Arnoud van der Slot, Ward van den Berg and Gijs Berkhout

Study

Clean Economy, Living Planet

The race to the top of the global cleantech market

Roland Berger
Strategy Consultants

Arnoud van der Slot, Ward van den Berg and Gijs Berkhout

Study

Clean Economy, Living Planet

The race to the top of the global cleantech market

This report was commissioned by WWF-Netherlands (Wereld Natuur Fonds)

Contents

Executive summary

This report investigates the progress of the cleantech industry in the Netherlands and worldwide. Cleantech includes all technologies that save energy or generate renewable energy. In the 2009 report for The World Wide Fund for Nature Netherlands (WWF-NL), Roland Berger ranked countries by their economic value added from manufacturing cleantech products and formulated recommendations to advance the sector's growth. This follow-up report shows the increase in cleantech sales worldwide and the progress of countries within the ranking. Lessons drawn from the top-performing countries in this new ranking confirm and underscore the recommendations from the 2009 report. Progress on these recommendations in the Netherlands, however, has been mixed. In a survey, Dutch cleantech companies have listed the barriers they face in expanding their businesses. Based on the lessons and the barriers, stakeholders in the Dutch cleantech sector have developed three recommendations for accelerating its growth.

The market for cleantech grew by 31% per annum between 2008 and 2010 and now stands at EUR 179 billion. Wind energy is the largest segment in the cleantech sector with a 30% market share. Solar PV has grown by 100%, with sales now totaling EUR 45 billion. Denmark leads both the 2009 and 2011 rankings. China, at number two, is growing at 77% per annum. The Netherlands, however, has dropped a position and now ranks 18th. Although the Netherlands has grown by 15% since the 2009 report, this growth is insufficient to keep pace with global market growth.

The top-performing countries reveal three main best practices. First, a country must develop a coherent and integrated industrial policy, setting targets on the future fuel mix, developing a domestic market and investing in supportive infrastructure and R&D in line with the country's strengths. Second, a country must provide access to capital. And third, it must foster the presence of large companies in cleantech.

Dutch cleantech companies mention that unstable regulation and the absence of stable market development are the main barriers to cleantech growth. These barriers also stand out in an international perspective. At the WNF cleantech symposium on May 9, 2011, cleantech stakeholders formulated three recommendations that will accelerate Dutch cleantech sector growth, overcoming the barriers companies face and implementing the lessons from top-performing countries:

- The government must make a clear-cut choice for renewable energy and then base its industrial policy on best practices, from R&D to deployment
- Financial institutions must cooperate with each other and with government in devising financial solutions to support the cleantech sector
- Large cleantech companies must work with smaller cleantech companies

Implementation of these recommendations will help get the Netherlands back on track towards a top-10 position in the global cleantech industry. If the Netherlands grows between 18% and 24% to reach a total value added of EUR 3-4 billion, it will achieve a top-10 position by 2015. Dutch companies alone aim to grow by 25-30%, which means that this ambition is feasible.

0 Preface

This report is a follow-up to the 2009 report on Clean Energy Technology for the World Wide Fund for Nature. That report investigated the rationale and potential for challenges of building a strong Dutch industry in Clean Energy Technology. As a starting point, Roland Berger ranked countries based on national total value added weighted by real GDP. The report concluded that the Netherlands should strive for at least a top-10 position in the cleantech industry in 2015. In this follow-up report, Roland Berger reevaluates the global data and compares the current status of the Dutch cleantech sector with its 2009 results, revealing a sector that is growing steadily but which is lagging behind global developments.

WWF-NL turns to Clean Energy Technology because energy efficiency and renewables are the best options for reducing energy-related CO_2 emissions and for mitigating the serious impacts of climate change. Recent studies indicate that an average global warming of 2° C will have dangerous and irreversible effects on humans and wildlife, and that these effects will rapidly worsen should warming exceed 2° C. Ecosystems cannot adapt to these changes and more than 30% of species may disappear. WWF-NL wants to see swift and large-scale application of solutions that reduce CO_2 emissions, and finds that this is best achieved by stimulating cleantech business and by implementing binding CO_2 targets on the national and international levels. A business focus can leverage WWF-NL's efforts to realize its CO_2 emissions reduction objectives, as business innovation and technology development can offer cost-effective solutions that can be rolled out on a large scale.

This new report is structured in five chapters and an epilogue. The first chapter explains the threat of global warming and cleantech's potential to reduce CO_2 emissions. It also defines cleantech for the purposes of this report. Chapter 2 looks at the economic attractiveness of this upcoming industry and illustrates its current and future pace of growth. The current standing of the Dutch cleantech industry in the global ranking is detailed, both in absolute terms (i.e. total value added) and in relative terms (i.e. total value added weighted by GDP). Chapter 3 responds to these concerns with lessons from the top-performing countries in cleantech, and lists those factors that will lead to accelerated growth. Chapter 4 deals with the barriers that obstruct the growth of Dutch industrial activities in cleantech, findings which are based on an extensive poll that was taken among a representative number of players in the industry. Chapter 5 takes a close look at the companies active in the Dutch cleantech sector and introduces the company that won the 2011 WNF cleantech Star, which recognizes the contribution that promising Cleantech enterprises make to the transition towards renewable energy. The chapter concludes by explaining the pace of growth required if the Dutch cleantech industry is to rank 10th in the 2015 ranking. The conclusions and recommendations briefly summarize the main findings.

Appendix A describes the methodology of the cleantech country ranking. The report draws on many sources for its data and insights. A complete list can be found in appendix B. Appendix C introduces the expert group that supervised the report, the sounding board and the jury that selected the WNF Cleantech Star nominees and winner.

June 2011

1 Introduction

Temperature increases due to global warming can be limited to 1.5° C if clean energy technologies (cleantech) are deployed rapidly and worldwide. The 2009 report for the World Wide Fund for Nature Netherlands (WWF-NL) set a course for the Netherlands to become a top-10 player in the growing cleantech sector. The report ranked countries according to their cleantech production and made three recommendations to position the Netherlands at the forefront of cleantech developments. Progress since that first report, however, has been mixed.

1.1 Cutting CO_2 emissions will preserve ecosystems and wildlife

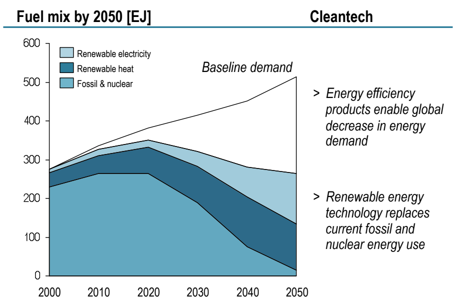
Global warming is threatening global ecosystems and wildlife. For example, melting ice caps are diminishing the habitat of polar bears. Higher temperatures affect sea water quality and are bleaching coral reefs, one of the most diverse ecosystems in the world[1]. The majority of the world's population lives in coastal areas threatened by storms and flooding. The pace of climate change is alarming. To preserve life on our planet as we know it, the reduction of CO_2 emissions is vital.

If current national policies remain unchanged, the World Energy Outlook of the International Energy Agency demonstrates that the increase in CO_2 emissions will continue and global warming will exceed 6° C. If the policies that have been announced are implemented, global warming will still exceed 3.5° C. In its most optimistic "450 ppm" energy scenario[2], the probability that global warming will exceed 2° C is still 50%[3].

WWF developed a scenario for a renewable energy future and outlined this scenario in its Energy Report[4]. WWF's scenario establishes the feasibility of replacing all fossil and nuclear fuels and limiting the temperature increase to 1.5° C. Total energy demand must and can be reduced through the more efficient use of energy. By 2050, efficient energy use can shrink almost 50% of the baseline energy demand. While the current share of renewable electricity, heat and fuels is only 13% of total energy supply[5], by 2050 this share can increase to 100% – and global warming can be limited to 1.5° C.

1 *IPCC Fourth Assessment Report: Climate Change 2007*
2 *In IEA's 450 ppm scenario, the concentration of CO2 in the atmosphere will stabilize at 450 parts per million*
3 *IEA, World Energy Outlook 2010*
4 *WWF/Ecofys, The Energy Report, 2011*
5 *IEA, World Energy Outlook 2010*

Figure 1 - Fuel mix scenario put forward in WWF's Energy Report 2011



1.2 Clean Energy Technology cuts CO_2 emissions by reducing fossil fuel demand and by replacing fossil fuels with renewables

To realize its vision of a 100% renewable energy future and to preserve ecosystems and wildlife, WWF advocates the rapid deployment of cleantech. Cleantech will help utilities, industry, households and governments reduce energy use and will enable the switch to renewable resources. In addition to realizing important climate objectives, cleantech offers major societal benefits, including employment (through green-collar jobs) and economic growth. The environmental and economic advantages of cleantech reinforce each other, create incentives to innovate and improve technologies, and warrant its large-scale deployment.

