In this second edition of the Global Cleantech Innovation Index, we have used the same methodological approach as the first edition,[19] drawing from the same mixture of sources and indicators, wherever possible. There have been a few exceptions.[20]

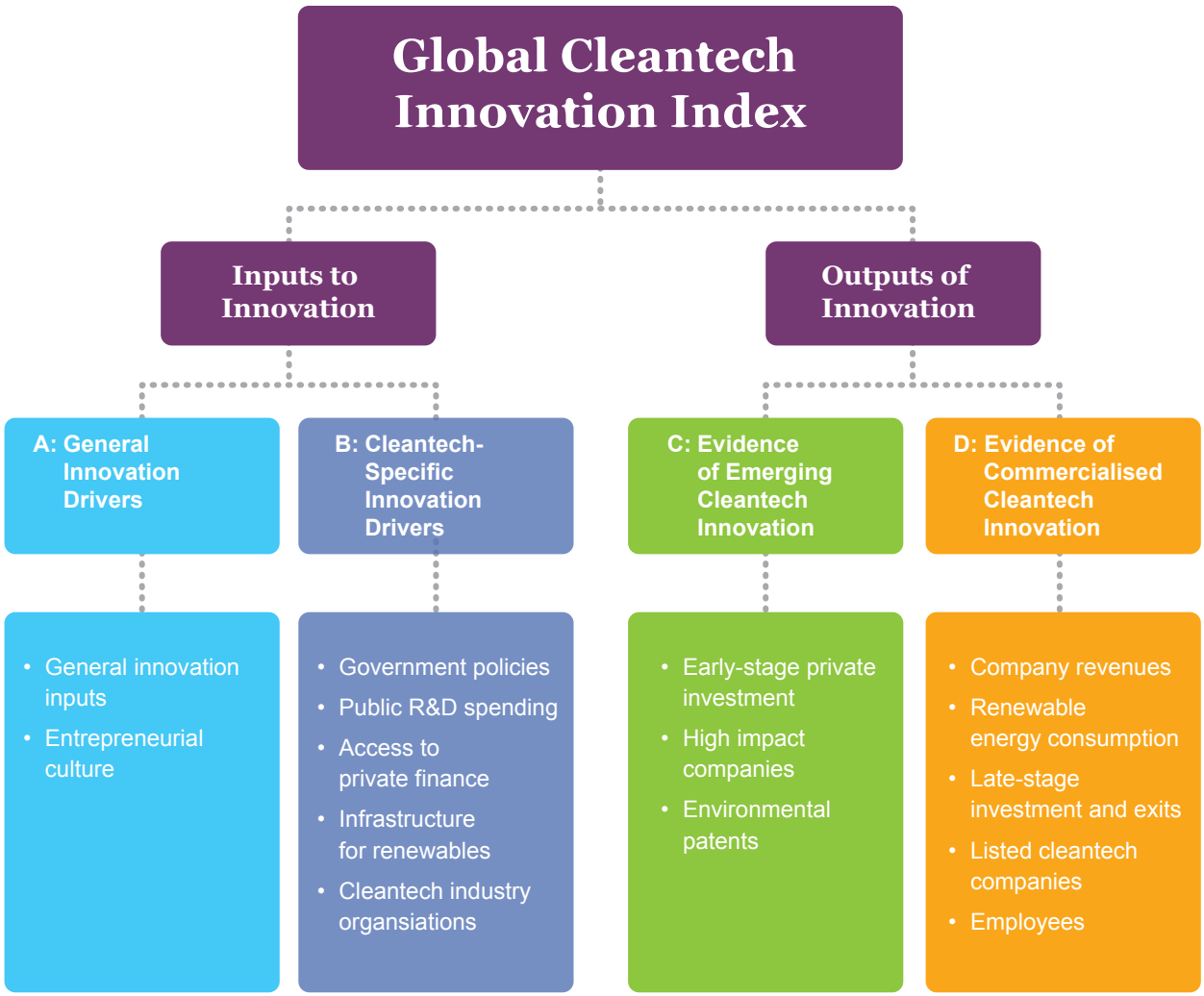
The overall *cleantech innovation index* score for each country is based on the average between *inputs to innovation* and *outputs of innovation*. By definition, "inputs" correspond to the creation of innovation (the development of technology supply) and "outputs" relate to the country's ability to commercialise innovation (the creation of market demand). Each of these inputs and outputs are determined by four equally weighted pillars as shown on the next page. The four pillars are built from a total of 15 indicators, drawn from both third party research and Cleantech Group's proprietary data. The raw data for each indicator was normalised to allow for comparisons on a common scale and extreme outliers were controlled for, by using a standard deviation method (capping at 3 deviations from the average within each sub-factor). The majority of indicators were analysed from a 'per GDP purchase power parity'[21] basis so as 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 felt appropriate to measure on a per total labour force basis).

The scope of the study covered 40 countries including all of the G20. In addition to the 38 countries from the 2012 index, we also included Singapore and New Zealand, due to more expensive data sets becoming available and the countries' high relevance in looking at emerging cleantech innovation companies internationally.

We attempted to include the Philippines, but data availability did not allow for this. Based on feedback from the 2012 edition, we also looked at the possibilities of including indicators on private R&D, energy efficiency, and private bank funding but lacked appropriate data to include such measures (see Appendix A).

19 See Global Cleantech Innovation Index 2012
20 See Appendix A for more details on the indicators and sources used
21 World Bank 2012 indicators used for GDP and population

Framework of the Global Cleantech Innovation Index



The following sources of data were drawn upon to populate the above framework and to derive the scores:

INSEAD, Global Innovation Index, 2013
Global Entrepreneurship Research Association (GERA), Global Entrepreneurship Monitor, 2013
The Pew Charitable Trusts, Who's Winning the Clean Energy Race? 2013
IEA, Energy R&D database, 2011
IEA, Tracking Clean Energy Progress, 2013
Ernst & Young, Renewable Energy Country Attractiveness Index, 2013
Cleantech Group, Global Cleantech 100, 2011 - 2013
OECD, Patent Cooperation Treaty database, 2011
WWF and Roland Berger, Clean Economy, Living Planet, 2012
UK BIS, Low Carbon and Environmental Goods and Services, 2011/12
BP, Statistical Review of World Energy, 2013
Cleantech Group, FTSE, Ardour and WilderHill indices of publicly traded cleantech companies, 2013
Cleantech Group i3 data, 2011 - 2013
World Bank indicators, 2012

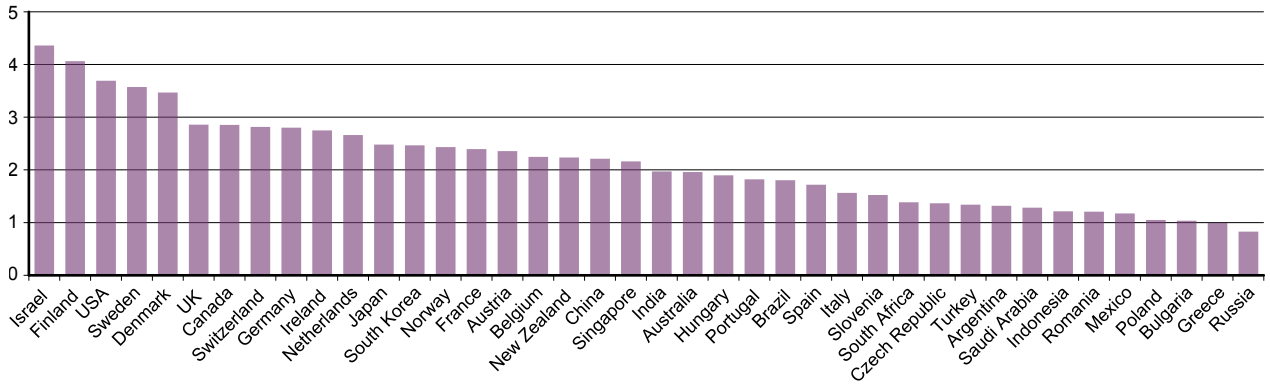
Global Cleantech Innovation Index 2014 Factor Table

2014 Rank	Country	2014 Score	Inputs to Innovation	Outputs of Innovation	General Innovation Drivers	Cleantech-Specific Innovation Drivers	Evidence of Emerging Cleantech Innovation	Evidence of Commercialised Cleantech Innovation
1	Israel	4,34	2,87	5,81	2,86	2,88	8,92	2,70
2	Finland	4,04	2,90	5,18	2,83	2,97	7,59	2,77
3	USA	3,67	3,13	4,21	3,29	2,98	6,41	2,01
4	Sweden	3,55	2,98	4,12	3,59	2,37	5,56	2,68
5	Denmark	3,45	3,13	3,76	3,15	3,12	3,23	4,29
6	UK	2,84	2,77	2,91	2,82	2,71	3,87	1,95
7	Canada	2,83	2,84	2,83	3,34	2,34	3,34	2,32
8	Switzerland	2,80	2,90	2,69	3,38	2,42	3,33	2,06
9	Germany	2,78	2,56	3,00	2,26	2,87	3,39	2,61
10	Ireland	2,73	2,34	3,12	2,50	2,18	3,92	2,32
11	Netherlands	2,64	2,57	2,71	2,84	2,31	3,84	1,58
12	Japan	2,46	1,92	3,00	1,37	2,47	4,51	1,49
13	South Korea	2,45	2,40	2,49	3,00	1,81	3,12	1,86
14	Norway	2,41	2,52	2,30	3,11	1,93	1,78	2,82
15	France	2,38	2,39	2,36	1,83	2,94	3,06	1,67
16	Austria	2,34	2,31	2,36	2,35	2,26	2,35	2,38
17	Belgium	2,23	2,34	2,11	2,04	2,65	2,13	2,09
18	New Zealand	2,22	2,30	2,13	2,64	1,97	1,26	3,00
19	China	2,19	2,50	1,89	2,26	2,74	0,92	2,85
20	Singapore	2,14	2,47	1,82	2,52	2,41	1,21	2,42
21	India	1,95	1,92	1,98	1,39	2,44	2,10	1,87
22	Australia	1,94	2,52	1,36	2,54	2,49	1,12	1,60
23	Hungary	1,88	2,13	1,62	1,55	2,71	1,49	1,75
24	Portugal	1,80	2,00	1,61	1,40	2,60	0,85	2,37
25	Brazil	1,79	1,90	1,67	1,95	1,85	0,31	3,03
26	Spain	1,70	1,60	1,80	1,45	1,74	0,80	2,80
27	Italy	1,54	1,78	1,31	1,31	2,26	0,95	1,66
28	Slovenia	1,50	1,52	1,49	1,37	1,67	1,00	1,98
29	South Africa	1,37	1,62	1,11	1,43	1,82	0,26	1,96
30	Czech Republic	1,35	1,57	1,13	1,65	1,48	0,30	1,96
31	Turkey	1,32	1,93	0,72	1,69	2,16	0,10	1,33
32	Argentina	1,30	1,44	1,16	1,73	1,14	0,05	2,27
33	Saudi Arabia	1,26	1,51	1,02	1,93	1,09	0,12	1,91
34	Indonesia	1,19	1,65	0,74	1,90	1,40	0,01	1,47
35	Romania	1,19	1,36	1,01	1,37	1,35	0,07	1,96
36	Mexico	1,15	1,57	0,74	1,95	1,19	0,04	1,44
37	Poland	1,03	1,27	0,79	1,25	1,29	0,15	1,43
38	Bulgaria	1,01	1,22	0,81	1,17	1,27	0,20	1,42
39	Greece	0,97	0,78	1,17	0,61	0,94	0,55	1,79
40	Russia	0,81	1,12	0,50	0,71	1,52	0,16	0,84

FOR COMPARISON, THE INDEX AND INDICATORS HAVE A MEAN SCORE OF 2.11 – 2.12, SEE APPENDIX D FOR PROFILES OF INDIVIDUAL COUNTRIES.

Results and Analysis

Figure 2: Cleantech Countries Innovation Index



Israel leads the 2014 Global Cleantech Innovation Index, with Finland following closely behind. The characteristics of the top performers highlight that there is no single pathway for creating a cleantech innovative economy – countries vary in how they score in all the sub-factors and indicators (as you will find in the following sections). It is also important to note that no one country excelled in all four indicators – Israel, for example, far exceeded others in the emerging cleantech innovation factor, however dropped to 8th place in the 'evidence of commercialised innovation' factor – confirming that there is room for improvement in even the most inspiring countries. In fact, all top 10 countries were relatively good at early stage cleantech development but share a common challenge in increasing commercialisation rates. One relative outperformer on commercialisation, however, is Denmark (see page 25).

While there is a mixture of both small (e.g. Finland, Ireland) and large economies (e.g. USA, Germany) at the top, there is, on average, a notable divide in the index between the cleantech innovators and their followers, in terms of country income. The top half of the index has twice the average GDP as the bottom half ($1 trillion more). This demonstrates that there is a correlation between greater wealth and the development of innovation capital in the cleantech sector. However, there are some exceptions: Russia and Italy lag behind (considering the size of their economies) and Australia has fallen behind the curve on a few metrics (see Figure 3) such as environmental patents and early stage cleantech capital, despite its attractive project finance market.

Nordic countries were high performers in the index, with Finland, Sweden, Denmark placing in the top five and Norway following closely behind. Denmark, which topped the list in 2012, continues to be a leader on many fronts, however the country saw a drop in venture investments, patent filings and number of cleantech specific funds, while Finland saw growth in those areas.

Some 'emerging economies' (in old parlance) have outperformed others. For example, China took 19th place this year, due to its high availability of expansion capital and high sales generation from manufacturing of solar cells and other cleantech products. Brazil also made it into the top 25, with a mixture of good inputs and outputs, notably achieving a high perception of entrepreneurial opportunities, and a high consumption of renewables as a share of their total energy mix.