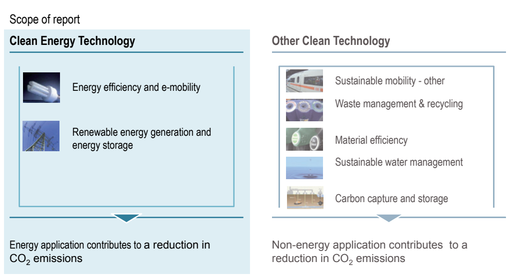
For the purposes of this report, cleantech is defined as those technologies that contribute *directly* to reducing CO_2 emissions. There are two segments of the cleantech industry which specifically reduce fossil fuel use: energy efficiency and renewable energy.

Energy efficiency is the most cost-effective way to reduce CO_2 emissions. Simply put, using less energy saves fossil fuels *and* money. Investments in this sector are offset by lower energy bills; efficient energy use means falling energy demand, which means lesser volumes and lower total energy costs. Cleantech contributes to energy efficiency by enabling, for example, low-energy lighting, better insulation and electric cars.

A large part of cleantech also involves renewable energy solutions. Solar, wind and biomass sources replace fossil fuels that cause global warming. Solar and wind can be used to generate heat and electricity, and biomass has the additional advantage that it contains molecules that can be converted to liquid form to replace fossil-based transport fuels. Cleantech enables these solutions by developing solar cells, wind turbines and biofuels, more effective energy storage, and more.

Clearly, there are other technologies that are equally necessary and valuable in the struggle against global warming and environmental destruction, such as the recycling of fossil-based materials, using material more efficiently, and carbon capture and storage. These, however, have an indirect effect on CO_2 emissions, or, in the case of carbon capture and storage, only solve the symptoms of excess emissions, not the root causes.

Figure 2 - Scope of Clean Energy Technology as defined in this report



1.3 In 2009, WWF-NL set a course for the Netherlands to reach a top-10 position in cleantech

In 2009, the first report on building the Dutch Clean Energy Technology industry has been published[6]. In that report, WWF-NL made known its ambition that Dutch cleantech claims a global top-10 position by 2015. The 2009 report also included a ranking of countries by their value added in cleantech in 2008. The size of the cleantech industry in the Netherlands at the time put the country at number 17.

The ambition was a challenging but realistic one, based on competences and resources prevalent in the Netherlands. The Netherlands has the capital, labor and knowledge to support the acceleration of global cleantech[7]. In particular, as one of the world's wealthiest countries, the Netherlands has the financial means to invest in cleantech R&D, product development and production capacity, and for these investments to reverberate worldwide. Through its economy, the Netherlands can make a major contribution to reducing climate change.

[6] *WWF, Clean economy, living planet – building the Dutch clean energy technology industry, 2009*
[7] *At EUR 35,600 in 2010, the Netherlands has one of the world's highest GDP per capita (Eurostat); 36.1% of the working population (25-64 years old) has a tertiary education (ISCED); Dutch researchers filed for 3364 patents in environmental technologies in 2007 (OECD)*

The ambition, however, was also based on a grim reality. Dutch CO_2 emissions per capita are among the highest in the world, roughly three times higher than the global average[8]. As a heavy contributor to global warming, the report challenged the Netherlands to take the reigns of a sustainable future, both for its own citizens and for the world as a whole.

The report made three recommendations for Dutch cleantech growth. The implementation of these recommendations would create favorable conditions for the entire industry, from start-ups to maturing companies.

- The Dutch government should provide foundational support starting in the early stages of the innovation cycle and continuing through market launch.
- Make more funding available to cleantech companies in the seed stage of their development
- Develop a home market

Since the publication of the 2009 report, the Clean Energy Technology sector has garnered much attention, but activities to stimulate its growth have been mixed. The Dutch government acknowledged the sector's importance and, via the Innovation Platform, confirmed the economic advantages of the renewable energy industry for the Netherlands[9]. The Social and Economic Council (SER) also advised the government to develop the biobased economy, a position endorsed by Minister Verhagen[10]. The government invested in a few pilot projects, like Plant One in Delft or the offshore wind program FLOW, and regional initiatives were established, such as Solaris. However, no coherent policy to support the innovation cycle has been developed[11].

To answer the call for more seed funding, WWF-NL and Rabobank established the Dutch Green Fund. This venture capital fund provides financing to new cleantech companies and is a first to step towards expanding the capital available in this sector. Nevertheless, investments in energy and the environment have dropped to EUR 6 m[12]. The Holland Financial Centre[13] is currently investigating the feasibility of a green investment fund. The green investment fund should accelerate financing for energy transition projects and may contribute to sustainable economic growth.

[8] In OECD Europe, the Netherlands has the third highest amount of CO2 emissions per unit GDP (IEA CO2 emissions from fossil fuel combustion)

[9] Innovatieplatform/Roland Berger, Stimulering van de economische potentie van duurzame energie voor Nederland, 2010

[10] SER, Meer chemie tussen groen en groei, 2010

[11] For instance, measures to support energy efficiency in housing were temporary

[12] NVP, Ondernemend Vermogen 2010

[13] Holland Financial Centre is is a public-private initiative set up by organizations throughout the financial sector, the government and regulators. These include banks, insurers, trading firms, pension funds, asset managers, audit firms and law firms

The government's replacement of the two-year old SDE with a new SDE+ support program for renewable energy initiatives has again led to uncertainty in the market. Similarly, the partial abolition of tax advantages in the Green Fund scheme will reduce domestic cleantech investments. The reduction in the renewable energy target for 2020 inhibits large-scale deployment of cleantech and home market development.

Dutch progress on the implementation of these recommendations has been mixed. The government has not improved its activities in terms of the first and third recommendations. And though the financial sector has shown some initiative, total seed investments have not risen significantly.

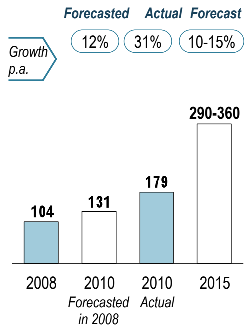
2 Clean Energy Technology market

In WWF's vision, renewable energy and energy efficiency technology must be applied on a large scale. The production and utilization of such technology is more than an environmental necessity – it is also a business opportunity. From manufacturing component parts to financing renewable energy projects, the development of cleantech is a global economic stimulus. Since the 2009 study, the global cleantech market has soared. The 2011 ranking reveals the strong and rapid growth of cleantech, but unfortunately also uncovers the fact that the Netherlands is not keeping up with the pace of global developments.

2.1 The global cleantech market continues to exceed expectations – especially in solar PV

In 2009 report, Roland Berger estimated the size of the global Clean Energy Technology market in 2008 at EUR 104 billion with an annual growth rate forecasted at only 12%, or EUR 131 bn by 2010. In reality, the demand for Clean Energy Technology grew by a spectacular 31% per annum. At EUR 179 bn in 2010, the global market exceeded the forecast by more than a third.

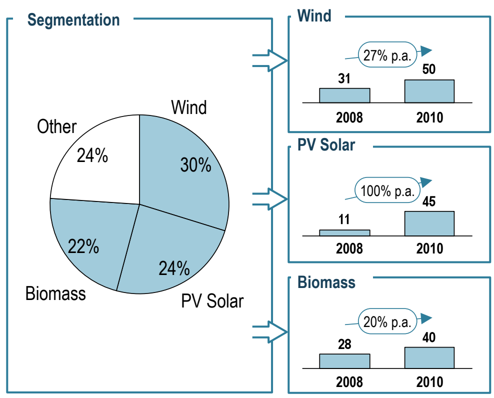
Figure 3 - Cleantech market size



With a share of 30% in the total cleantech market, wind energy is the most important technology, not to mention one of the most cost effective sources of renewable electricity. Demand for wind turbines is spread across the globe and there are many companies active in this segment, such as Vestas, GE, Dongfang and Suzlon, in Europe, the United States, China and India. Its total market share has grown by 27% per annum and has reached a size of EUR 50 billion. Wind turbines and component parts are often manufactured in close proximity to the wind farms themselves, putting production and sales on national soil.

Solar PV is the fastest growing cleantech segment, growing at nearly 100% a year. With a share of 24% (EUR 45 billion), it has now become a major contender in the cleantech market. Chinese companies like Yingli, LDK Solar and Suntech Power have shown high growth in the past two years. This growth is matched by the increase in sales numbers at companies like Applied Materials, Roth und Rau and Centrotherm, providing Asian companies with the necessary manufacturing equipment to produce solar cells and panels.

Figure 4 - Clean Energy Technology market segmentation in 2010 [EUR bn]



The biogas and biofuels market segment shows growth of 20% per annum since 2008. Its current market share stands at about 20% of the total cleantech market. Demand for biofuels and biogas is also spread around the world. While the United States and Brazil are the main suppliers of bioethanol, European countries have a strong market position in biogas. The biodiesel market, however, is characterized by strong fluctuations in supply. European suppliers have been affected by a number of developments, including the United States' dumping of biodiesel on the market and Argentinean suppliers' strong positions in global export markets[14].

Other renewable energy segments include solar thermal, concentrated solar power, ocean power and geothermal power. While 70% of all solar thermal is produced in China, geothermal companies are based mainly in the United States, Iceland, the Philippines and Italy.

Energy efficiency segments include CFLs (compact fluorescent lights) and LED lighting, insulation and electric vehicles. Energy storage includes batteries and flywheels. The majority of energy efficient lighting and batteries comes from

[14] *Biodiesel magazine, Global Biodiesel Production and Market Report, September 1, 2010*

Asia. Insulation is produced all over the world, and supplies are close to the places where it is used.

The global cleantech market is expected to continue to grow at a high pace. Forecasts put growth between 10% and 15% per annum through 2015[15], valuing the global market at EUR 290-360 billion. In order to realize the WWF vision of a 100% renewable energy future, demand for Clean Energy Technology must grow by 7-10% per year[16]. To meet the high level of demand, companies – and the economic landscapes in which they work – must continue to grow their production.

2.2 Despite global growth, the Netherlands dropped one place to number 18

The 2010 rankings clearly demonstrate the remarkable growth of the global Clean Energy Technology market. Many countries have taken huge steps forward, though a few, like the Netherlands, have taken steps back.

As in the 2009 report, the ranking measures the contribution of the cleantech sector to a nation's economy. Unlike other rankings, which focus on deployment or investment potential, the ranking reveals which countries are manufacturing attractive products, at favorable prices and quality. The ranking includes the 27 EU member states, the G7 countries, the BRIC countries, and South Africa, South Korea, Taiwan, Turkey and Australia.

To measure the status of each country, the value added for the major renewable energy and energy efficiency technologies in 2010 was analyzed. Renewable energy here is defined as the technologies to create heat, electricity or transportation fuels. Energy efficiency consists of those technologies that are only dedicated to increasing efficiency or replacing less efficient technologies. The value added ranking shows how much money is earned by manufacturing cleantech in each country. In essence, the value of manufactured products in each country was counted. If a Japanese company manufactures a Solar cell in China and sells it in the US, the value of the Solar cell would be attributed to China. To show the economic potential of cleantech, only the capital expenditures on tradable goods was counted[17].

[15] *Growth based on market reports on the various cleantech segments*

[16] *Forecast is based on the growth in the capacity of renewable energy in the IEA 450 ppm scenario and the WWF/Ecofys Energy Report. It is important to note that in both scenarios, renewable energy capacity will increase until 2020, and accelerate thereafter*

[17] *Tradable goods are those that have export or import potential. Their prices are set in international markets*

For each technology in each country, Roland Berger listed the important steps in the value chain and assessed the total production volume and the value added in each step of production. This value chain approach to the ranking prevented products from being counted twice. For instance, a solar PV cell may be produced in one factory and used as an intermediate product in a panel factory[18].

The value added was counted in three stages. In the first stage, the manufacturing volume in each value chain step was totaled per country. The second stage determined the cost share per step in the value chain. Total costs of a cleantech product were allocated to the various production steps in the value chain. In the third stage, the value added per country now equals the manufacturing volume in each step in the value chain multiplied with the cost share per step in the value chain.

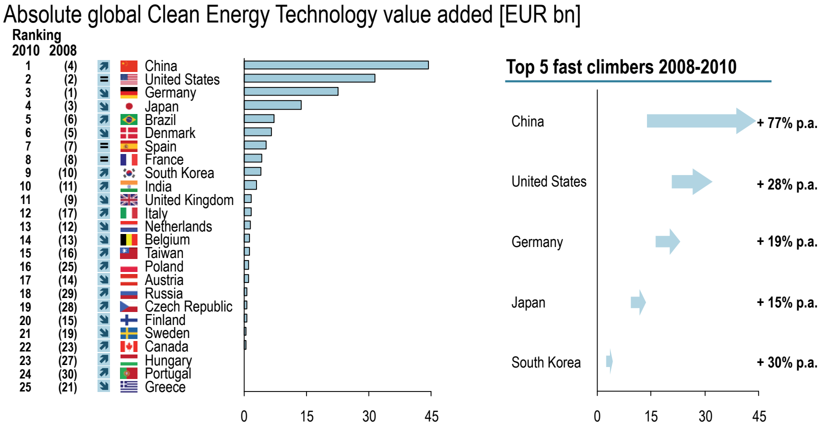
A comprehensive overview of the total value added of the cleantech market did not exist. The ranking therefore draws from a broad range of sources, including industry trade organizations, broker and industry reports, and the companies themselves. A complete list can be found in appendix A.

Figure 5 reveals the top 25 countries in 2010, according to both absolute value added and relative value added weighted by GDP. In both rankings, China is a clear growth leader, showing remarkable growth at 77% per annum with close to 25% global market share.

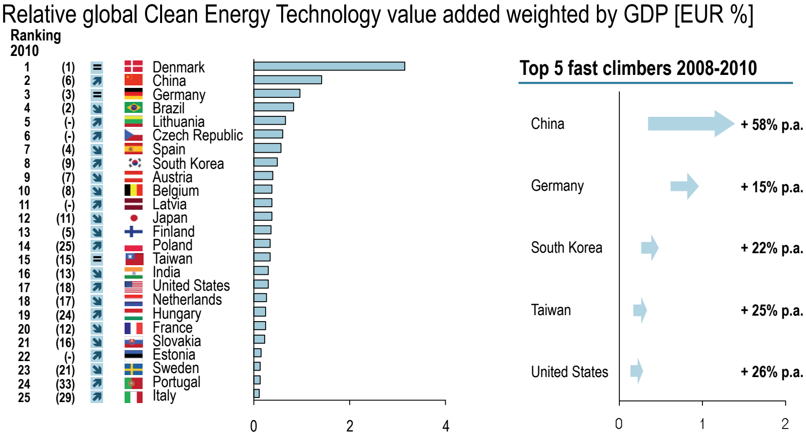
[18] *For details, see appendix A*

Figure 5 - Clean Energy Technology rankings

Absolute global Clean Energy Technology value added [EUR bn]



Relative global Clean Energy Technology value added weighted by GDP [EUR %]



In the relative ranking, Denmark remains the global cleantech leader. Though a relatively small country, Denmark is home to large companies in this sector. Vestas, for instance, holds a 12% share of the global market for wind turbines, and Rockwool is a world leader in insulation material. Denmark's presence in the biomass industry is small, but growing.

Germany is present in most cleantech segments, a fact that is reflected in its top-3 position in both rankings. Companies like Repower and Enercon develop and manufacture wind turbines, and the country is a major producer of manufacturing equipment for the solar PV segment. Its also manufactures solar PV cells and modules. One of the largest inverter companies, SMA, is also based in Germany.

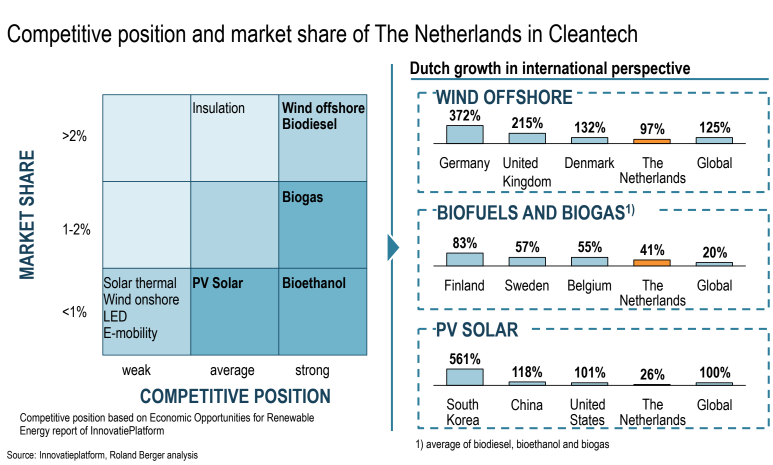
With strong positions in all cleantech segments, the United States is growing well at 28%, and has risen by EUR 11 billion in value added. In absolute terms, it is now in second place with a total value added of EUR 32.5 billion. Given the large size of its economy, however, it holds the 17th position in the relative ranking.