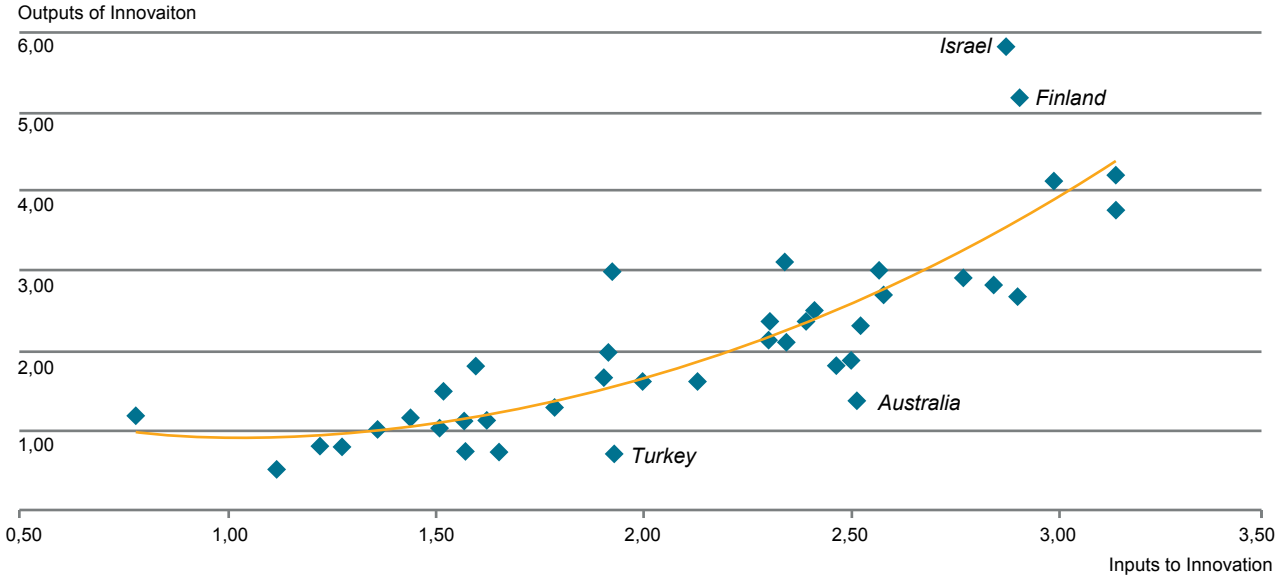
Korea, which came in 13th in the index, has identified cleantech as the 'next engine for growth' and is committed to ambitious 2030 objectives: 20 percent renewables target, 1 million new green jobs, and a $24 billion plan to establish nationwide smart grid. As such, Korea may be expected to rival the top ten of the index in future years.

France, which is currently dominant in seed and early-stage cleantech venture capital (representing 20 – 25 percent of deals in Europe in 2013) came in 15th this year. The country did not make the top 10 largely because of its average marks on general innovation drivers and entrepreneurial attitudes. France shows signs of PE, M&A, and IPO action[22]; however, amidst slow economic growth, cleantech company revenues and manufacturing sales are relatively low as is the country's renewables consumption. We might anticipate, however, that in a 2016 index, France will have progressed further given recent signals from 2012 to 2014 data.

Russia showed the weakest evidence of inputs and outputs into cleantech innovation, while Greece also joins the bottom three this year, in part due to the Government's harsh austerity measures and its effects on the renewables industry (retroactively taxing consumers on renewable power in 2012 and 2013). Saudi Arabia remains in the bottom five. However, with its $100 billion plan to source 41,000 MW of solar projects in the next two decades, the country is poised to shift its position substantially in the years ahead.

When comparing aggregated scores for the inputs to innovation and outputs of innovation sub-indices, it can be seen which countries are capitalising on their inputs more efficiently. As demonstrated below in Figure 3, Israel and Finland perform far above the curve while Australia and Turkey have perhaps not reached their full potential. Most countries are in the 1 - 3 range on 'outputs to innovation,' demonstrating that more progress remains to be made by all countries.

Figure 3: Cleantech Innovation Efficiency



SOURCE: CLEANTECH GROUP ANALYSIS

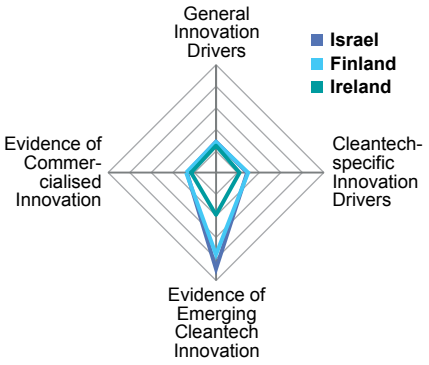
22 Please see Appendix C for definitions of PE, M&A and IPO.

Country Archetypes

Cleantech Start-up Generators:

'Cleantech start-up generators' is a term we use to describe countries that are extremely good at developing the right set of innovation tools for their local start-ups, combined with a set of stimuli to make the cleantech theme attractive to entrepreneurs. These countries tend to agree on the long-term necessity of investing in clean technologies and are gearing up in various ways to ensure future wealth and prosperity for their economies. The cleantech start-up generators are not however necessarily strong commercialisers in terms of rapidly scaling their businesses. These countries have to overcome the challenges of having relatively small domestic markets compared to larger economies like Brazil, India and China (which are strong cleantech commercialisers).

Figure 4: 'Pureplayers' in the Emerging Cleantech Innovation Factor:



Israel is able to compensate for its small domestic market, sensitive geo-political setting, and water constraint by drawing the attention of both local and foreign investors to bet on its pool of high-tech entrepreneurs. The country is *the* cleantech innovation archetype for both embedding entrepreneurial spirit into its educational system and into its society's everyday norms as well as for predisposing its start-ups to resource innovation – as a survival mechanism to overcome resource constraints and energy dependency. Relative to the size of its economy, Israel has had a disproportionate number of cleantech companies (19 in total) voted by the cleantech community into the shortlist of the *Global Cleantech 100 index*[23] over the past 3 years. Examples of such innovators include Kaiima (the developer of proprietary non-GMO genomic-based breeding technologies) and Emefcy (the developer of Electrogenic Bioreactors (EBR) that treat industrial wastewater).

Finland's harsh climate, lack of fossil fuel resources and recently-sagging ICT industry (with Nokia facing high competition from Apple products),[24] has propelled the country towards creating new employment prospects in cleantech-related industrial activities. Finnish cleantech businesses currently employ around 50,000 people, with 40,000 new jobs expected to be created by 2020 (a significant amount given its population of only 5 million).[25] Companies like MetGen are innovating around the country's well known pulp and paper industry, and many others (over 50 percent) are focused on Energy Efficiency solutions (leveraging their IT human capital).

Ireland enjoys strong institutions, a vibrant science, engineering and ICT workforce, and market sophistication – with a good inflow of Foreign Direct Investment (FDI). Ireland anticipates that cleantech jobs will grow to 80,000 by 2020.[26] The country has the advantage of vast natural resources specifically in tidal/wave energy, wind energy and various feedstocks for the production of

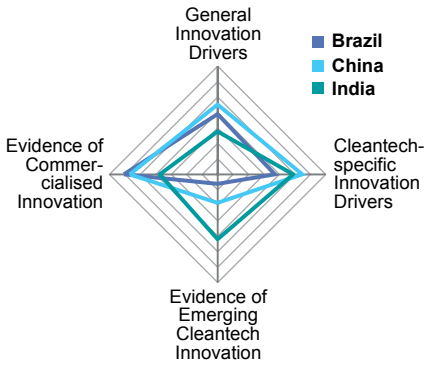
23 To find out about the Cleantech 100 methodology: http://www.cleantech.com/global-cleantech-100/
24 Is Cleantech Finland's Next Nokia? Greentechmedia.com
25 About Cleantech Finland
26 According to the Greenway (Dublin's Cleantech Cluster)

biofuels. Ireland is investing heavily in their renewables capacity, with pioneers like Mainstream Renewable Power planning to build a 138MW Jeffrey's Bay wind farm. Ireland has also held a number of initiatives through the Greenway (Dublin's Cleantech Cluster) over the past few years, to encourage the growth of its cleantech sector both locally and internationally.

Strong Cleantech Commercialisers:

Countries that are strong commercialisers of cleantech today (as shown in Figure 5), tend to have strong economic and social pressures to procure clean technology solutions and products as they face pressure to address more visible environmental and resource problems, compared to countries that have 100 percent of their population with access to electricity, water, food etc. These countries are not driven simply by moral commitments to address climate change but also by the urgency to deploy clean technologies to solve mounting public health and environmental issues.

Figure 5: Countries with Evidence of Commercialisation Rates:



China in particular has an impetus to speed up investment in cleantech so as to curb the effects of air pollution in the country. The Government's strategy to deploy cleantech across its economy has provided start-ups with a burgeoning market. Chinese cleantech companies enjoy preferential corporate tax rates and are offered easy access to loans at low interest rates through the country's state-owned development bank. The fact that there were over 55 Chinese publicly listed cleantech companies on major international stock exchanges in 2013 (more than any other country in the world) is a testament to the sector's momentum and success in the country. Start-ups across the globe are now seeking access to the Chinese market, although they face greater hurdles (cultural challenges and unfamiliar business climates) than their local competitors.

India is facing rapid urbanization, a rising energy deficit and growing industries which are fast-depleting the country's natural resources. As a result, India expects to spend almost $30 billion on renewables[27] and $1.7 trillion on energy supply infrastructure by 2035.[28] In the 12th Five year plan period (2012-17), the government intends to add a grid interactive renewable capacity of about 30,000 MW. India is also offering very attractive foreign investment policies for environmental equipment and services companies. As a result, the country is emerging as one of the fastest growing supply chain hubs for both local and international manufacturers of renewable technology (i.e. wind blades, convertors, towers, etc.). A good number of private equity deals have also surfaced in India over the past few years (e.g. Goldman Sachs' $40 billion commitment to ReNew Windpower, the developer of wind energy projects).[29]

Brazil is a resource-rich nation (with the 4th largest agricultural sector, for example), with over 200 million potential customers to serve. The country benefits from an old agri-industrial society, vast amounts of arable land, and is now a leading producer and exporter of advanced biofuels following the establishment

27 Ren21, Renewables Global Futures Report, p 35
28 IEA, South East Asia Energy Outlook, September 2013
29 Cleantech Handbook India, Cleantech Finland and FinPro

of the Bonsucro sustainability standard.[30] Brazilian biofuels developers have been scaling up through partnerships with international players – for example, Granbio's partnership with Italy's Beta Renewables, or Cosan's joint venture with Shell to produce ethanol.[31] What's more, Amyris, among other American and European biofuels companies, is setting up shop in Brazil to get a slice of the market – demonstrating the traction in this sector. The Government is also promoting the cleantech industry through its $66 billion infrastructure stimulus package, its $16 billion 'Plano Inovar' towards agricultural technologies and its $200 million fund for sustainable innovation through the Brazilian Development Bank (BNDES).[32]

Cleantech Innovation Laggards:

The 'Laggards' describe countries that on a *relative* basis are creating fewer drivers for cleantech generation and commercialisation. However over the last few years, even the countries that rank at the bottom of the index have demonstrated an increased interest in developing enabling policies or support systems to foster sustainable innovation.

Russia, despite its sizeable population and vast natural resources (it is one of the largest producers of oil and gas in the world), the country has a very low level of energy efficiency, requiring several times more energy per GDP than its western European counterparts. As of yet, Russia has failed to capitalize on its available cleantech resources, and continues to focus on its conventional energy supply. Nonetheless, a few pockets of new developments in the country could signal potential for cleantech startup development. The Wermuth-Tatarstan Fund, setup in 2012, is the first ever venture cleantech fund dedicated to investing in the Russian market - specifically in companies (local or foreign) with a manufacturing base 1000km from Kazan. The Skolkovo foundation also initiated the first of its kind science and technology innovation center in Skolkovo (a suburb of Moscow) with various investors, incubators and cleantech companies residing within the ecosystem. Skolkovo includes an Energy Efficient Technologies cluster which connects over 80 companies.

Saudi Arabia, the oil superpower has not yet tapped into its vast solar potential, given that the country receives twice the amount of sunshine of anywhere in Europe. However, it has more recently become interested in making 'smart' use of its deserts for building photovoltaic and concentrated solar power plants. In 2012, the King Abdullah City for Atomic and Renewable Energy (KACARE) set in motion a $100 billion plan to install more than 41 GW of solar to enable the country to get 20 percent of its electricity from solar energy by 2030. In 2012, the Mecca Municipality also put together the first scheme in the country to install a 100MW solar power plant. This is part of the country's larger strategy to preserve more of its oil assets for export, which represent 86 percent of its current total revenue.[33]

30 Certified Brazilian sugarcane ethanol must now meet the required minimum 50 percent reduction in full lifecycle greenhouse gas (GHG) emissions. http://wwf.panda.org/?200720/Sweet-news-for-environment-as-sustainable-sugar-comes-to-market

31 Clean and Cool Mission Brazil 2013

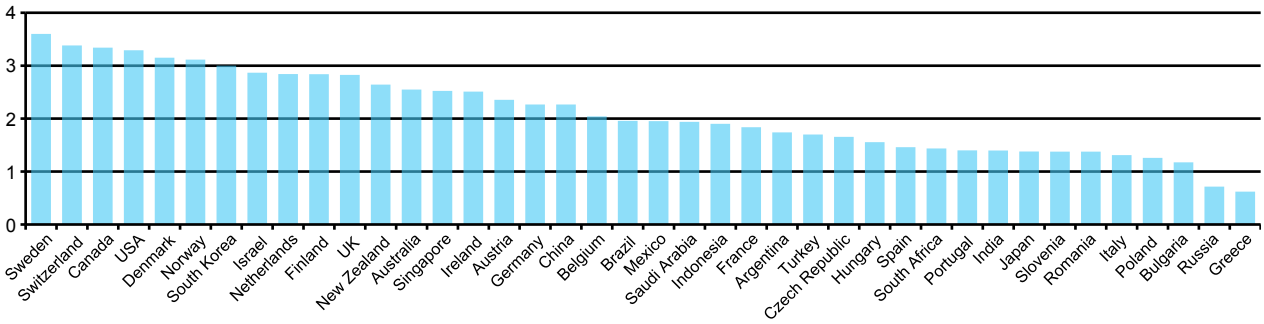
32 Seven ways sustainable businesses can break into Brazil, The Guardian

33 Mecca Seeks to Lead Saudi Arabia's Solar Energy Expansion, Bloomberg

A: General Innovation Drivers

General innovation drivers are the general conditions that facilitate the development of innovative start-ups in a country. It is not sufficient to look only at external parameters (i.e. R&D expenditures, patents, or academic publications) to judge a country's supportive structure for entrepreneurs. Rather, it is important to also account for the culture and psychology of individuals within a society to determine the likelihood of entrepreneurial success.[34] This factor sources from both the INSEAD *Global Innovation Index* and the *Global Entrepreneurship Monitor,* in order to best measure the underlying economic and social structures which shape countries' innovation systems.

Figure 6: General Innovation Drivers



It is interesting to note that the entrepreneurs in the top performing countries in the 'General Innovation' category (Sweden, Switzerland, Canada and USA), are less driven by 'necessity motives' for starting a business (i.e. because of unemployment), but rather are inspired by the intrinsic value of entrepreneurship – the perceived opportunity for a better income and/or independence.[35] Therefore, what makes these countries 'top performers', is that they have been diligently investing in making entrepreneurship attractive, both by giving individuals the necessary training, advice, or connections to ensure their success, and also by greatly rewarding them for their endeavours.

However, there is no one 'Silicon Valley way' to promote entrepreneurship, and the top countries have all leveraged their local strengths to produce good results. The USA and Canada perform well based on having highly ranked universities, high venture capital investment per GDP, and a large number of joint ventures or strategic alliances established. On the other hand, Denmark and Norway excel due to their stable political and regulatory environments, ease of starting a business and resolving insolvency combined with solid human capital and R&D availability.

Switzerland and Norway also rank high in Yale's environmental performance index (EPI),[36] a sub-factor used by INSEAD to measure ecologically sustainable infrastructure. Good energy and transportation infrastructure ultimately helps to create productive and efficient societies, thus inspiring overall better innovation systems. Norway, for example, has built out a significant network of EV charging stations across the country and has accelerated electric vehicle penetration beyond any coun-

34 INSEAD Global Innovation Index 2013
35 Global Entrepreneurship Monitor, p32
36 Environmental Performance Index (EPI) ranks how well countries perform in two policy areas: protection of human health from environmental harm and protection of ecosystems.

try in the world, with electric vehicles taking 12 percent market share of total car sales (compared to less than 1 percent in the U.S. for example).[37]

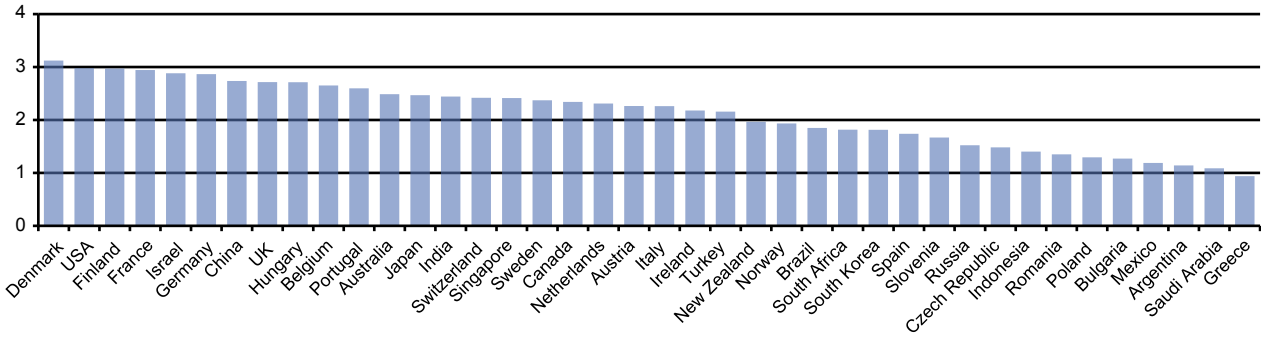
Emerging markets like Mexico and Indonesia perform better in the general innovation metric, relative to other factors, with both countries climbing rapidly up INSEAD's Global Innovation Index[38] (ranked 16 and 15 respectively). Mexico has enacted a number of policies aimed to boost entrepreneurship (including new R&D initiatives, and tax incentives for SMEs). The country also recently approved an energy reform which nationalizes the energy industry, and opens up possibilities for new technologies to be deployed.[39] In Indonesia, the World Bank is implementing education, training and research programs that aim to improve the country's science and technology capacity.[40] According to the Global Entrepreneurship Monitor, Indonesia beats all other economies in early-stage entrepreneurial activity followed by other emerging markets of Turkey and Brazil. Ultimately the cleantech theme should reap the benefits of general advances in innovation support systems, although the impact of current efforts may take a while to realize.

37 Record: Norway Electric Car Sales Hit 12 percent Of Total Car Sales, Cleantechnica
38 INSEAD Global Innovation Index 2013
39 Mexico's Energy Reform
40 World Bank Supports Move to Accelerate Indonesia's Economic Growth

B: Cleantech-Specific Innovation drivers

Cleantech-specific innovation drivers help to promote market adoption of clean technologies and address barriers to entry for the industry. Both public and private driven support are important considerations, including cleantech friendly government policies, cleantech public R&D spending, development of national infrastructures for renewable energy, availability of private funding and access to cleantech clusters and other organisations.[41]

Figure 7: Cleantech-Specific Innovation Drivers



More than other innovation themes, cleantech requires government support, not only to scale up new technologies, but also in many cases to help create entirely new markets. The additional market risk which cleantech ventures carry means that regulatory frameworks and financial backing can be crucial to their survival. Cleantech friendly policies include, for example, the establishment of a carbon market, auto efficiency standards, feed-in tariffs and grant funds, green bonds and other government financial instruments. Grants in particular have continued to play a part in funding global cleantech, with budgets allocated to specific technologies that fulfil countries' targets and agendas (e.g. Japan's $300 million grant for battery storage system systems to help integrate renewables into the grid).

Equally important to cleantech are the private backers, who seem to concentrate their funding in very specific geographies. In the past few years, there have been more cleantech funds set up to invest in China than any other part of the world, even though the U.S. still attracts the largest amount of capital. This is because investment rounds tend to be smaller in China, although local investors put down capital more frequently. Examples of active local funders include names such as Origo Partners, Tsing Capital, and Shenzhen Capital Group. However, foreign investors are increasingly seeking to participate in the Chinese market opportunity for innovation. For example, in February 2013 U.S. investor Kleiner Perkins, through its China office, partnered with Hong Kong investor CLSA Capital Partners to invest in Scinor Technology (the water membrane manufacturer).

41 Sources include The Pew Charitable Trusts Clean Energy Race Report; IEA RD&D data; Ernst & Young Renewable Energy Country Attractiveness Index; and Cleantech Group www.i3connect.com data

Outperformers in Cleantech Drivers:

Countries that outperform on the cleantech specific innovation drivers measure have excelled in several sub-factors (though not all) – generating their own mix of public and private resources to help facilitate the economic success of cleantech companies.

Finland and **Denmark** have the largest public cleantech R&D budgets[42] relative to the size of their economies, combined with a high number of supportive cleantech clusters and government policies.[43] As an example, the Finnish Funding Agency for Innovation – Tekes – is partnering with MOST, China's Ministry of Science and Technology, in 2014 on joint calls for proposals for cleantech-related R&D projects.[44] Such opportunities are critical value add to start-ups – allowing them to bridge the 'valley of death',[45] and make efficiency and cost improvements to their products or services, or develop their manufacturing capacity both locally and abroad. Finland and Denmark also succeed at attracting a high number of local investors[46] as well as established government supporters (such as Finland's innovation fund SITRA and Denmark's Innovationsfonden).

France has a high number of early stage investors securing new cleantech funds (including Demeter Partners, Emertec, and Idinvest Partners) through the support of the government's €600 million National Seed Money Fund scheme, as well as a 'Investments in the Future' (Investissements d'Avenir) programme which secured €1 billion for clean energy companies starting in 2010.[47] In addition, there are a number of other beneficial government policies coming to the forefront. For example, France currently has a Government ban on shale gas exploration (on environmental grounds). France also came fifth in the renewable attractiveness index, currently doubling its targets for installed solar capacity. The Government pledged to cut reliance on nuclear power to 50 percent by 2025 (down from 78 percent in 2013), with the default focus on shifting towards renewable energy, so as to meet their 23 percent target by 2020.[48]

USA leads particularly in private sector metrics, with U.S. start-ups consistently attracting capital from both local and international investors. On the other hand, a lack of energy or environmental consistency with regard to federal policy has led to a degree of uncertainty on the future of the public sector's role in promoting a renewable and low-carbon future. Nonetheless, the Obama administration has put forth a climate plan that proposed a cut in carbon emissions from power plants of 30 percent by 2030.[49] The U.S. has also promoted improved fuel economy standards for its vehicle fleet (hybrids, powertrains, CNG, etc.) and extended tax credits for the wind sector despite the country's intransigent political climate. With regard to renewable energy attractiveness, the U.S. still maintains the top spot on the Ernst & Young RCAI index, although China may overtake it, given how fast they are accelerating deployment efforts. On the other hand, the U.S. pledged to increase its FY14 budget for clean energy R&D by 30 percent to $7.9 billion,[50] at least demonstrating that the country is still serious about promoting a green agenda.

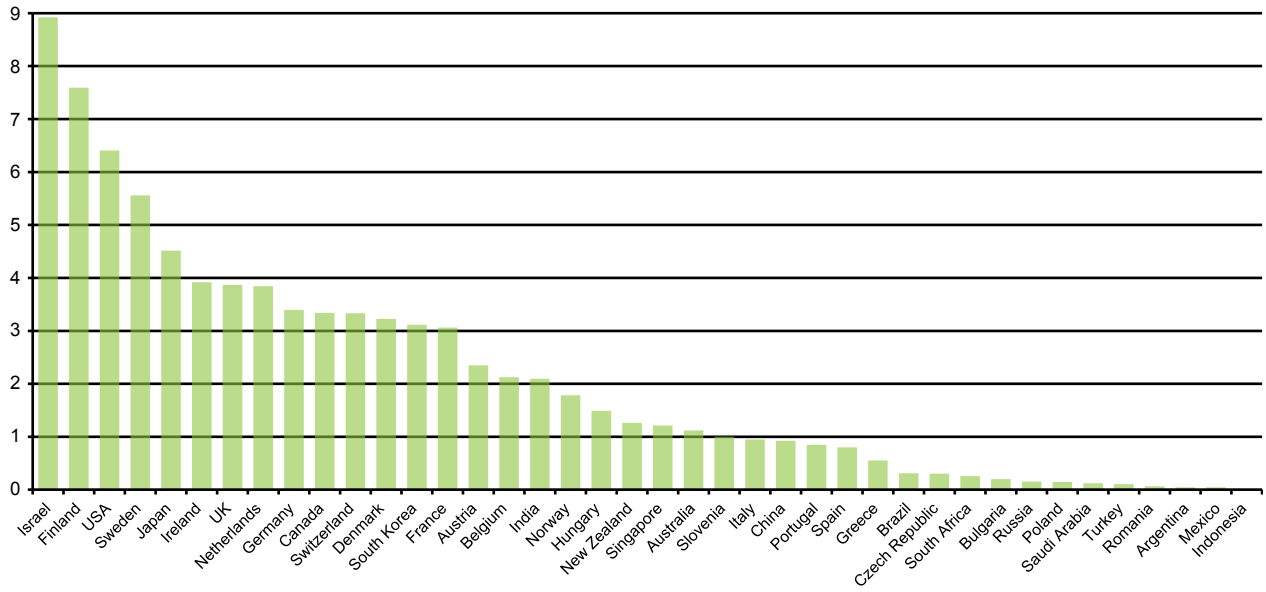
42 More than 40 percent of Finnish public R&D goes to the energy and environment sector
43 For example, Copenhagen has set the ambitious goal of becoming carbon neutral by 2025, with initiatives across transport, buildings and energy production.
44 Tekes – MOST call for proposals
45 Refers to a time period when startups are cash strapped – usually just before they reach commercialisation
46 Example private investors include VNT management, Cleanech Invest, Finnvera, Finnish Industry Investment. Examples in Denmark include BankInvest New Energy Solutions, Vaekstfonden, Northzone Ventures. For more examples see: www.i3connect.com
47 Investissement d'Avenir – Les Programmes Energie
48 Ernst & Young Renewables Attractiveness Index
49 Taking Page From Health Care Act, Obama Climate Plan, New York Times, June 2, 2014
50 Ernst & Young, RECAI, August 2013

Germany continues to be a top renewables market, as the operator of one-third of the world's installed solar capacity, despite a rather un-sunny location. Nonetheless, in early 2014, the German Government put together a reform package in which FITs are replaced with a scheme that lays the groundwork for achieving a target of an 80 to 95 percent cut in carbon emissions. However, ongoing discussions as to concrete details of this scheme are likely to result in a slowdown for renewables investment in the short term.[51] On the other hand, Germany has a substantial number of cleantech funds per GDP, as well as some core supportive organizations such as the Fraunhofer (the R&D institute) and High-Tech Gründerfonds (the early-stage fund) which means the country will likely continue to drive cleantech innovation in the years to come.

C: Emerging Cleantech Innovation

Evidence of emerging cleantech innovation drivers determine the emergence and early-stage progress of cleantech innovations and entrepreneurial cleantech companies. This factor is made up of OECD records of environmental patents filed under the Patent Cooperation Treaty; Cleantech Group data on cleantech venture capital (VC); and records from the 2011-2013 *Global Cleantech 100* lists, (Cleantech Group's annual ranking of the top 100 private cleantech companies globally).

Figure 8: Evidence of Emerging Cleantech Innovation



Overall, patent filings for the 40 countries have grown from 2008 to 2011 by nearly 100 percent which is a testament to the growth of sustainable innovation. The top countries for environmental patents include USA (with a majority located in California) and Japan (mostly surrounding areas of Tokyo and Osaka). However, on a per GDP basis, South Korea comes out on top, with over 6672 patents filed in 2011 alone. The Korean Intellectual Property Office (KIPO) has put in place a fast track program for green innovation (where patents have been approved in less than one month), in order to get these technologies to market as quickly as possible. Similar policies also exist in Canada, the UK and Israel. On the other hand, three of the G20 countries, Argentina, Mexico and Indonesia, have filed 70 times fewer environmental

51 Ernst & Young, RECAI, Issue 40, February 2014

patents by size of their GDP compared to the top five countries: Japan, Israel, Sweden, Finland and South Korea.

The USA garners by far the most venture capital investment in cleantech, with $5 billion allocated in 2013 alone. Moreover, multi-national corporations have participated consistently in over 20 percent of deals in North America since 2011.[52] Silicon Valley, in particular, is home to large enterprises (e.g. Google, Hewlett Packard) and their proximity to start-ups in the area helps to facilitate investment and partnership opportunities. On the other hand, countries with low levels of venture capital per GDP include Japan, South Africa, Mexico and Russia. China attracts an impressive amount in absolute terms ($304 million over the past 3 years), but still has a way to go when its size is accounted for.

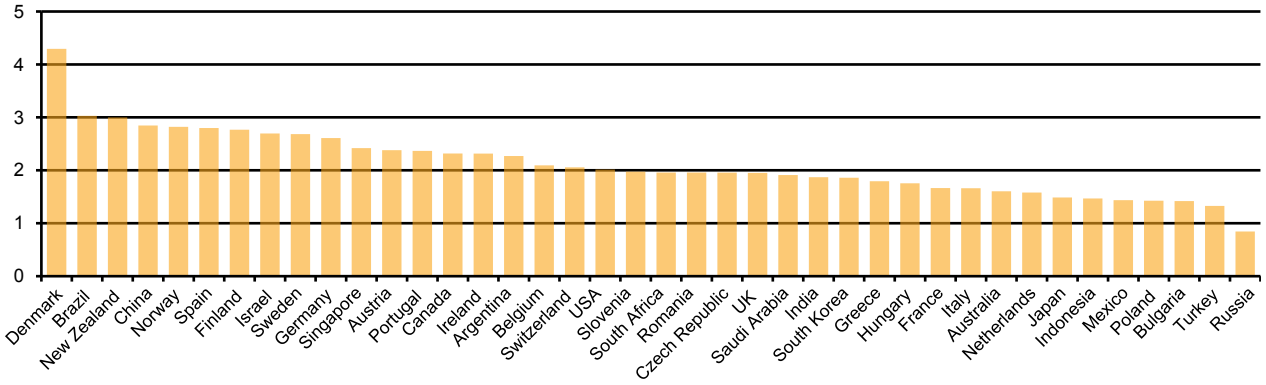
As was the case in the 2012 index, the standard deviation within the emerging cleantech innovation factor was by far the highest of all factors, demonstrating a clear divide between geographies leading in generating start-ups and their followers. There are a few countries which have significantly raised their overall scores by providing actual 'proof' of generating high quality emerging start-ups. These are Israel, Finland, USA, and Ireland, which fare well (average or above average on all factors) but are extreme in their performance on emerging cleantech innovation (as described on page 15).