Like a few countries, the Netherlands dropped positions in both rankings and now trails the United States in the relative ranking at number 18.

2.3 Cleantech growth in the Netherlands lags behind global developments

In its advice to the Dutch government, the Innovation Platform identified those cleantech segments in which the Netherlands holds a strong competitive position: offshore wind, biobased solutions and solar PV. The Innovation Platform proposed that the Netherlands concentrate its resources on these three segments. It based this advice on the level of Dutch R&D competences, the number of patents which have arisen from this R&D, the Dutch economic structure where cleantech is concerned, the infrastructure of the economy in general and the country's geographical position. Although the total size of the Dutch sector has increased by 15% per annum to EUR 1.4 bn, it is not sufficient to keep up with the pace of growth in the global market.

Figure 6 - Dutch strengths in Clean Energy Technology and segment growth



Growth in the Dutch offshore wind segment slightly trails the global market, though solar PV growth severely lags behind the global average. The biobased segment is the only one of the three that exceeds the global pace. As the major assets of the Dutch cleantech sector, these three segments are the drivers behind its potential success, but they are not growing fast enough to advance the Netherlands in the ranking, much less place the country in the top 10.

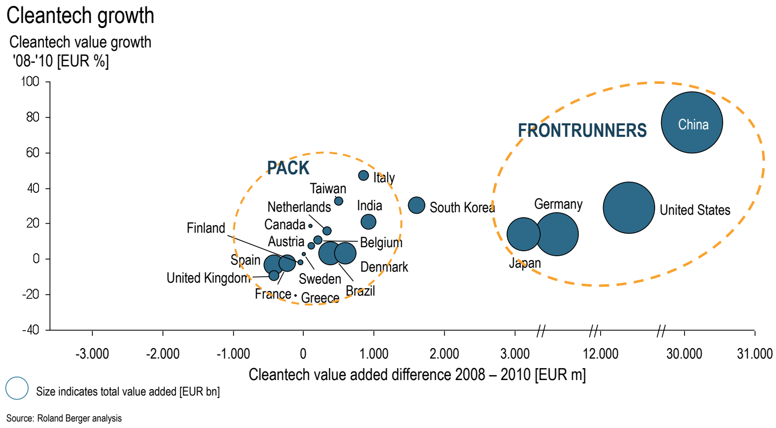
3 Leading cleantech nations: pointing the way towards accelerated growth

The global cleantech market has grown significantly in the past two years, but the growth is not uniformly spread across countries. Some countries, like China, have successfully captured large shares of the global cleantech market, while other countries have not been able to increase their cleantech value added enough to compete. The cleantech ranking reveals five successful countries that have either shown high growth in recent years or have captured a large share of the market relative to their GDP. Their example can guide other countries, like the Netherlands, towards becoming a leader in this attractive sector. Denmark, China and Germany are the top 3. These countries have a value added in cleantech between 1% and 3% of GDP. China is also growing rapidly at 77% p.a. Other fast climbers include the United States and South Korea.

To pick up the pace, the Netherlands must emulate countries like the United States or South Korea which have stepped up their cleantech game. The frontrunner nations (figure 7) seem to be concentrating on absolute growth and are thus responsible for most of the growth in the sector as a whole. These frontrunners have also secured competitive positions in some or all cleantech segments. At their heels is South Korea, which has been able to step out of the "pack" and is now well on its way towards becoming one of the frontrunners.

Figure 7 - Clean Energy Technology growth rates per country

The five leading cleantech countries point to the steps the Netherlands must



take to move ahead at a global level. These top-performing nations share three key success factors:

- A coherent and supportive industrial policy for cleantech
- Easy access to capital and financing for growth
- Presence of large companies, economies of scale and consolidation

Figure 8 - Lessons from top-performing countries

LESSON					
INTEGRATED **INDUSTRIAL POLICY**	✓	✓	✓	✓	
EASY ACCESS TO **FINANCING** FOR GROWTH			✓	✓	✓
ECONOMIES OF SCALE AND **CONSOLIDATION**		✓	✓		✓

3.1 A coherent and supportive industrial policy enables cleantech companies to grow

Denmark, Germany, China and South Korea have clear and coherent industrial policies for their cleantech sectors. Each country has made the choice that cleantech has a major role in its economy and industrial structure. Often, countries have focused on one or only a few cleantech segments, e.g. Denmark on wind or South Korea on LED lighting and batteries for e-mobility.

A coherent and supportive industrial policy that fosters the sector's competitiveness and growth consists of four related components. First, a country has developed a vision or roadmap for a low-carbon economy and has set targets for its future fuel mix that are in line with its strong economic position in one or a few cleantech segments. Second, the government's policy emphasizes large-scale deployment and has set up incentives to create a (domestic) market. Third, the government invests in supportive infrastructure that enables the sector to operate or which facilitates the uptake of its products. And fourth, the government's R&D investments support its industrial objectives. Alignment between these four components is necessary to successfully foster and maintain a stable cleantech sector. R&D efforts should support the development of those technologies for which there is also a market. And a market should be created for those technologies that the country wants to include in its energy mix.

3.1.1 Renewable energy vision

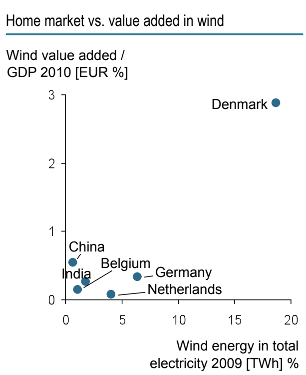
Denmark, Germany, China and South Korea have included their objectives for renewable energy and energy efficiency in their cleantech industrial policies. Their visions for reducing dependency on limited and foreign resources, some decades old and some relatively new, underpin policies that have accelerated their cleantech industries above the rest. Denmark and Germany, for example, woke up to their dependence on foreign oil during the 1970s oil crisis; their shifts towards renewable energy have broadened their energy portfolios[19]. China, noting its limited fossil resources and the heavy pollution caused by coal and transportation[20], set a target for 2020 that 20% of its energy supply must be renewable[21]. In its Green Korea plan, South Korea sees renewable energy and energy efficiency as important drivers behind reducing its fossil fuel dependence[22].

3.1.2. Deployment and domestic market development

Policies also boost and shape domestic market development. In Germany, feed-in tariffs for renewable energy and prioritized grid access for renewable electricity served two purposes. First of all, these measures helped the governments realize their targets for renewable energy use. Secondly, fostering the home market built up the local industries and enabled them to test new products and take innovations to the next levels. Large-scale domestic deployment is necessary if a cleantech sector is to mature[23], and target-setting is a major aspect of domestic market development. South Korea has set a target of 30% LED lighting by 2015, which will help companies innovate and develop new products that will compete on the global market[24]. In Denmark and Germany, the large-scale deployment of wind energy enabled the local industry to improve the technology. Within the cleantech sector, large-scale deployment – rather than advances in the lab – is responsible for many technological advances and for the reduction of costs of those technologies[25] .

[19] *Amos, 2009 and Lipp, 2007*
[20] *Karplus, 2007*
[21] *HSBC and the Climate Group even predict China will realize this target and may possibly exceed it*
[22] *Cleantech Group, 2010*
[23] *For instance, the growth of the country's wind energy industry is matched by growth in domestic deployment (Lewis, J.I. and Ryan H. Wiser, 2007)*
[24] *Korea Energy Management Corporation, IEA DSM Task 22 Presentation, 2010*
[25] *Deutsche Bank, The German Feed-in Tariff for PV, 2011*

Figure 9 - Domestic market development and cleantech industry size



3.1.3 Supportive infrastructure

Next to developing targets and offering financial and legal support, the government must also invest in supportive infrastructure to foster sector growth. Germany's investments in port infrastructure in Bremerhaven are a good example. Offshore wind farms require not only a connecting grid that can handle the fluctuations of renewable energy sources, but also the deployment of large installation vessels. The German government is helping the Bremerhaven port develop into the home base for this traffic. The port is also becoming the manufacturing base for turbine parts, which are often too large for ground transportation[26].