Other countries of note include Sweden and the UK, which demonstrated a high density of *Global Cleantech 100* companies (after Israel and Finland). Many of these companies have benefited from their respective countries' government agencies like the Swedish Energy Agency and the UK Department of Energy and Climate Change (DECC) which played roles in fostering innovation by providing grants for early stage cleantech start-ups.

D: Commercialised Cleantech Innovation

Evidence of commercialised cleantech innovation measures the ability of a country to scale-up cleantech innovations. This factor is derived from: cleantech manufacturing value-added; cleantech company revenues; renewable energy consumption data; cleantech late-stage private investment, M&A's and IPOs; and the number of publicly traded cleantech companies in major indices.[53]

Figure 9: Evidence of Commercialised Cleantech Innovation



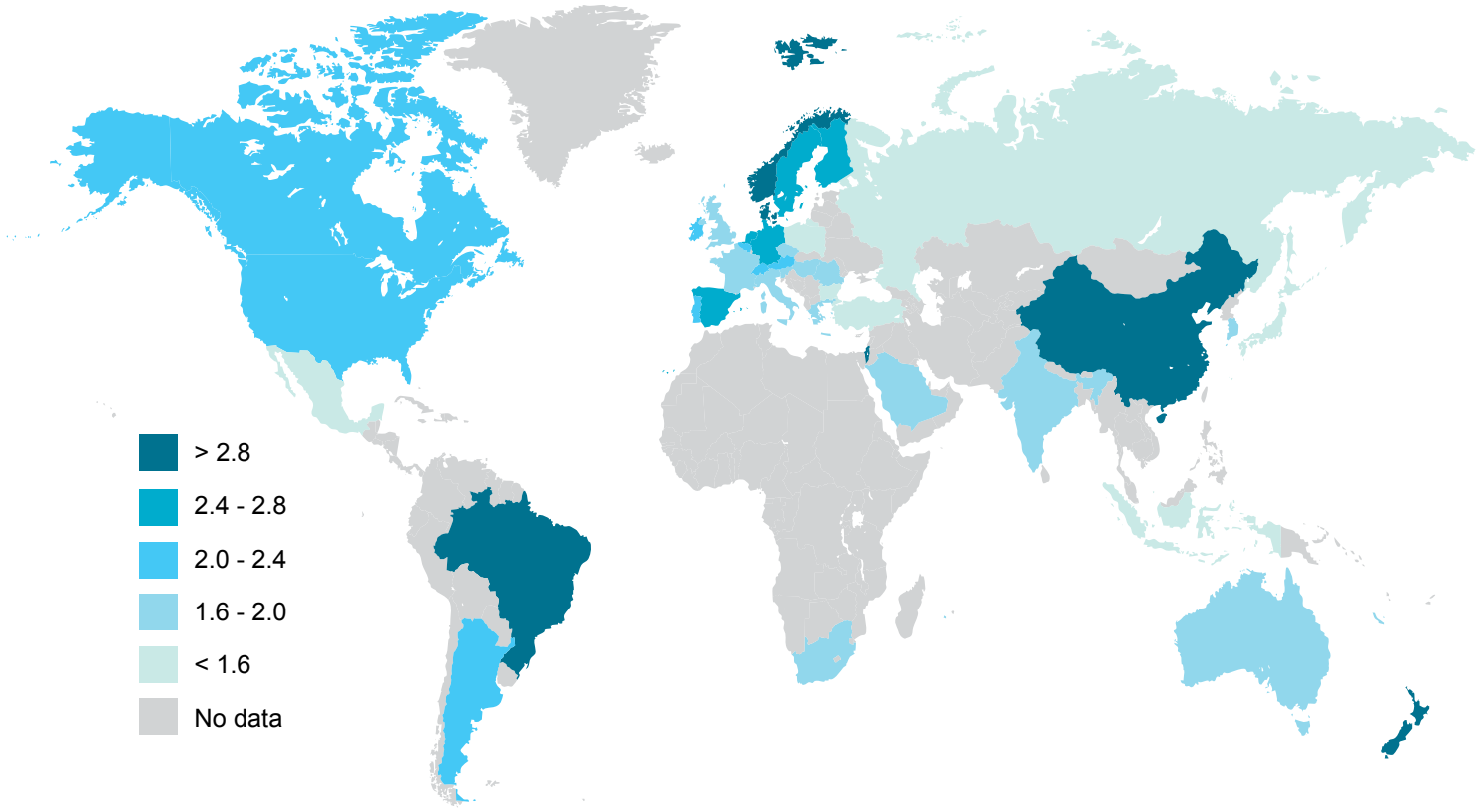
52 European Cleantech Fundraising 2013-2014 Report, Cleantech Group and Georgieff Capital

53 Sources include WWF/Roland Berger Clean Energy, Living Planet; UK Department for Business Innovation & Skills, Low Carbon and Environmental Goods and Services report; Ren21 Renewables 2013 Status Report; IRENA Renewable Energy and Jobs; Cleantech Group Index (CTIUS), FTSE, Ardour and WilderHill indices and Cleantech Group data: www.i3connect.com

Creating favourable conditions for companies at the later stage of development is equally if not more important than the early stage. Determining the size of supply chain activity and revenues generated from cleantech businesses is one way to quantify economic activity and market traction for the sector. According to UK's Department of Business Innovation & Skills, the total worldwide sales from low carbon and environmental goods and services were £3.4 billion (approximately $5.7 billion) in 2011/2012 a 3.8 percent annual increase over 2010/2011. The U.S. accounts for 19.2 percent of the global total, followed by China (13 percent), Japan (6 percent), India (6 percent) and Germany (4 percent).[54]

Commercialised cleantech innovation is spread across the globe as shown on the map below: Denmark, China, Brazil, New Zealand, Norway perform well in this indicator for various reasons.

Figure 10. Map of *Commercialised Cleantech innovation* scores



SOURCE: CLEANTECH GROUP ANALYSIS

Denmark comes out on top for cleantech value-added from manufacturing (representing 3 percent of GDP), [55] and the largest number of publicly traded cleantech companies considering the size of its economy. Key examples include Novozymes, Vestas, the biotech and wind corporations respectively and Rockwool, Grundfos and Danfoss – all strong in the energy efficiency space.

54 UK Department for Business Innovation & Skills, Low Carbon and Environmental Goods and Services report 2012
55 WWF Roland Berger, Clean Economy Living Planet, 2012

China had the largest number of IPOs since 2011 (57 in total), as compared to next in line - 22 IPOs in the U.S. The country generates the largest value (in absolute terms) from cleantech manufacturing, even if renewable energy employment represents less than 1 percent of its total 1.35 billion population. Meanwhile, **India** derived $337 million in revenues from cleantech companies[56] – the highest in absolute terms after the USA and China, and a relatively high number of private equity investments (though not as impressive as Denmark).

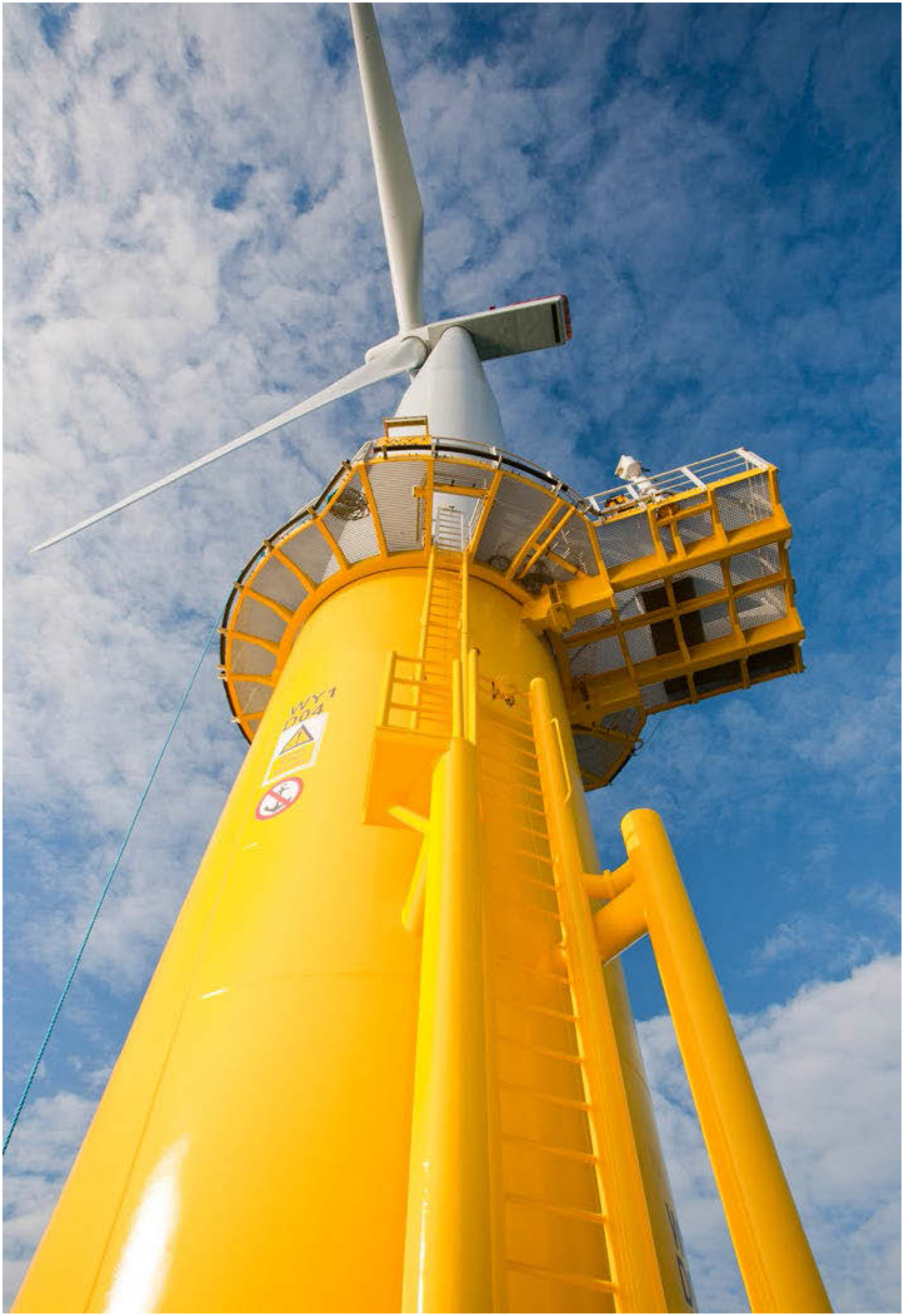
Over 45 percent and 39 percent of **Brazil**'s and **New Zealand**'s energy consumption comes from renewable sources respectively. **New Zealand** already has specialisation in forestry, horticulture, manufacturing and engineering which are highly transferrable to areas of clean technology. New Zealand also has a high renewables consumption, due largely to a period of aggressive hydro-electricity development between 30 and 60 years ago, and the world's highest geothermal energy use per person. Notably, Sweden and Norway are also countries with a high percentage of renewables in their energy portfolio (over 50 percent and 65 percent respectively), though Norway is 97 percent concentrated in hydro power.[57]

Germany was also among the top commercialisation markets, with a long history of feed in tariff support and high renewables consumption. Under the plan known as *Energiewende,* or "energy change," Germany has pronounced an end to its nuclear program (partially attributable to the Fukushima disaster of 2011), as well as a renewed focus on promoting renewables.[58] Germany has the third largest number of publicly listed companies (after the USA and China).

UK, despite the country's many advantageous carbon policies, a new 'levy control framework', and project financing via its Green Investment Bank, it had a poor representation of cleantech companies on stock exchanges, relative to the size of its economy. **France** had an average number of M&A and IPO deals for its size, with an additionally low percent of energy consumption from renewables (13.7 percent in 2012). It is important to note, however, that public markets for cleantech stagnated globally, particularly in Europe, during the period of study (though it has begun to pick up at the end of 2013/beginning of 2014).

Though **Israel** topped the overall index, the country generates very low cleantech revenues. Israel, as well as Finland and Sweden, have demonstrated the largest gaps between 'evidence of emerging cleantech innovation' and 'evidence of commercialised cleantech innovation,' perhaps because companies in these geographies have not yet reached full maturity or are having trouble scaling up efficiently. The gap between venture capital and private equity or acquisition for these geographies may remain a concern in future years.

56 WWF Roland Berger, Clean Economy Living Planet, 2012
57 http://www.nve.no/no/Kraftmarked/Sluttbrukermarkedet/Varedeklarasjon/Varedeklarasjon-2012/
58 Energiewende, the Economist



Renewables in the Innovation Index

There has been a global shift in the kind of public finance available to renewable energy companies, with a declining support of feed-in tariffs (FITs) and other renewables incentives across Europe and India. Only in some parts of the world (namely Africa and the Middle East) have new FIT policies been implemented, with South Africa in particular, witnessing the launch of ambitious new policy frameworks. Japan also revised its New Low Carbon Technology plan, which identifies various advanced environmental technologies that have the potential to contribute to halving global carbon emissions by 2050.[59]

The shift in political sentiment towards support for renewable energy has naturally affected the investment climate for renewable technologies in these markets (at least in the short term). While 2011 was a record year for global renewables investment ($317 billion),[60] subsequent years 2012 ($286 billion) and 2013 ($254 billion) have shown a decline (a similar downward trend was also experienced in venture capital for renewables).[61] However, we will be sure to see longer term increases in global investments in the industry, especially coming from China, India and Latin America, which are already increasing their contributions. Rapid cost-cutting achieved in part through recent innovation in key renewables sectors will instil confidence for increased investments towards more innovative products and services.

On the one hand, allowing the 'invisible hand'[62] to take care of market forces can be useful in the long-term for renewables companies to increase performance without reliance on subsidies or tax incentives. On the other hand, the industry still has a way to go, given that most countries source less than 30 percent of their primary energy from renewables (with some exceptions like aforementioned Brazil or Sweden). In addition, the fossil fuel industry continues to receive much larger overall subsidies than renewables do.[63] The U.S., Germany, Canada, and China are among the top countries raising the most amount of venture capital in renewables[64] over the past 3 years.[65] According to various sources such as the 2013 PEW Charitable Trust Report, *Who is Winning the Clean Energy Race?* the same countries also had some of the most aggressive renewables targets and renewables installations.

59 http://www8.cao.go.jp/cstp/english/doc/new_low_carbon_tec_plan/summary.pdf, p 3
60 Clean Energy Investment Falls For Second Year, BNEF, Jan 2014
61 The reduced volume of investment in 2013 reflected two main influences – a continued sharp reduction in the cost of photovoltaic systems, and the impact on investor confidence of shifts in policy towards renewable power in Europe and the U.S.
62 Adam Smith's to describe the self-regulating behaviour of marketplace
63 Energy Subsidies, IEA (http://www.iea.org/publications/worldenergyoutlook/resources/energysubsidies/)
64 Includes Solar, Wind, Biofuels & Biochemicals, Biomass Generation, Hydro & Marine, Geothermal
65 Data from Cleantech Group's i3 connect platform. Venture Capital includes seed, Series A, Series B and Growth Equity

Figure 11. Venture Capital, Global Rank versus Renewables Targets and Installed Capacity[66]

Country	2011 - 2013 Venture Capital Investment in Renewables ($ millions)	Rank in the Global Innovation Index	Solar 2020 Cumulative Target	Wind 2020 Cumulative Target	Renewables share of final consumption	Cumulative Renewables Installed Capacity 2013
USA	$5118	3	14.6GW	57GW	25% by 2025	60 GW
Germany	$330	7	50GW	49GW	18% by 2020	77.4 GW
Canada	$310	9	10.6GW	15GW	75% by 2015	13.5 GW
China	$304	19	50GW	200GW	9.5% by 2015	191 GW
UK	$263	6	2.7GW	26GW	15% by 2020	18.7 GW
India	$213	21	10.9GW*	32.4GW*	15% by 2020	30 GW
France	$136	15	4.9GW	25GW	23% by 2020	14.7 GW

*INDIA'S SOLAR AND WIND TARGETS ARE FOR 2017

China is often mentioned as winning the 'clean energy race,' as it has attracted a total of $54.2 billion in project finance, has dominated exports, and is now experiencing dramatic growth in domestic solar installations (from 3.2 GW in 2012 to 12.1 GW in 2013). That said, it is far from being number one in renewables venture capital investment, most likely because several renewable sectors (namely solar) are undergoing consolidation and growth at the moment, rather than generating a new crop of innovative companies; and because the capacity and compulsion to innovate locally is not as strong in China today as in, say, the U.S. Japan was another country with honourable mention in the renewable space, because it has invested considerably in small-distributed capacity, but has not yet garnered attention from venture capitalists in the past few years. The innovations in Japan are still coming from the very large industrials, like Mitsubishi or Nissan, not from start-ups. While the U.S. and Germany top the charts in venture capital, the countries' reduction in incentives for renewables in 2013 might simultaneously get reflected in reduced renewables innovation over the next few years.

Breaking down renewables by a few sample sectors (solar, wind, marine power), also brings interesting insight into what type of innovation is trending in a given country. We see that countries which are adapting to new global renewables consumption patterns, are also generating interesting new business models which will make them globally competitive over the next decade.

Solar

The U.S. has achieved the most amount of venture capital towards solar, just as they have across all sectors of cleantech. However, because of the changing solar landscape, in which China has been winning the race in solar module manufacturing and prices, venture capital has been flowing mostly towards U.S. downstream solar companies (e.g. financing, instalment, monitoring) as opposed to builders of physical parts to a solar module, plant or tower. Coincidentally, the U.S. has also scaled back on its grant making towards solar hardware companies in favour of companies that decrease the 'soft costs' of solar, which are the enablers of mass deployment. For example, the Department of Energy's Sunshot initiative incubator program, has selected more non-hardware companies in 2012 and 2013, such as Mosaic (the organizer of community solar financing projects) and Clean Power Finance (provider

66 Table Sources include: PEW Charitable Trust, Who is Winning the Clean Energy Race?, 2013; REN21 Global Status Report 2014; Energy Information Agency, Annual Energy Outlook 2012 (USA); Database of State Incentives for Renewables & Efficiency (DSIRE), average of 36 States' Renewable Portfolio Standard targets (USA); National Renewable Energy Action Plan 2010-2011 (Germany, UK, France); European Wind Industry Association, Pure Power III (Germany, UK) ; Canadian Solar Industry Association, Solar Vision 2025 Report; National Energy Board, Canada's Energy Future 2013 Report; National Action Plan on Climate Change (India).

of finance and software for distributed solar energy) than in the 2007-2008 class, where hardware companies like Abound Solar (thin film PV cell maker) and Solexel (crystalline silicon solar cell producer) were better represented.

Germany scaled back its subsidized support for solar companies, which subsequently resulted in high profile bankruptcies in 2011 and 2012 (e.g. Q-Cells, Odersun, Solon). As a result, venture capital has turned its attention towards less capital intensive 'cleanweb' solar companies such as pvXchange (developer of an online wholesale trade platform for the downstream PV market) or the Changers (developer of a social energy platform for charging mobiles through a portable off-grid solar system).

At the opposite end of the spectrum, China has continued to emphasise innovation in advanced materials for solar modules to increase the performance of solar power installations. For example, Dupont, the chemicals giant, is collaborating with Zhenfa New Energy (a Chinese EPC and power generation company) and separately Yingli Energy (a Chinese PV manufacturer) on advanced materials research. The Government has set a target of 14GW of installed solar for 2014 and is taking steps to enable further integration of renewable sources by installing ultra-high-voltage electric power transmissions across the country. Due to the country's large financial reserves, its generous incentives for cleantech, and a strong domestic market, western renewables companies have been particularly attracted to China.[67]

Much innovation in the solar space continues to focus on better integration with the power system and further cost cutting. Various companies such as SMA Solar Technologies (Germany) are developing photovoltaic inverters with integrated energy storage, which make solar consumption even more convenient to households. Others, like Convertergy (China) and Optistring Technologies (Sweden) are solving the problem of power loss, through development of cost efficient modules and software control tools.[68]

Wind

Europe, and in particular, Germany, the UK and Denmark, is strong in the wind sector, thanks to a history of incentives (such as FITs). Moreover, with leading wind turbine manufacturers such as Vestas, Siemens Wind Power, and Enercon, Europe persists as the largest market of wind power shareholders. However, as the industry has matured the new crop of wind technology start-ups are now in the field of monitoring and control – focused on improving operational efficiency of existing wind farms, as opposed to building new capacity. An example of a new innovator in the wind sector includes CyberHawk Innovations, the UK provider of aerial infrastructure inspection services.

Venture capital in the wind sector has also recently been flowing in additional parts of the world which are increasing their wind generation focus - China, India and also Sweden and Belgium. Coincidentally, India has installed 1729 MW in 2013 alone and will continue to be a moving force, as the country attempts to roll out its national "wind mission" consisting of grid improvement.

Offshore wind development, in particular floating turbines, holds promise for coastal countries like Japan and South Korea, which have strong offshore wind deployment targets. The UK has the largest offshore market in the world (around 3681 MW) [69] as well as an established offshore wind accelerator (OWA) managed by the Carbon

67 More Western clean-tech companies take off in China, but there are gaps in the runway: http://www.eenews.net/stories/1059975492
68 http://climatesolver.org/innovations/supplying-energy/solar-pv-optimizing-inverter
69 GWEC, Global Wind Report 2013

Trust,[70] which finances companies like SPT Offshore, that have installation and engineering expertise of offshore vessels.

In the U.S., which is also a big wind market, companies are concentrating on making blades more aerodynamic by using different advanced materials (such as nanotechnology). As an example, Electron Energy Corporation produces rare earth materials and magnet products.

Various innovative companies are also now harnessing the excess power of wind to convert it to water or energy. French company Eole Water for instance, has modified a traditional wind turbine design to create an appliance that can manufacture drinking water – enabling rural areas to become self-sufficient in terms of water supply.

In Germany and Denmark (countries with a surplus of wind energy), energy storage companies are applying their core competences in electrolysis[71] and hydrogen productions towards wind power-to-gas (P2G) applications. These technologies tap into an otherwise curtailed power from wind farms and feeds it into the gas distribution grid. There are several P2G companies opening the possibility for utilizing excess energy in different ways whether it is for hydrogen (e.g Sunfire) or synthetic natural gas (e.g. Etogas).

Energy Storage/Smart Grids

Smart grid distribution systems and energy storage can boost renewable energy's significance by overcoming the intermittency obstacle and enabling far more distributed power than conventional forms of energy.[72] New innovation has surfaced in the form of intelligent power grids, i.e. where communications and 'internet of things' (advanced connectivity devices) is allowing for fluctuating renewable power generation to be optimally managed and consumed. These technologies are connecting different parts of the energy system 'virtually' to provide a decentralised reserve capacity and demand-side management of renewables.

Energy storage optimizes the existing electric power system and facilitates more renewable energy deployment, creating a virtuous cycle leveraging further renewable energy penetration and cost decreases. A large range of chemical, mechanical, thermal and gravitational energy storage options are commercially available and already being deployed on the grid. In fact, storage options like flywheel energy storage is far more effective at balancing the grid compared to fossil back-up solutions.

Energy storage models globally are specializing in eliminating issues of intermittent power output, and preserving the reliability of the grid as more renewable sources go online. Examples include General Compression (USA), the developer of isothermal compressed air storage[73] systems, Isentropic (UK), the producer of pumped heat electricity storage systems and Sonnenbatterie (Germany) the specialist in solar PV and micro-CHP storage systems.

Concurrently, Utilities are increasing their engagement with energy storage innovation, so as to optimize their own arrays for the purposes of selling their excess power, or for arbitrage. As a result, several companies in the US, like Stem and Green Charge Networks, are providing software and web tools specifically designed for utilities to monitor energy usage or to utilize reserve capacity in existing power infrastructure (e.g. AES Energy Storage).

70 The OWA accelerator is two thirds funded by utilities and other industry players. http://www.carbontrust.com/our-clients/o/offshore-wind-accelerator

71 Running an electrical current through water

72 The Third Industrial Revolution: Leading the Way to a Green Energy Era, Jeremy Rifkin

73 Regenerating energy using the waste heat energy from compressing air

In Asia and elsewhere, companies are building materials innovation (anodes, cathodes, separators) mainly around lithium ion batteries as a high-energy capacity option for use in tandem with renewables generation; examples include Kureha Battery Materials (Japan) and Cnano Technology (China).

Geothermal

Technology to harness geothermal resources has existed for many years and is competitive with conventional energy in many places around the world with large potential for further scaling. In the innovation space there are various on-going pilots in the area of Enhanced Geothermal Systems (EGS), an engineering technique used to artificially create hydrothermal resources to generate electricity. There is no commercial-scale EGS plant to date, although projections of installed capacity from EGS in the U.S. could amount to 100,000 MW in the U.S. by 2050.[74]

There are also small pockets of innovative companies which are refurbishing and improving performance of existing facilities and power plants. For example, Greensleeves (US) has developed intelligent controls to improve cost barriers to implementing geothermal into thermal control systems. Exergy (Italy) has also developed an outflow turbine for Organic Rankine Cycle (ORC)[75] to advance the efficiency of numerous geothermal plants including Enel Green Power's 1MW plant in Monte Amiata.[76]

Retrofitting of ground source heat pumps used for energy efficient heating and cooling of homes and other buildings is another up and coming innovation area. Companies involved in this area include Ice Energy (UK) and Hero Renewables (USA).

Tidal & Marine Power

While large scale hydro development has been dominated by a specific set of leaders (Alstom, Andritz, IMPSA, and Voith), there is much innovation in wave, tidal and smaller hydro-power technology. Innovative marine power companies for instance, are looking to help increase capacity of existing large hydropower and to tap into growing hydro consumption markets, such as China. For example, OpenHydro group, the Irish manufacturer of marine turbines, has established various joint ventures and international partnerships to create utility-scale tidal generation. Furthermore, Eco Wave Power, the Israeli hydrokinetic developer, has established a China-based production facility, to promote its technologies throughout the country.[77]

In the UK, there are several wave energy converter companies achieving venture capital traction, examples include Aquamarine Power and Scotrenewables. The 'Deep Green' concept is also up and coming in the tidal space, which is associated with unlocking inaccessible deep water and harnessing power from low-velocity currents. The Department of Energy and Climate Change (UK) recently awarded support to three companies in this area (Minesto, IT Power and NPL).[78]

In Europe, service-oriented businesses are trending, such as Geppert, the Austrian provider of electrical and mechanical equipment for small hydropower plants, receiving €15 million in 2013 from Mountain Cleantech and Austria Wirtschaftsservice. Operators of small hydro projects, generally have a need to improve the timing, scheduling and utilization of their sites.