3.1.4 R&D and demonstration projects

Finally, the government must align its R&D efforts with the goals of its industrial policy. In other words, the government must concentrate public and private investments in R&D to build the skills needed in the cleantech segments. Denmark, for example, spends a higher than average share of its GDP on government-sponsored R&D. It has even doubled its R&D spending, which now stands at DKK 1 billion or EUR 135 million.

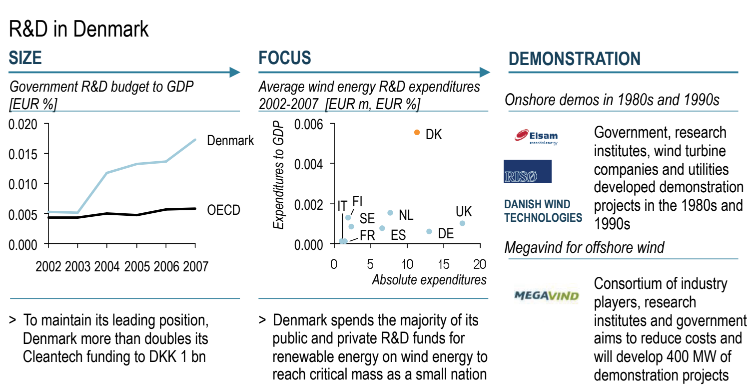
China has built its local wind energy industry by mandating a 70% local content requirement for domestic wind energy farms[27]. Establishing joint ventures with foreign players has also helped develop the Chinese wind energy industry,

[26] *Bremerhavener Gesellschaft für Investitionsförderung und Stadtentwicklung mbH*
[27] *J.I. Lewis 2007*

as its foreign partners could bring in expertise not immediately available in China. Now, China is stepping up its own R&D efforts. South Korea has included large funds for R&D in its green stimulus packages, and the government directly supports companies' R&D in LED lighting and batteries[28].

These large R&D investments are met with a strong focus on demonstration projects, which enables the R&D to progress towards those who might buy the resulting products. Denmark's long history in onshore demonstration projects and large-scale deployment, fostering "learning by doing" throughout the 1980s and 90s, has developed a competitive wind energy industry. Its attention has now shifted to focus on offshore wind energy. In the Megavind consortium, government, industry players and research institutes are working together to reduce the costs of offshore wind. Megavind also aims to develop 400 MW of demonstration projects.

Figure 10 - R&D in Denmark



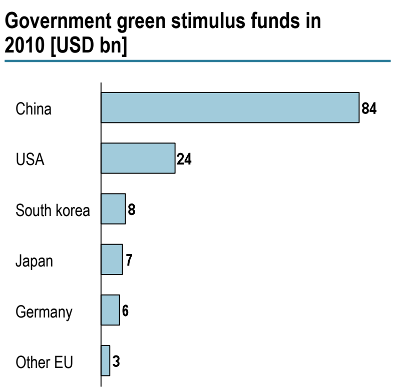
3.2 Access to capital powers cleantech growth

Companies need capital to develop new and better products, and to set up and expand their businesses. As mentioned above, the governments of top-performing cleantech countries have invested large sums in the sector, particularly through green stimulus packages in the wake of the recent economic crisis[29]. Financial institutions in these countries are also investing. Next to providing equity and debt to cleantech companies, banks also provide project financing needed to buy the capital intensive cleantech products and to apply them.

[28] *The Breakthrough Institute, "Rising tigers, sleeping giant", 2009*
[29] *HSBC, "Climate Investment Update", 2010, data covers period up till August 2010*

Venture capitalists and corporate venture investors provide (equity) capital to cleantech companies as well.

Figure 11 - Green stimulus packages in 2010



In China, South Korea and the United States, cleantech companies have easier access to equity funding. Easy access to capital has two advantages for cleantech companies. First, capital itself is needed to grow the business. Second, easy access to that capital means that companies have more time for their businesses, which means they can focus on keeping up with the high growth pace in the industry.

South Korea, for example, has developed a complete set of policy measures (i.e. "green financing") to stimulate financial support of the cleantech sector. The South Korean government has designated the Korean Finance Corporation (KoFC) as the leading government-sponsored institution for green financing. The KoFC provides indirect debt and equity and acts as a loan guarantor to cleantech companies. Next to this, government-sponsored banks provide the majority of loans and project financing[30,31].

One of the outstanding competitive factors of the Chinese solar PV industry is its access to cheap capital. State-owned enterprises in China can invest in cleantech companies under favorable terms. Regional governments often grant land use at low costs to cleantech companies in an effort to increase regional GDP. And banks and the state-owned bank offer credit at low interest rates. Capital in China is readily available[32].

30 *Korea Capital Market Institute, System Architecture for Effective Green Finance – Korea's Case, 2011*
31 *Part of the green finance scheme is a green deposit scheme, modeled after the Dutch Green Fund*
32 *Climate Policy Initiative, Survey of Photovoltaic Industry and Policy in Germany and China, 2011*

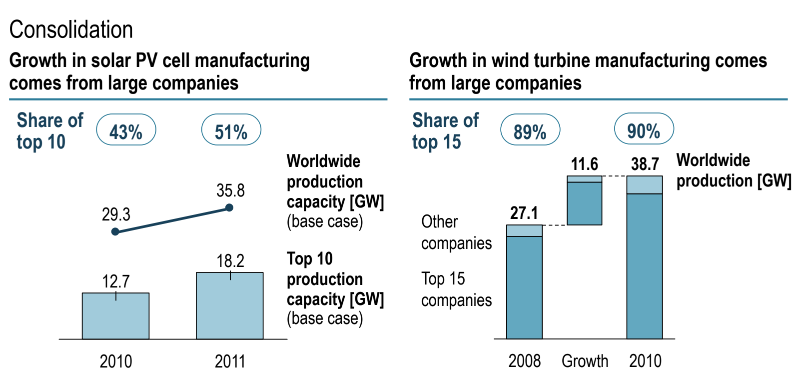
In the United States in 2010, the venture capital industry increased its investments in cleantech by 8%[33]. This high-risk capital enables companies to invest in R&D and develop innovative products, building the foundations of the industry and positioning the country for further growth.

3.3 Large companies drive cleantech sales growth

Top-performing cleantech nations have established large companies in the sector, and these companies are major drivers of their success. Take Vestas in Denmark or Yingly in China. They have the capabilities to keep pace with the high growth in the market and are able to utilize their competences to develop better products and expand their sales across the world. For instance, GE has entered the wind turbine market by acquiring Enron Wind; likewise, Siemens acquired Bonus. These two companies have leveraged their competences and global presence to create a worldwide cleantech footprint and sales base.

In the cleantech sector, large companies are chiefly responsible for the increase in sales and are therefore needed to grow the sector. In wind turbines, for example, 90% of market growth comes from the top-15 companies in the industry (figure 12).

Figure 12 - Consolidation in the cleantech sector



Large cleantech companies also build up strong networks of suppliers. Thanks to their size, they offer smaller companies a key sales opportunity and even enable the execution and coordination of research projects between companies.

33 *US venture capital (VC) investment in cleantech companies increased by 8% to USD 3.98 billion in 2010 from USD 3.7 billion in 2009, and deal total increased by 7% to 278, according to Ernst & Young and Dow Jones Venture Source*

Large companies also act as launching customers. Large utility companies, for example, have developed the market for wind turbines in Denmark and Germany; as experienced and demanding customers, they incentivize the industry to innovate.

3.4 The lessons reaffirm the 2009 WWF-NL recommendations

The three lessons from the top-performing countries closely parallel the recommendations from the report in 2009, reaffirming their relevance to Dutch government, research institutes, companies and society.

The first recommendation on foundational support starting in the early stages of the innovation cycle and continuing through market launch is reflected in the lesson of a coherent and supportive industrial policy. A good R&D strategy supports both fundamental and applied research demonstration projects and market creation, and which can thus move innovations from idea to product.

The second recommendation on the limited availability of seed capital for cleantech companies is mirrored in the second lesson on easy access to capital.