74 http://www.c2es.org/technology/factsheet/EGS
75 ORC – the use of a high molecular mass fluid for heat recovery from geothermal or other low temperature sources
76 REN21 Global Status Report 2014, p41
77 Israeli wave energy company turns on Chinese subsidiary, Cleanbiz.Asia
78 http://www.plantengineer.org.uk/plant-engineer-news/half-million-decc-award-for-deep-green-tidal-power/59768/

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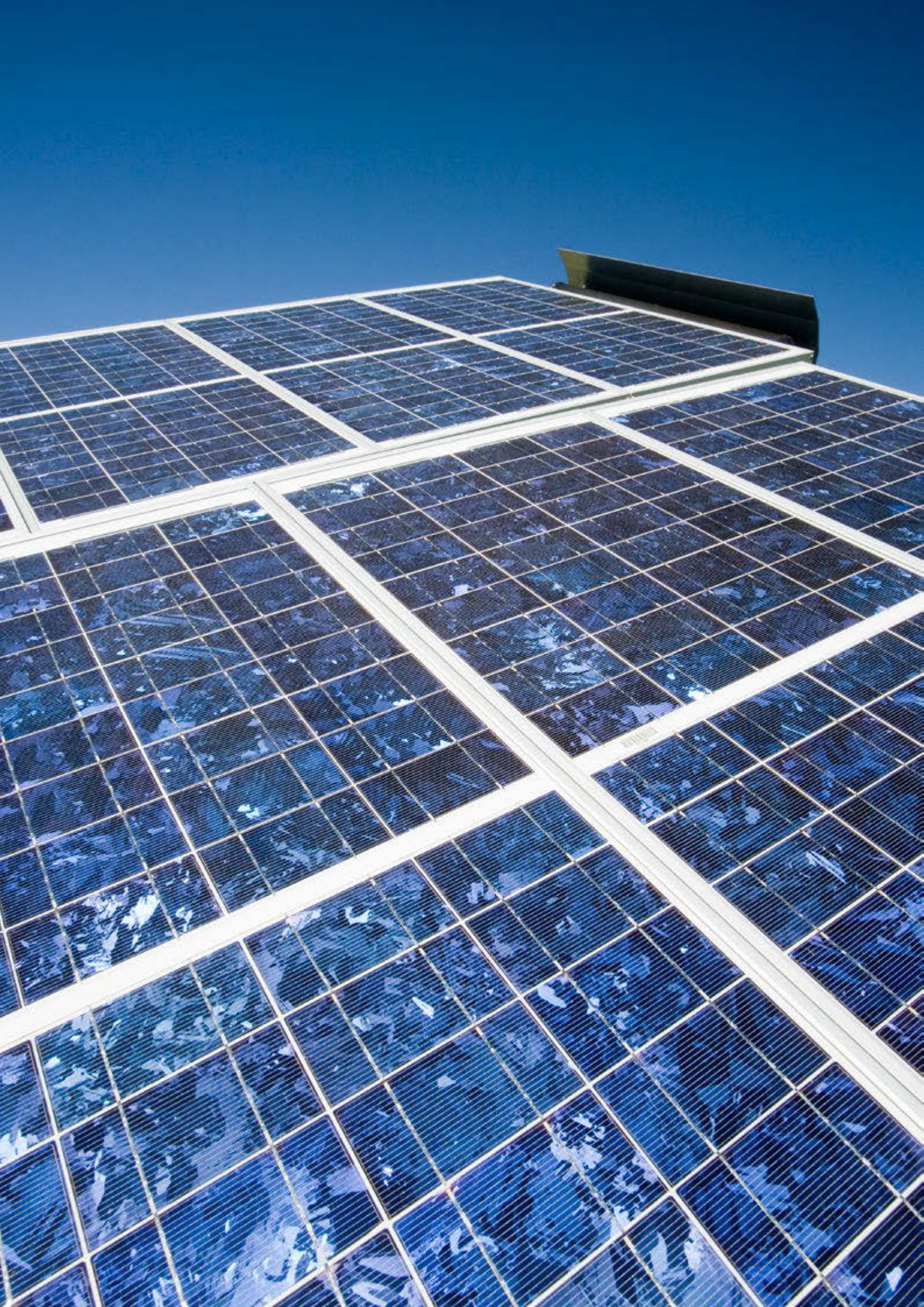
Other

Over half of the chemical energy from fossil or renewable fuels today is lost during combustion processes, primarily as waste heat. In industrial applications and in transportation, large quantities of waste heat remain unused. The primary area of innovation in bioenergy has been in this area, specifically in waste heat recovery technology, such as HeatMatrix (Netherlands) which converts waste heat from flue gas and preheat combustion air. Other companies are specialized in thermo-electric products, such as Alphabet Energy (U.S.) O-Flexx Technologies (Germany) or Sheetak (India).



Conclusion

More needs to be done globally across all factors of the innovation index, whether it is to increase investment in research (cleantech R&D currently represents less than 3 percent of total global R&D spend); diffuse low carbon solutions at the scale required to combat climate change (estimated to be an extra $480 billion investment inflows per year to 2030 to avoid a temperature increase of greater than 2°C); [79] revamp aging energy infrastructures to accommodate a new set of technologies; or facilitate the right education, training and mind-set for entrepreneurs of the next decade. Technological progress has certainly been made in the last decade, with evidence of mature cleantech found in wind power, solar energy and LED lighting. However, the next wave of cleantech businesses will require not just capital and policy backing to grow – they will need to build relationships with local and international partners to bring them to desirable scale.

Policymakers have the opportunity to help start-ups both capitalize on the needs of their domestic markets and take innovation to the next level, by partnering internationally on cleantech strategy or funding and learning 'how they do things' in the East or West, North or South. Countries that fall behind the curve on the index can seize the opportunity to address their gap on cleantech innovation by engaging in cross border alliances and discussions. Countries that have smaller domestic markets yet a knack for developing cutting edge technologies will need to help their enterprises access larger cleantech hungry populations in other geographies and markets. And on the reverse side, countries that have large domestic markets but need to catch up on generating innovative companies will look to partner with smaller start-up generator countries to learn from their technological expertise.

The world needs to accommodate an additional 3 billion people by 2050 all of whom will wish to have a good quality of life, and access to food, water and energy privileges. We are already seeing a shift in countries' mind-sets towards cleantech – evidenced by new policies and new programs to expedite sustainable innovation such as South Korea's fast track green patent process and China's investment into renewables worth billions over the next decade. Even the 'laggards' are reacting to changes in the global landscape, increasing their activities in areas where they have never before been present.

In our view, initiatives like Tekes and MOST joint call for cleantech proposals between Finland and China are worth watching – as they may prove to be a lead example of a new direction for innovation policy in clean technology. Strategically combining the strengths of the world's best Start-Up Generators (eg Finland) with the Strongest Commercialisers (eg China) carries a lot of potential for years ahead.

79 IPCC WG III on Mitigation, Annual investment Flows to 2030

Appendix A: Indicators and Sources [80]

General innovation drivers				
Indicator	**Source**	**Date**	**Definition**	**Weight**
General innovation inputs	INSEAD Global Innovation Index	2013	Insitutions, human capital, infrastructure, market sophistication and business sophistication facilitating innovation	50%
Entrepreneurial culture	Global Entrepreneurship Monitor	2013	Positive attitudes towards entrepreurship and early stage entrepreneurial activity	50%
Cleantech-focused innovation drivers				
Indicator	**Source**	**Date**	**Definition**	**Weight**
Cleantech-friendly government policies	The Pew Charitable Trusts Clean Energy Race Report and Cleantech Group research	2013	Government policies supporting clean energy including tax incentives, feed-in tariffs, renewable energy mandates and others	25%
Government R&D expenditure in cleantech sectors	International Energy Authority (IEA) RD&D budget data ; IEA Report - Tracking Clean Energy Progress	2011	Total budget for cleantech R&D as a proportion of GDP (PPP)	25%
Access to private finance for cleantech start-ups	Cleantech Group data	2011 - 2013	Number of cleantech investors and cleantech-focused funds recently raised weighted by GDP	25%
Country-attractiveness of Renewable Energy Infrastructure	Ernst & Young Renewable Energy Country Attractiveness Index	2013	National renewable energy markets, renewable energy infrastructures and their suitability for wind, solar, biomass and other renewable energy technologies	20%
Cleantech cluster programs & initiatives	Cleantech Group research	2013	Number of industry associations, physical clusters and economic initiatives supporting the cleantech industry as a proportion of GDP (PPP)	5%
Evidence of emerging cleantech Innovation				
Indicator	**Source**	**Date**	**Definition**	**Weight**
Patents in cleantech sectors	OECD database	2011	Environment-related technology patents filed under the Patent Cooperation Treaty weighted by GDP (PPP)	45%
Early-stage private investment	Cleantech Group data	2011 - 2013	Amount of venture capital invested in cleantech companies as a proportion of GDP (PPP)	45%
High impact cleantech start-ups	Cleantech Group data	2011 - 2013	Number of companies included in the Global Cleantech 100 weighted by GDP (PPP)	10%
Evidence of commericalised cleantech innovation				
Indicator	**Source**	**Date**	**Definition**	**Weight**
Revenue of cleantech companies	WWF/Roland Berger Clean Energy, Living Planet and UK Department for Business Innovation & Skills, Low Carbon and Environmental Goods and Services report	2012	Value-added from cleantech manufacturing as a proportion of GDP and revenue of Low Carbon and Environmental Goods and Services companies as a proportion of GDP (PPP)	50%
Renewable energy consumption	BP Statistical Review of World Energy 2013	2013	Renewables as % of Primary Energy Consumption	20%
Late-stage private investment and exits	Cleantech Group data	2011 - 2013	Number of cleantech private equity deals M&As, and IPOs weighted by GDP (PPP)	15%
Successful publicly traded cleantech companies	Cleantech Group, FTSE, Ardour and WilderHill indices of publicly traded cleantech companies	2013	Number of listed cleantech focused corporates weighted by GDP (PPP)	10%
Renewable Energy Jobs	IRENA Renewable Energy and Jobs Annual Review	2014	Number of direct and indirect employees related to renewables by total labor force	5%

80 The notable differences in the methodology (compared to the 2012 index), include: 1) the use of per GDP purchasing power parity (PPP) as an underlying comparative metric rather than just per GDP to take into account relative costs and inflation rates 2) Renewable energy consumption calculated as a % of primary energy rather than weighted by GDP as a better measure for ambition towards 100% renewables 3) Employment figures were estimated as renewable energy jobs rather than low carbon jobs due to availability of data.

Appendix B: Methodology Considerations

We would like to acknowledge that despite the robust methodology for this index, like in any study, there are parts of the framework which could be improved given a wider availability of data. For instance, while public R&D data was included in the report, private R&D data was not. However, there are still barriers and a lack of incentives for the private industry to confidentially report on R&D data.[81]

In addition, we would have also liked to include an energy efficiency indicator, given that it is the largest and fastest growing sector in cleantech. However, besides the American Council for an Energy-Efficient Economy (ACEEE) scorecard which rates countries on various metrics (like energy consumption of commercial buildings), only 12 economies were considered in their study, without enough proxies to extrapolate effective estimates for the other 28 countries).

Furthermore, while Cleantech Group collects data on early stage funding from venture capital, other types of financing (i.e from private banks) could also generate a more granular picture of early stage capital commitment, especially as other such sources are becoming increasingly important at the early-stage. However, we did not find a comprehensive data set on this metric either.

And finally, we considered factoring in a country's domestic market size as well as their focus on collaboration and trade, as they could illustrate even more accurately, the likelihood that companies are able to commercialise both inside their local economies and internationally. However, we did not find an applicable structure which could fit within our framework, nor did we want to devalue the other very cleantech specific sub-factors within the 'evidence of commercialised cleantech innovation' driver.

Appendix C: Abbreviations

VC: Venture Capital - Investment from investors seeking private equity stakes in start-up and small- and medium-size enterprises with strong growth potential. These investments are generally characterized as high-risk/high-return opportunities.

M&As: Mergers & Acquisitions – Refers to the aspect of corporate strategy, corporate finance and management dealing with the buying, selling, dividing and combining of different companies that can help an enterprise grow rapidly.

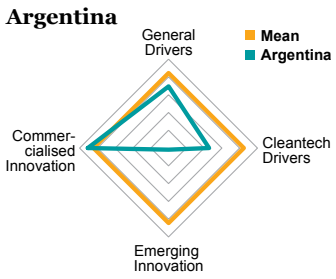
IPO: Initial Public Offering - A stock market launch. IPO is the first sale of stock by a private company to the public. It can be used by either small or large companies to raise expansion capital and become publicly traded enterprises.

81 IEA, Tracking Clean Energy Progress, 2012

Appendix D: Country Profiles

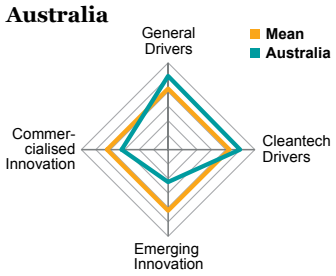
Argentina

Argentina excels in early-stage entrepreneurial activity, but is below average in general innovation inputs. The country is relatively attractive for renewables but has little public cleantech R&D and access to private finance. Low scores on all emerging cleantech innovation indicators result in a score well below average. Argentina stands out only on commercialised cleantech innovation, with very strong cleantech company revenues though it lacks publicly traded cleantech companies and later-stage deals. Argentina is below neighbour Brazil but above Mexico
in the overall index.



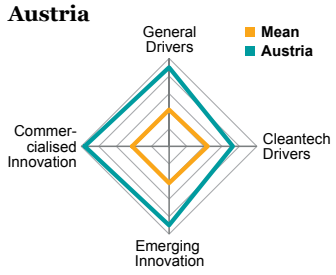
Australia

Australia scores very well on innovation drivers, but ranks lower on innovation outputs. The country's performance on general drivers was built on a reasonably entrepreneurial culture and good early-stage entrepreneurial activity. Cleantech-specific drivers are supported by Australia's attractiveness for renewables, mainly due to its geo-climatic features, and a good number of cleantech funds. While Australia has seen a number of later-stage cleantech transactions, the country's commercialised and emerging cleantech innovation score are held back by low renewable energy consumption. Uncertainty surrounding the continuation of carbon pricing, the renewable energy target and other policies has correlated with weaker early-stage private investment in the country.



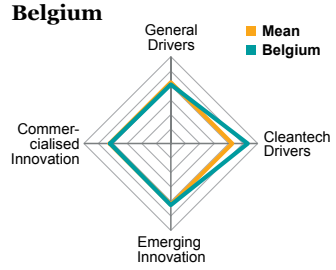
Austria

Austria has largely above-average scores in all innovation outputs and relatively strong innovation drivers. General innovation factors benefit from an increasingly entrepreneurial culture. Good public R&D spending counterbalanced by low access to private finance for cleantech start-ups result in a slightly above-average cleantech specific drivers' score. Austria scores well on outputs of innovation, with excellent production of environmental patents and largely above-average renewable energy consumption. Austria sits in a similar position to Belgium and France but falls behind Germany and Nordic leaders.



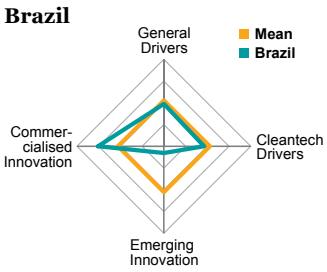
Belgium

Belgium scores average in all areas but for cleantech innovation drivers, where they scored above the mean. Poor entrepreneurial culture and low early-stage business activity lower the country's general innovation drivers score. In contrast, top government policies and large cleantech funds focused on the country pulls up its cleantech-specific innovation drivers' score. Belgium has otherwise average innovation outputs, undermined by low renewable energy consumption and cleantech companies revenues, despite good VC activity and a good number of deals. Belgium sits in a similar position to Austria and France, behind Northern Europe, the US, and Asian leaders.



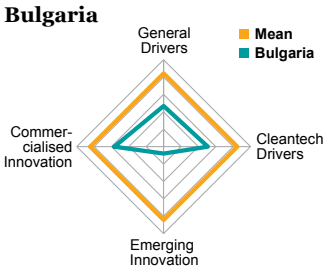
Brazil

Brazil has slightly below- average innovation and emerging cleantech drivers, but the country is in the top three in commercialised cleantech innovation, primarily due to its established biofuels industry. However, it falls behind on the emerging cleantech innovation score with few patents and below-average venture capital investment. Brazil has a very strong entrepreneurial culture but lacks other innovation inputs, public R&D spending, and cleantech-focused investors. Scoring better than Argentina and Mexico, Brazil falls behind other emerging giants such as India and China.



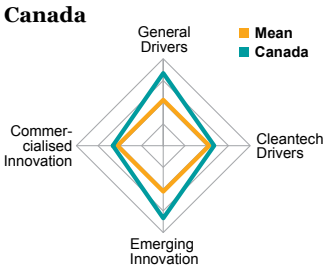
Bulgaria

Bulgaria rates fairly low on all four factors, with particularly weak innovation output scores. Bulgaria stands out for having very few cleantech investors and funds, VC investments, or later-stage deals. Entrepreneurial attitudes in the country are also relatively weak. However, the country is stronger in consumption of renewable energy and the proportion of its population working in renewable energy businesses. The country tops only Russia and Greece in the overall index, though it falls short of higher ranked Eastern European countries such as Romania, Poland and Turkey.



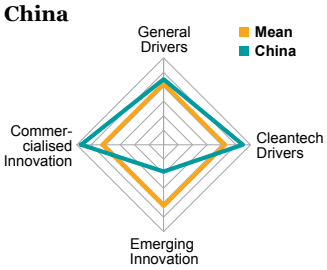
Canada

Canada sits in the top 10 of the overall index and has excellent general innovation inputs, but does not stand out on cleantech-specific drivers. With excellent entrepreneurial attitudes, the country has very strong general innovation inputs but lacks strong government policies in support of cleantech innovation. The country has seen strong VC investment, along with a good number of high-profile cleantech companies and scores well on emerging cleantech innovation. On the downside, the country's commercialised cleantech score is held back by small cleantech revenues. Canada scores below Northern Europe and its immediate neighbour the US.



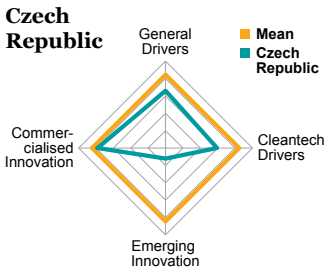
China

China has average general innovation drivers with a strong early-stage entrepreneurial activity but does better on cleantech-specific drivers due to top scores for attractiveness of infrastructure for renewables and cleantech funds. Despite this, currently limited VC investment for the size of the economy and a low number of environmental patents kept the country's emerging cleantech innovation score well below average. In contrast, China is in the top ten on commercialised cleantech with the most cleantech IPOs after Israel as well as strong cleantech manufacturing and revenues.



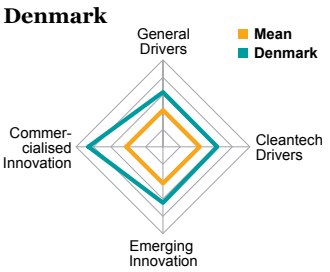
Czech Republic

The Czech Republic scores below average on all four factors. The country has poor entrepreneurial attitudes, very low public cleantech R&D spending and lacks a local cleantech investment community, which pulls down its innovation inputs scores. Despite this, the Czech Republic has a good added value to its clean economy and average cleantech companies revenues, scoring better for commercialised cleantech. The Czech Republic stands out from its European neighbours for its weak emerging cleantech innovation score, due to scarce VC investment and few environment-related patents. Overall, the country ranks poorly against neighbours Germany, Austria and Hungary, though it comes ahead of Poland. Overall, the country ranks poorly against neighbours Germany and Austria, though it comes ahead of Poland and just behind Hungary.



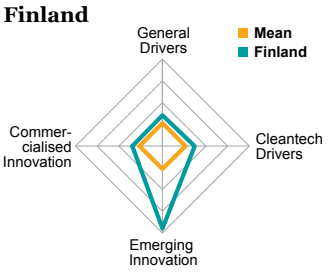
Denmark

Denmark ranks fifth on the overall index, and is first for cleantech-specific drivers. The country has excellent general innovation inputs and strong cleantech policies, including ambitious green energy provisions until 2020. It has a number of high-impact cleantech start-ups, and a relatively high number of investors, but on the other hand, a stagnant number of environmental patents and a decreasing amount of venture capital compared to prior years. However, its top score for commercialised cleantech demonstrates a thriving clean economy, and density of publicly traded cleantech companies. Denmark tops Norway in the overall index but falls behind neighbouring Sweden and Finland.



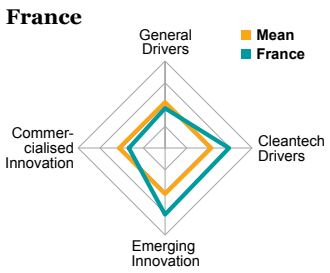
Finland

Finland takes the second place on the overall index. The country scores second on both cleantech innovation drivers and evidence of emerging cleantech innovation. It has strong general innovation inputs, such as cluster development and human capital, and ranks second for public R&D, though it lacks availability of cleantech specific funds. Finland's top emerging cleantech innovation score is supported by its high-profile cleantech companies and many new environmental patents. However, Finland is not as successful in commercialising cleantech innovation, with average cleantech companies revenues and few M&As and IPOs. Finland scores above neighbours Sweden and Norway, and above the US.



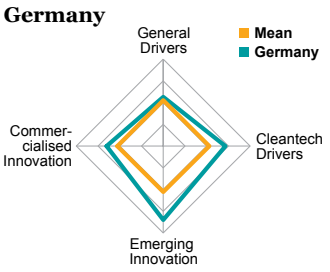
France

France ranks above average on the overall index, though its strengths lie in the cleantech innovation drivers. France has strong public R&D and attractive infrastructure for renewables as well as abundant cleantech funds. The country scores relatively high on emerging cleantech innovation, thanks to good VC investment and environmental patents. France's other scores are below average, with its general innovation drivers score pulled down by a score below average on entrepreneurial attitudes. The country fell behind for commercialised cleantech due to little value-added cleantech manufacturing, despite a number of recent IPOs and good cleantech companies revenues. France has fallen behind Northern European neighbours such as Germany and the UK but tops Southern countries such as Italy and Spain.



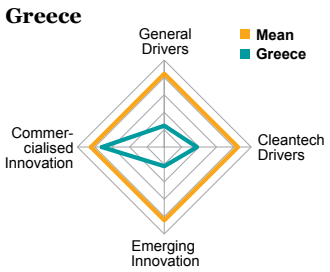
Germany

Germany shows high scores on all factors except general innovation drivers, where it is slightly above average. The country has strong general innovation inputs but this is not matched by positive attitude towards entrepreneurship or level of early stage entrepreneurial activity. The country is very attractive for renewables and shows a good number of cleantech funds, Germany scores high on cleantech-specific drivers in spite of supportive government policies and good public R&D. Germany is in the top 10 for environmental patents per GDP and shows good signs of emerging cleantech innovation. Cleantech manufacturing is well developed, while high renewable energy consumption built on a history of strong incentives provides a strong domestic market. Germany is among the top scoring countries in Europe, alongside the UK, Ireland, Netherlands and the Nordic countries.



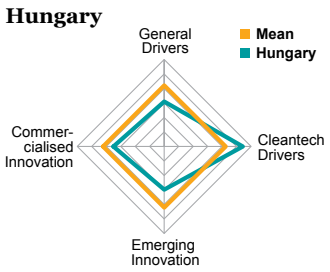
Greece

Greece sits at the bottom of the overall index, followed only by Russia, and is the worst performer in innovation drivers. The country lacks both innovation inputs and emerging cleantech innovation. Moderate investment activity in cleantech fails to offset very low public R&D funding and a less attractive infrastructure for renewables then in past years, resulting in a low cleantech-specific drivers score. Average VC investment failed to deliver high-profile cleantech companies and environmental patents, meaning a low emerging cleantech innovation score. Slightly above-average cleantech manufacturing revenues were thwarted by low renewable energy consumption and the few later-stage deals led to a low commercialised cleantech innovation score.



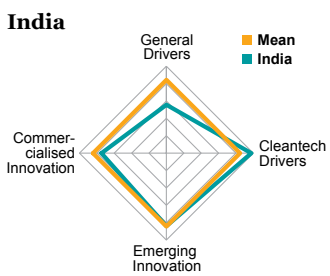
Hungary

Hungary scores below average for all factors except cleantech-specific drivers. The country lacks strong general innovation inputs and entrepreneurial culture. Average venture capital activity does not offset low-profile companies and failure to support environmental patents, resulting in a low emerging cleantech innovation score. Very low renewable energy consumption and a lack of late-stage cleantech companies account for a weak commercialised innovation score. However Hungary does have relatively strong public R&D and supportive government policies but lacks a favourable environment for renewables deployment. Hungary scores behind most Central European countries, but comes top in Eastern Europe and above neighbours Romania, Bulgaria, and Slovenia.



India

India scored average on the overall index. The country has weak general innovation inputs and average entrepreneurial culture. This contrasts with its high score in cleantech-specific innovation drivers, based on the country's public R&D spending and density of cleantech funds. Good VC investment fails to offset a low number of environmental patents and few high-profile cleantech companies, resulting in an average emerging cleantech innovation score. The country performs slightly worse on commercialised cleantech, its score pulled down by low renewable energy consumption and few publicly traded cleantech companies. India ranks above Indonesia but below China and Singapore.

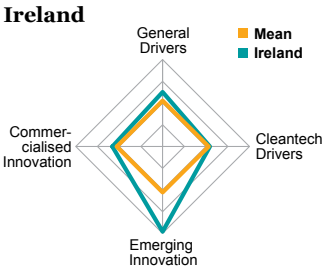


Indonesia

Indonesia has the lowest emerging innovation score and is the lowest ranking Asian country in the overall index. The country has the lowest general innovation inputs but has a strong entrepreneurial culture, coming in first for early-stage entrepreneurial activity per GDP, resulting in an average general innovation score. Good attractiveness for renewables, including newly implemented tariffs for geothermal energy, fails to counterbalance a lack of local cleantech investors. The country scored last on all emerging cleantech indicators, with little evidence of venture capital activity, high impact start-ups, or patents. However, Indonesia has strong revenue from cleantech companies but this does not offset low renewable energy consumption and a lack of later-stage cleantech deals.

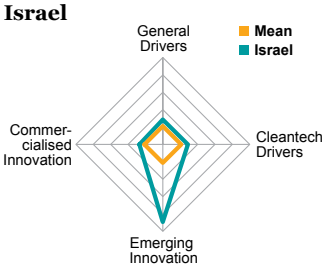
Ireland

Ireland scores especially well on evidence of cleantech innovation, and is above average on other drivers. Ireland has numerous supportive cleantech organisations relative to its size. Ireland stands out for emerging cleantech innovation due to its top 10 early-stage investment and high-impact cleantech start-ups. By contrast, the country is barely above average for commercialised cleantech innovation, with several publicly traded cleantech companies and a large percentage of the population working in cleantech, but low cleantech companies revenues. Ireland sits in a similar position to Germany and the Netherlands but falls behind the UK and the Nordic countries.



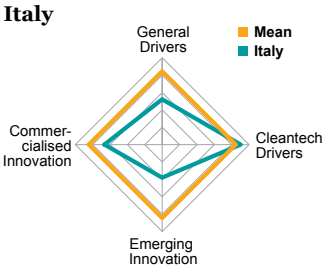
Israel

Israel places first on the overall index, with extremely high evidence of emerging cleantech innovation drivers. The country has demonstrated the greatest density of high-impact cleantech start-ups, as well as a high level of business sophistication and entrepreneurial attitudes, strong venture capital activity, and a good number of environmental patents. Israel has increased its supportive government policies and has early stage cleantech-oriented funds as well as substantial M&A activity, even while cleantech company revenues remain low. The country has seen an impressive number of cleantech companies voted into the Global Cleantech 100 index per GDP over the past 2 years.



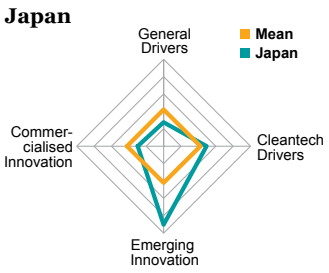
Italy

Italy scores well on cleantech-specific innovation drivers but falls behind on all other factors. An insufficient entrepreneurial culture and a dearth of new businesses translate in to one of the lowest general innovation drivers' scores. Although there have been supportive policies for renewables and innovation support systems, the government's contradictory actions in recent years has created uncertainty for investors. There is also a lack of cleantech-focused funds and investors. Mediocre venture capital activity, environmental patenting and few high profile cleantech companies led to a low evidence for emerging cleantech. Italy scored slightly better on commercialised cleantech innovation due to above average cleantech companies revenues and number of jobs per GDP. The country scores low in the overall index, below most of Western Europe.



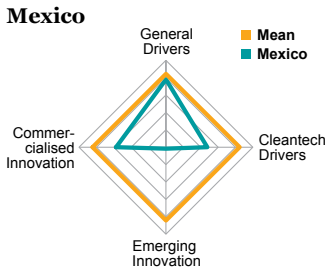
Japan

Japan is the highest ranking Asian country. It topped the list for environmental patents, in both relative and absolute terms, leading to its high score on emerging cleantech innovation. On the other hand, the country scores very low for VC activity and for high-impact cleantech start-ups. This is not surprising given the country's good score for general innovation inputs (e.g. research, government effectiveness and education) but very low score for entrepreneurial culture. Japan also has few cleantech focused investors and organisations but balances that with good public R&D spending. The country improved in its attractiveness for renewables after key policy developments and new feed-in tariffs. Despite good cleantech revenues, Japan scores low in commercialised innovation, due to insufficient access to private finance.



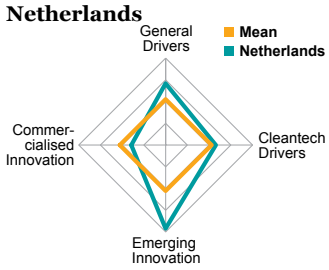
Mexico

Mexico scores below average on every indicator except general innovation drivers, fostered by a strong entrepreneurial culture and new tax incentives for SMEs. Recently approved cleantech-friendly government policies and R&D budget have yet to improve access to private finance or increase local cleantech investors' start-ups in the country. Little venture capital investment and no high-profile cleantech companies account for a low score on emerging cleantech innovation. The country also lacks: renewable energy consumption in the residential sector, later-stage deals and publicly traded cleantech companies. Overall, Mexico scored lower than Brazil and Argentina.



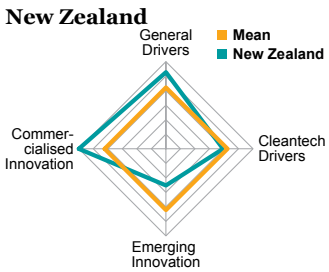
Netherlands

Overall, the Netherlands scores above average but falls behind on commercialised cleantech innovation due to low cleantech manufacturing and a lack of publicly traded cleantech companies and IPOs. The country has strong general innovation inputs and government policies supportive of cleantech, but a lower density of cleantech-focused funds. This is counterbalanced by a good number of local investors, resulting in a slightly above-average score for cleantech innovation drivers. Many environmental patents, a number of high impact start-ups and VC activity mean the country scores well for emerging cleantech innovation. The Netherlands ranks above its southern neighbours but below Germany, the UK and the Nordic countries.