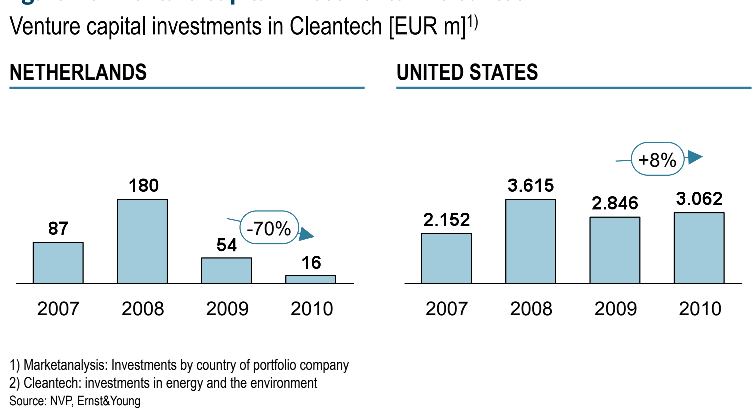
The third recommendation emphasized the importance of developing a home market. This recommendation is reflected in both the first and the third lessons. Government support to develop a home market is mandatory for the development of the cleantech industry. A home market gives local cleantech companies the opportunity to develop and sell their products and grow into mature and competitive businesses. Also, start-ups and smaller cleantech companies benefit from larger cleantech companies taking the role of launching customers.

As outlined in the introduction, these recommendations have only been implemented to a certain extent. It is clear from the cleantech leaders that there remains great, untapped potential in the Netherlands to accelerate the growth of the Dutch cleantech sector.

For instance, there is no alignment of industrial policy and energy policy in the Netherlands. In the current “topteam” debate, cleantech industrial policy is intermingled with general energy industrial policy. The government has not focused its policy on those cleantech segments in which the Netherlands has a competitive advantage. It is thus not creating a home market by ensuring the large-scale deployment of a certain technology. Nor is the Dutch government investing in supportive infrastructure in the Netherlands. The government has increased its investments in R&D in renewable energy and energy efficiency since 2005, but these amounts have fluctuated widely[34] and are not targeting those technologies in which the country wants to excel. A few pilot projects have been funded (e.g. PlantOne), but the demonstration stage of the offshore wind project FLOW did not receive funding. No integration between R&D and market creation is present. R&D in solar PV has not been met with subsidies for the deployment of solar PV.

Nor has access to capital improved in the Netherlands. The amount of venture capital invested in cleantech segments in the Netherlands dropped to only EUR 6 million in 2010[35]. In other countries, this figure rose. While the Dutch government does provide guarantees to banks for loans offered to cleantech companies, it is not meeting the demand for equity capital[36]. Also, the tax advantages in its Green Fund program have been scaled down, reducing the amount of project financing available to cleantech. A noteworthy fact is that Dutch bankers are investing in cleantech – abroad.

Figure 13 - Venture capital investments in cleantech



Furthermore, no large Dutch companies in the cleantech sector are present. In solar PV, for example, Dutch companies have not been able to expand their production capacities in line with the global market. Many of the solar PV equipment manufacturing companies have been acquired by larger, foreign companies. The situation in the Dutch wind segment is similar. Dutch cleantech companies are currently too small to compete on a global scale.

34 *PWC/Decisio, Monitoring van publiek gefinancierd energieonderzoek, 2005-2009*

35 *NVP, Ondernemend Vermogen 2010*

36 *The Technopartner seed facility cap of EUR 4 m is too low and thus does not permit venture capital funds to diversify risk and invest considerable amounts in start-ups*

4 Barriers in the Dutch cleantech sector and recommendations for overcoming them

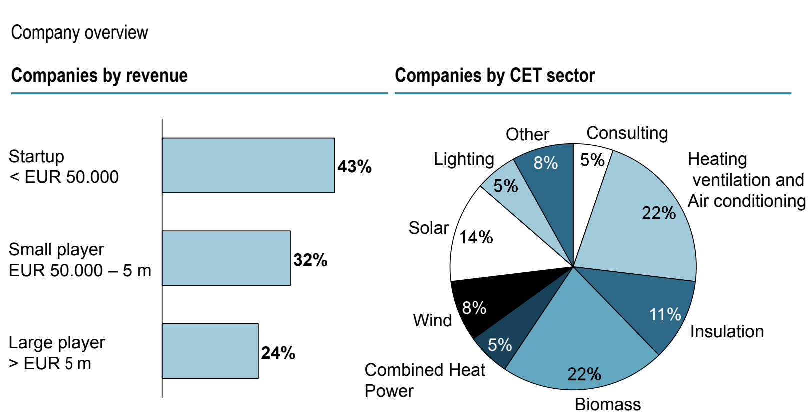
The Netherlands holds no major market share in any of the main cleantech segments. Since 2009, the Netherlands has not made progress in those areas the WWF-NL recommends are most crucial to its growth and success in this sector.

The top-performing countries exemplify what countries should do to achieve a strong position in cleantech. Companies were asked to identify the obstacles they face in the Dutch sector. A number of barriers are inhibiting the Netherlands' progress. Understanding what those barriers are can point the Netherlands in the direction of growth.

4.1 Five barriers inhibit the acceleration of the Dutch cleantech sector

To understand the discrepancies between global cleantech growth and that of the Dutch sector, we conducted a survey of Dutch companies. The survey asked companies to name the barriers that most severely hamper their companies' growth, what actions are needed to overcome those barriers, and how they would rate government policy on the sector. Sixty companies, representing the range of cleantech segments, responded to the questionnaire.

Figure 14 - Dutch companies which participated in the cleantech survey

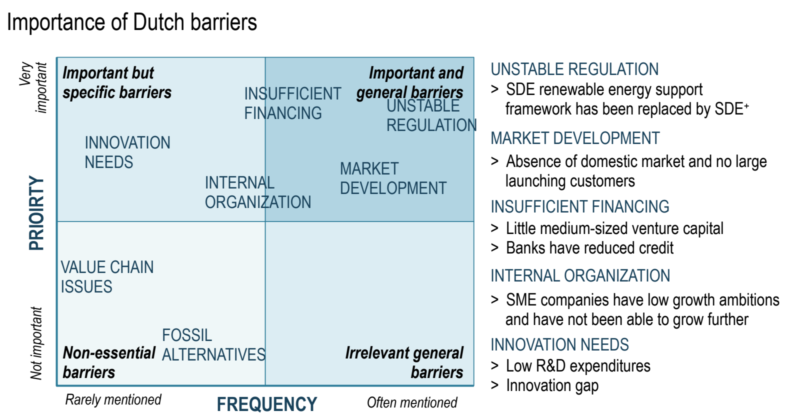


Responses were classified into seven categories:

- Unstable regulation
- Insufficient financing
- Market development
- Internal organization
- Innovation needs
- Value chain issues
- Fossil alternatives

Figure 15 grades these responses according to the number of times they were mentioned and the level of priority applied to them by respondents. The survey clearly reveals that unstable regulation, market development and insufficient financing are major obstacles to sector growth in the Netherlands. Internal organization and innovation needs are also major issues that must be addressed.

Figure 15 - Barriers to Dutch cleantech growth



Source: Roland Berger analysis

Unstable regulation is mentioned most often and is given high priority by respondents. The new government's replacement of the SDE subsidy framework with the SDE+ regulation is seen as a signal that the government is not committed to renewable energy. Important technologies are effectively excluded from obtaining subsidies and the caps to the total budget adds to the uncertainty of investments. Regional and municipal regulation, too, may hinder the adoption of renewable energy technology (e.g. the installation of biogas plants is often delayed by lengthy permit processes).

The absence of a home market is also frequently mentioned. Companies face difficulties in selling their products, as customers are risk averse and do not want to experiment with new technology. Companies also face difficulties in obtaining financing for capital intensive cleantech products that have a payback period over three years, or which are considered more risky.

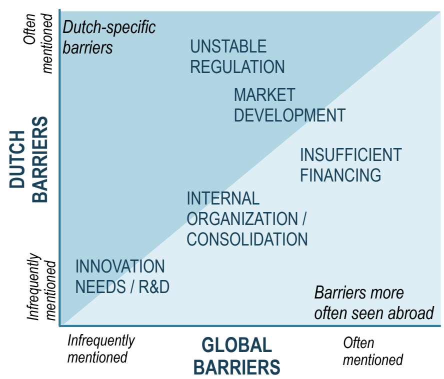
The third major barrier is insufficient financing. While mentioned less often, it is given high priority. Financing is necessary on both sides of the value chain, for consumer purchasing as well as for company growth. The most frequently mentioned issues are the need for working capital, the lengthy procedures required to obtain bank or venture capital, and the necessity for government guarantees.