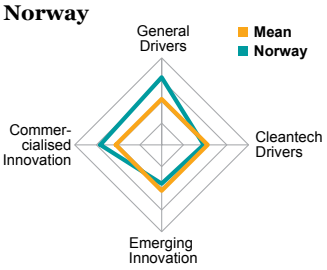
New Zealand

New Zealand ranks third overall in commercialised cleantech but well below average on emerging cleantech innovation. The country has good general innovation drivers (investor protection, knowledge economy) and good entrepreneurial culture. On cleantech-specific drivers, New Zealand stays above average thanks to an attractive infrastructure for renewables, although it has weaker R&D spending and cleantech funds. By contrast, low VC activity pulls its emerging cleantech score down despite an average number of environmental patents. Finally, New Zealand stands out for commercialised cleantech, mainly due to its top renewable energy consumption (although most of its renewable energy capacity was built 30 to 60 years ago) and the proportion of its population working in that sector.



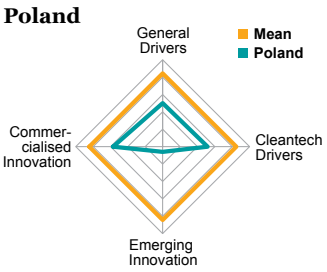
Norway

Norway scores well on general innovation drivers, due to strong innovation inputs, as well as above average entrepreneurial culture. The country falls below average for cleantech-specific innovation drivers due to low support mechanisms for renewables innovation, low public R&D budgets and weak cleantech funds, although it has a number of supportive clusters and investors. Norway sees a number of high-profile cleantech companies and environmental patents but below-average VC investments amount leads to a modest emerging cleantech innovation score. However, the country has a high density of publicly traded cleantech companies and good IPO and M&A numbers, resulting in a good commercialised cleantech innovation score. Norway ranks high on the list, but falls below the other Nordic countries.



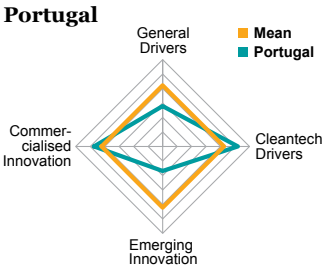
Poland

Poland scores very low on all four factors in the cleantech innovation index. The country has poor general innovation drivers, limited access to private finance and low public R&D, resulting in weak scores for both general and cleantech-specific innovation drivers. The country has seen virtually no VC investment or high-profile cleantech companies and has produced few environmental patents. On the bright side Polish cleantech companies have moderately strong revenues, but still lags in terms of late-stage deals and renewable energy consumption. Poland sits low in the list, overtaking only Russia, Turkey and Bulgaria.



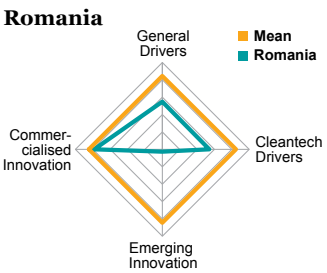
Portugal

Portugal scores below average on the general index. The country lacks general innovation inputs, an entrepreneurial culture, high-profile cleantech companies and produces few environmental patents, resulting in low scores on general innovation drivers and emerging cleantech innovation. However, Portugal's supportive government policy and strong public R&D budget lead to an above average score for cleantech-specific innovation drivers, despite scarce cleantech funds and organisations. The country also scores well on commercialised cleantech innovation, mainly due to moderate cleantech companies' revenues and renewable energy consumption, but has yet to produce late-stage deals and IPOs. Portugal scores above Italy and Spain but below other Eastern European countries.



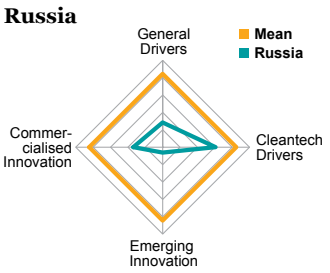
Romania

Romania held mostly below average but received a better score on commercialised cleantech innovation due to moderate cleantech revenues and above average private equity investments. Otherwise, the country lacks general innovation inputs, early-stage financing, and a local cleantech investment community, but shows above-average government support. There is little emerging cleantech innovation, as seen by very low scores for venture capital activity, environmental patents, and high-impact start-ups. Romania sits below most central and Eastern European countries except Bulgaria.



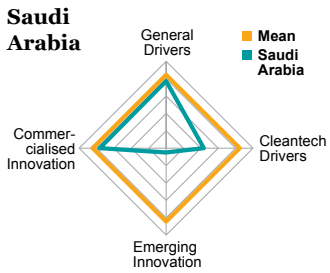
Russia

Russia takes the bottom spot on the overall index. The country has poor general innovation inputs and entrepreneurial attitudes. Russia's score was very low on all cleantech-specific innovation driver indicators with the exception of cleantech funds, where the country scored moderately above average. Russia's record of venture capital investment and evidence of emerging cleantech innovation is especially poor. The country has a similar dearth of later-stage deals, publicly traded cleantech companies, and renewable energy consumption.



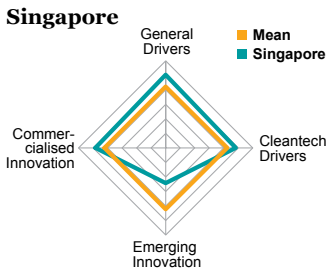
Saudi Arabia

Saudi Arabia scores very low on the overall index. The country has average general innovation drivers, thanks only to a strong entrepreneurial culture. Saudi Arabia shows no sign of cleantech-specific drivers except for government policies: it has the second lowest score for renewables infrastructure attractiveness and generally lacks a cleantech financing ecosystem. The country has a slightly below average commercialised cleantech score thanks to recently increased renewable energy consumption but scores poorly on other metrics, including late-stage deals, IPOs, M&A and emerging cleantech innovation in general.



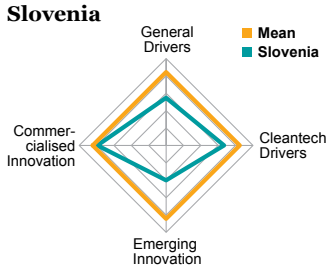
Singapore

Singapore has above average score on all factors except on evidence of emerging cleantech innovation. Singapore has good general innovation scores, driven by market sophistication, logistics and early-stage financing, but scores less well on entrepreneurial attitudes. On cleantech-specific drivers, the country has strong government policies and a good number of investors but lacks cleantech funds and organisations. It scores well on commercialised cleantech due to high late-stage activity and renewable energy consumption but has below average cleantech companies' revenues. Singapore's emerging cleantech score is pulled down by low VC activity and a dearth of high-profile cleantech companies. It scores above India and neighbouring Indonesia in the general index, but below other Asian countries.



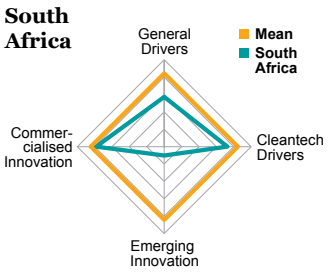
Slovenia

Slovenia scores moderately below average on all four factors. The country lacks a dynamic entrepreneurial culture and falls short of an average score on general innovation drivers. In the cleantech-specific area, Slovenia stands out for its supportive government policies but lacks a local cleantech investment community. It scores lowest on emerging cleantech innovation, with no signs of cleantech venture capital activity, environmental patents or high-profile cleantech companies. The country scores better in commercialised cleantech, thanks to moderate revenues from cleantech manufacturing and renewable energy consumption. A dearth of later-stage deals and public companies, however, curbs its score. Slovenia ranks below its neighbours Italy, Hungary and especially Austria.



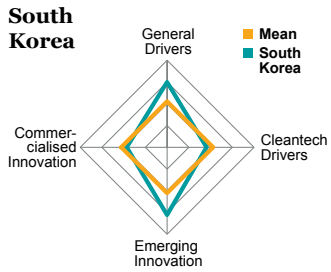
South Africa

South Africa scores below average on all factors. The country lacks general innovation and early-stage entrepreneurial activity, resulting in a weak general innovation driver score. South Africa does slightly better in cleantech-specific drivers due to supportive government policies, but lacks public R&D budget and access to private finance. The country scores very low on all indicators of emerging cleantech innovation. Finally, South Africa achieves an average score in commercialised cleantech, thanks to good cleantech revenues but falls behind in terms of late-stage investments in publicly traded cleantech companies. South Africa is the only representative of its continent on the list.



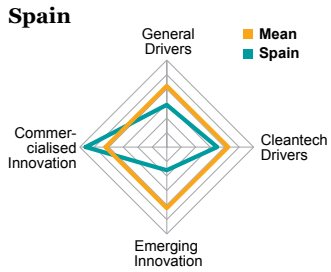
South Korea

South Korea scores well on the list, with strong general innovation drivers and emerging cleantech innovation scores. The country has excellent entrepreneurial culture, though small-scale early-stage activity. Its above average cleantech innovation score is supported by numerous environmental patents but hindered by low venture capital activity and few high-profile cleantech companies. On the downside, South Korea ranks below average on cleantech-specific innovation drivers due to a lack of a local investment community. Despite good cleantech revenues and some public companies, the country achieves a below-average score for commercialised cleantech mainly because of low renewable energy consumption and a lack of late-stage deals. Still, South Korea is the highest-ranking Asian country after Japan.



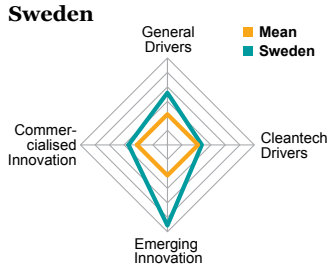
Spain

Spain scores well on commercialised cleantech innovation but scores poorly on other indicators. The country lacks: a strong entrepreneurial culture, public R&D spending, and access to private finance, though Spain does have a number of dedicated cleantech clusters. A dearth of venture capital investment, high-profile companies and environmental patents holds back its emerging cleantech innovation score. However the country scores well on commercialised cleantech, with strong revenues from cleantech companies, good renewable energy consumption and a density of publicly traded cleantech companies. Spain scores higher than Southern European countries such as Italy and Greece but below neighbouring Portugal.



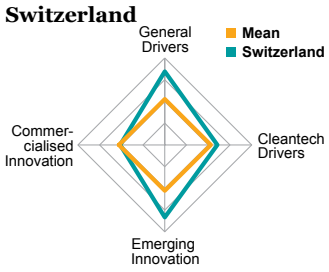
Sweden

Sweden ranks fourth in the overall index, scoring well in all factors and topping the list for general innovation drivers. The country has especially strong innovation inputs, entrepreneurial attitudes, above-average public R&D, and a relatively large number of cleantech organisations, resulting in high general and cleantech-specific innovation drivers' scores. The country has much evidence of emerging cleantech innovation, being home to a large proportion of high-impact cleantech start-ups. In commercialised cleantech, Sweden has high scores for renewable energy consumption, high cleantech revenues and a good density of publicly traded cleantech companies. Sweden demonstrates one of the largest gaps between 'evidence of emerging cleantech innovation' and 'evidence of commercialised cleantech innovation,' and so have improvement potential in scaling up efficiently. Sweden scores above the rest of Europe apart from Finland.



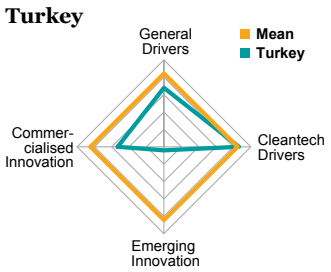
Switzerland

Switzerland's score is above average on all factors except commercialised innovation drivers. The country stands out for its general innovation inputs, despite weaker early-stage financing. Switzerland's high emerging cleantech innovation score is helped by strong environmental patent output. While the country has very supportive government policies and relatively abundant cleantech investors, its cleantech-specific innovation score is held back by low attractiveness for renewables deployment. It does however have moderate cleantech revenues and many M&As, but stays below average in commercialised cleantech due to low IPO count and renewable energy consumption. Switzerland scores above neighbours Germany and France, but below Scandinavia and the UK.



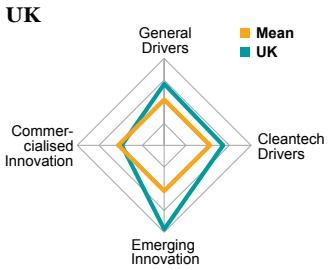
Turkey

Turkey has a very low emerging cleantech score but slightly above average cleantech innovation drivers. The country has poor general innovation inputs, though its entrepreneurial culture is solid. Turkey has few government policies supporting cleantech and still lacks access to private finance. Similarly, the country has seen little venture capital activity, produced few environmental patents, and shows little evidence of commercialised cleantech innovation across all indicators. The country ranks above neighbours Greece and Bulgaria.



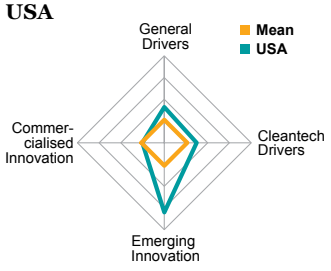
UK

The UK scored well in all factors, with the exception of commercialised cleantech, where it is less strong. While scoring average on entrepreneurial culture, the UK has very good general innovation inputs (e.g. ease of credit, research and education). Good access to private finance, and an infrastructure attractive to renewables all boost the UK's cleantech-specific innovation drivers' score, although the lack of political certainty around policy after 2020, has resulted in a slow-down of investment in renewables. Strong VC investment and a number of high-impact cleantech start-ups showed that there is evidence of emerging cleantech innovation. However the UK performed less well on commercialised cleantech innovation due to low renewable energy consumption and cleantech company revenues. The UK sits in the top 10 overall, but falls behind Nordic countries, the U.S. and Israel.



USA

The U.S. places third on the overall index, second only to Denmark for inputs to innovation. The U.S. combines strong general innovation inputs with a solid entrepreneurial culture. The country has an attractive infrastructure for renewables and exceptional access to private finance, but lacks strong government policies in support of cleantech. It tops the list for venture capital investment with Israel, and produces numerous high-profile cleantech companies, resulting in a very high emerging cleantech innovation score. The U.S. has strong M&A activity and cleantech company revenues. However the U.S. lacks strong renewable energy consumption, and future consumption may be postponed due to the so called 'shale gas revolution' which is currently driving energy prices down.



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The Global Cleantech Innovation Index 2014

NURTURING TOMORROW'S TRANSFORMATIVE ENTREPRENEURS

This report investigates the global state of cleantech innovation in entrepreneurial start-up companies. We are currently faced with a range of climate, energy and economic challenges. Technology start-ups provide one of the most important vehicles for developing and commercializing innovation to meet these challenges, while generating value for investors. This report reasons as to where these innovative cleantech companies will spring-up over the next decade, and shows which countries are falling ahead and below the curve for cleantech innovation.

The index was first launched in 2012.
This is the second edition.

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