A fourth barrier concerns internal organization. Many companies have a hard time reaching the scale needed to keep up with the high pace of growth in the cleantech market. Issues include managing business expansion, setting up sales and distribution channels, developing logistics and attracting skilled personnel.

While innovation needs is not frequently mentioned as a barrier, the companies that do mention it give it a high priority. Companies often lack financial support during the high-risk R&D stages in which fundamental research is demonstrated. Furthermore, R&D uncertainty and lead times require far too many resources from SME companies.

While these barriers exist in most countries, the degrees to which they inhibit growth differ. To identify which barriers are particularly detrimental to Dutch cleantech, we also surveyed companies abroad and the barriers they face in reducing CO_2 emissions. In this survey, 90 companies of all sizes and from all sectors participated. A comparison of the Dutch and international surveys reveals that unstable regulation and market development are obstructing Dutch development.

Figure 16 - Barriers in cleantech specific to the Dutch situation



4.2 Three recommendations will help the Dutch cleantech sector accelerate growth

The Dutch cleantech sector and its stakeholders – financial institutions, business associations and the government – convened at the WNF-FME cleantech symposium held May 9, 2011 to discuss the current state of the sector in the Netherlands and to develop recommendations to advance the sector's growth. Through roundtable discussions, the Dutch cleantech stakeholders formulated three recommendations that build on the lessons of the top-performing countries and incorporate the barriers to Dutch cleantech growth.

The government must make a clear-cut choice for renewable energy and then base its industrial policy on best practices

Guiding principles
In order to reach a coherent, stable and supportive industrial policy, and thus for business to thrive, the government must first make a clear choice for cleantech. The current government has not made a clear-cut decision for a renewable energy future and the government lacks vision and leadership in this respect.

To avoid reinventing the wheel and to accelerate policymaking (and to make up for the lost time), the Dutch government should look to successful countries (e.g. the frontrunners) and model its policy frameworks accordingly.

The government should also invest in the preconditions necessary for a successful cleantech sector, such as the construction and maintenance of an energy infrastructure and the large-scale deployment of cleantech, to demonstrate its sincere commitment. Furthermore, it should develop R&D budgets for large-scale demonstration projects. While companies would lead the initiation of these projects, contributing their knowledge and labor, the government (and other larger companies) would fund them.

Short-term measures
In the short-term, the Dutch government must focus its efforts on biobased applications (biochemicals, biofuels, biogas and biomass electricity and heat) and offshore wind[37]. These cleantech segments correspond with the competitive strengths of the Netherlands. Then, the government must create a stable home market for these technologies with a long-term support program that will enable large-scale deployment[38]. Also, the Dutch government needs to develop a roadmap for its R&D efforts in renewable energy. This roadmap should attribute a larger part of the budget to biobased applications and offshore wind. In other fields, the government should just maintain a sufficient level of R&D in order to keep up with developments worldwide. Analogous to the German Bremerhaven investment, the Dutch government and port authorities should invest in infrastructure for both the biobased economy and offshore wind sector. These investments will signal its commitment and will reduce market uncertainty.

The government must also increase its R&D budget to support the much needed demonstration projects. For instance, the government did not provide funding to the second stage of the highly praised FLOW demonstration project. The government should raise the budget such that it can support at least four demonstration projects in the next three years.

In these demonstration projects, suppliers and transporters of biomass, installation and equipment manufacturers, biomass conversion companies and end-users (business-to-business) need to cooperate in setting up a biobased value chain that replaces fossil fuels with second-generation biochemicals, biofuels and biogas. Projects could establish a bio-ethanol to bio-ethane value chain, large-scale biomass gasification or a lingo-cellulosic biomass refinery.

[37] *Solar PV has a second priority*
[38] *Either via target setting or via feed-in tariff schemes*

Financial institutions must cooperate with each other and with government in devising financial solutions to support the cleantech sector

Guiding principles
Providing access to capital is the main responsibility of the financial sector. There is a major need for cleantech venture capital to provide equity financing to entrepreneurs and firms in their expansion stages. The financial sector must also act proactively, i.e. bringing private players together as well as initiating more cooperation with the government. Such cooperation could, for example, overcome risks (through public financing) that would normally be insurmountable. Banks and other investors should build a knowledge base about cleantech, which would help them better understand the risks of their investments and enable them to provide their debtors with valuable information.

Short-term measures
In the Netherlands, around five venture capital funds dedicated to cleantech are present that have a size in excess of EUR 20 million. Hence, the total amount of investments possible in Dutch cleantech start-ups is very limited[39], as exemplified by the EUR 6 million in investments in 2010. The Dutch financial sector should actively raise capital from private and institutional investors to establish more VC funds. By raising the current cap of EUR 4 million in its "technopartner" regulation to at least EUR 15 million, the Dutch government can assist the financial sector in establishing VC funds that are large enough to invest in the sector and diversify risks. In so doing, the government thus supports the cleantech sector but also assists in building a sound Venture Capital sector, benefiting the Dutch economy as a whole.

Furthermore, government and financial institutions should continue their support of the Holland Financial Centre's initiative to assess the possibilities of establishing a Green Investment Fund. The financial sector should also develop lending principles that take into account the capital-intensive but low operating cost of cleantech products. Finally, financial institutions and government must also devise a common solution to the Green Fund scheme, which has become less attractive due to a cut in tax advantages.

[39] *Assuming an average size of EUR 30 m and a 5-year investment period, a theoretical maximum to annual investments in Dutch cleantech equals EUR 30 m at most. However, Dutch funds make substantial investments abroad, lowering the theoretical maximum further*

Large companies and cleantech companies should work with smaller cleantech companies

Guiding principles
Large cleantech companies should initiate more extensive cooperation with smaller players, like sharing knowledge and distribution channels, and should establish a representative body for the industry. Large companies can also act as launching customers, thus meeting the demand necessary to push the sector forward. The government should also take on its responsibility as launching customer.

Short-term measures
The WWF climate savers – WWF business partners in reducing the carbon footprint – procure cleantech solutions on a large-scale. For instance, KPN, as a launching customer, has helped Kyotocooling – one the WNF Cleantech Star nominees in 2009 – with the development of its cooling solutions for data centers. Eneco invests in renewable energy production like wind energy (both onshore and offshore), biomass, hydro, solar and geothermal energy. More Dutch businesses should adopt these cleantech procurement practices.

In the FLOW project, large companies and small companies in the offshore wind business cooperate in R&D. Similarly, large and small Dutch companies in (bio)chemicals, food and transport should also cooperate in innovation projects to develop a biobased value chain.

The government has ample opportunity to contribute to all of these activities. In 2008, 75% of the 334 Dutch government buildings did not have an energy label in either category A or B. To start, the Dutch government could act as a launching customer in many technologies in energy efficiency.

5 Getting the Netherlands back on track towards a top-10 position in the global cleantech industry

In the 2009 report, WWF-NL announced its ambition for the Netherlands to gain a top-10 position in the global cleantech industry. But since that first report, the Netherlands has dropped to 18th position – making this ambition more difficult to achieve. Although Dutch cleantech has increased in value, the accelerating global growth rate of the industry is hard to keep up with.

Despite its lagging performance, the Netherlands can still reach this goal. The Netherlands is home to many ambitious companies which share WWF-NL's plan. And because the cleantech sector is, in many ways, in its infancy, there is still ample opportunity for the Netherlands to secure significant market share in many areas. If realized, the three recommendations developed in collaboration with the Dutch cleantech sector should create a stable environment for growth. If the government, industry, academia and the public work together on these recommendations, a top-10 position can be within reach.

5.1 The Netherlands can grow its cleantech business to EUR 3-4 billion

In the 2011 ranking, the value added of the Netherlands equals EUR 1.4 billion. If the Netherlands grew its value added in line with the market, this would equal EUR 1.6-2.6 billion by 2015 – still not enough to advance the Netherlands far enough in the ranking to become a cleantech leader.

To gain a top-10 position by 2015, the Netherlands needs to overtake Belgium currently in 10th place. Assuming that the growth pace of the Belgian cleantech industry is in line with the global pace at 10-15% per annum, the added value of Belgium would be in the range of 0.6% to 0.7% of its GDP by 2015. To overtake Belgium, the Dutch cleantech sector must grow between 18% and 24% and reach a total value added of EUR 3-4 billion.

The success of the Netherlands in a renewable energy future depends on the success of its cleantech companies. The Dutch cleantech companies that participated in the 2011 WNF Cleantech Star survey have a current total sales volume of EUR 450 million. We asked these companies to state their sales growth ambitions for 2015. Combined, the sector aims to grow by a sales weighted average of 25-30%, implying total sales of EUR 1.4-1.7 billion by 2015. If this ambition is supported by the sector as a whole (and its stakeholders), the sector's growth can exceed the growth rate of 18-24% to reach a position in the top 10. A position at number 7 or 8 is then feasible[40].

[40] *Assuming that growth in sales is equal to growth in value added, all other countries grow in line with the market*

5.2 Ambitious and successful companies prove the feasibility of the top-10 ambition

To show the potential of Dutch cleantech companies, WWF-NL initiated the WNF Cleantech Star. The award is given to companies which make products that structurally contribute to the transition towards renewable energy and/or energy efficiency. The companies must invest in R&D, innovate and expand production and capacity in order the realize the transition goals on a larger scale. The companies must also have a successful strategy focused on growth, profitability and corporate social responsibility. A company with the WNF Cleantech Star is an example to other companies in the Netherlands and abroad. In recognizing excellence in economic, climate and innovation performance, the award inspires entrepreneurs and companies to take advantage of the opportunities in cleantech. It also shows government and the general public cleantech's contribution to the economy and to the creation of green collar jobs.

In 2009, Priva was awarded the first WNF Cleantech Star. Priva provides energy-efficient climate control and process automation for horticulture and for commercial and industrial buildings.

The selection of the 2011 WNF Cleantech Star was a three-step process. In the first step, companies were invited to complete a questionnaire on their economic, climate and innovation performance. The jury then chose six nominees, and each company was visited by a jury member. In the final step, each company gave a presentation to the entire jury. The presentation detailed the company's contribution to the Dutch knowledge economy and to the global environment. The jury then chose a winner.

For the 2011 award, WWF-NL identified 280 companies in the Dutch cleantech sector. These companies are active across the cleantech spectrum and are proof of Dutch competence in this sector. The growth of these companies, expanding sales at home and abroad and developing new and better products, contributes to the climate goals of WWF-NL and at the same time is good for the Dutch economy.

Topell Energy has been awarded the 2011 WNF Cleantech Star. The biocoal product developed by Topell reduces CO_2 emissions by up to 90% compared to coal, and can substitute coal for both heat and power applications. The torrefaction process developed by Topell is the most efficient available. What's more, Topell has the ambition to grow its production substantially by 2015, and could thus reduce CO_2 by 4 Mton per year. Topell's biocoal and processes represent an important step in the transition towards 100% renewable energy.

6 Conclusions and recommendations

The urgency to act on climate change is clear. WWF-NL's trip to Greenland with Crown Prince Willem Alexander van Oranje in May was a stark reminder of the massive changes in the Arctic. But the impact of climate change is evident around the globe; melting glaciers and rising sea levels are only the most noticeable consequences.

The solution to climate change is also clear. The main cause of climate change is the large-scale burning of fossil fuels and the subsequent release of CO_2 into the atmosphere. A 100% renewable energy future is feasible and energy efficiency and renewable energy will cut these emissions drastically.

Countries and companies are already investing in the R&D that will develop more efficient and more renewable – and economical – solutions that can meet our global energy demand without destroying the planet. In the last two years alone, the global cleantech sector has made major leaps towards a low-carbon economic future, though some countries have been more successful than others. China, for instance, grew in that time by more than EUR 30 bn in value added. The Netherlands, in contrast, fell behind, dropping one place to the 18th position in the ranking. WWF-NL's ambition that the Netherlands becomes one of the top-10 countries in cleantech seems a far reach in this rapidly developing sector.

But the Netherlands can learn from the countries that are performing well. Lessons taken from their success closely resemble the recommendations WWF-NL put forward in 2009. For the Netherlands to thrive in cleantech – more importantly, for the future economy and environment to be sustained and sustainable – the Netherlands must take the reigns of a 100% renewable energy future. Three recommendations will guide the way:

- The government must make a clear-cut choice for renewable energy and then base its industrial policy on best practices, including large-scale deployment, R&D and supportive infrastructure
- Financial institutions must cooperate with each other and with government in devising financial solutions to support the cleantech sector
- Large companies and cleantech companies should work with smaller cleantech companies

The goal is for the Netherlands to increase its cleantech value added to EUR 3-4 bn, or between 0.6% and 0.7% of Dutch GDP, by 2015. What is good for the planet and its citizens is also good for the economy. Cleantech Stars like Topell prove that a sustainable future – and a thriving Dutch cleantech sector – are within reach.

Appendix A Methodology

The cleantech country ranking measures the cleantech value added per country – how much is earned with the manufacturing of cleantech products and technology. The ranking includes the 27 EU member states, the G7 countries, the BRIC countries, and South Africa, South Korea, Taiwan, Turkey and Australia.

To measure the status of each country, we analyzed the value added of the major renewable energy and energy efficiency technologies in 2010. Renewable energy here is defined as the technologies to create heat, electricity or transportation fuels. Energy efficiency consists of those technologies that are only dedicated to increasing efficiency or replacing less efficient technologies. Insulation and lighting solutions are considered in the study, for example, because they are solely dedicated to increasing efficiency. Products where incremental advanced have been made, such as household appliances or cars with energy efficient engines, have not been included. Although we recognize that the contribution of these products can be large, they are not solely dedicated to reducing CO_2 emissions. It is important to note that we have excluded hydropower in this ranking. The environmental damage caused by hydropower and hydrodams contributes to global warming. Furthermore, hydropower has been used for more than a century and so does not represent a new or innovative application of cleantech. We acknowledge that this is an important industrial sector in countries like Austria, Germany, France and China, but exclude it from our definition of cleantech for the purposes of this report. Neither did we include CCS.

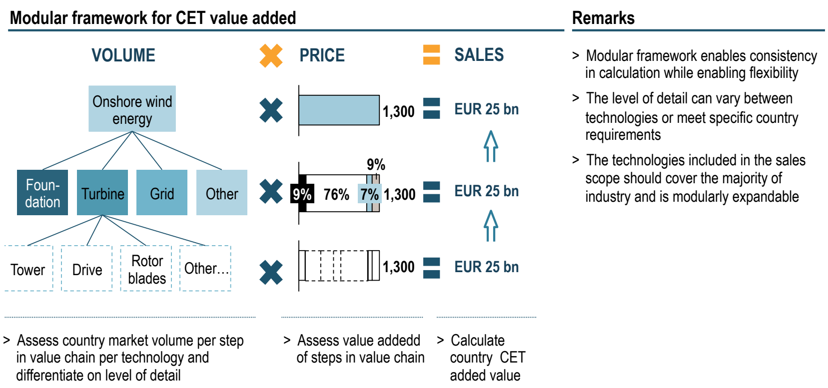
The value added of manufacturing cleantech products in each country has been counted. We attributed this value added to the country where the products were manufactured. For instance, if a Japanese company manufactured a Solar cell in China and sold it in the US, the value of the Solar cell was attributed to China. To show the economic potential of cleantech, we only counted the manufacturing of tradable goods[41]. That means, that we counted the capital expenditures on cleantech goods, but we did not count the operational expenditures or local installation costs[42]. Counting operational expenditures or local installation costs would imply that we implicitly measure the adoption as well, rather than only the manufacturing part of cleantech. Although adoption of cleantech also adds economic value to a country, other rankings already show which countries have already deployed cleantech on a large scale.

41 *Tradable goods are those that have export or import potential. Their prices are set in international markets*

42 *Except for these technologies, where installation has the characteristics of a tradable good and foreign companies and laborers are specialized in the installation, for instance in offshore wind or geothermal energy*

The methodology is based on a modular framework to include a country's manufacturing contribution in each step of the value chain of each cleantech segment. This modular approach enables the allocation of manufacturing value to countries in separate value chain step and avoids the allocation of all manufacturing volume to the country that makes the final product. For instance, a Danish wind energy turbine may include a Belgian gear box. While the wind turbine could be sold by a Danish company, the value of the transmission in this wind turbine was allocated to Belgian sales and the other parts of the turbine to Danish sales.

Figure 17 - Modular approach to value added calculation



The value added was counted in three stages. In the first stage, the manufacturing volume in each value chain step was totaled per country. The second stage determined the cost share per step in the value chain. Total costs of a cleantech product were allocated to the various production steps in the value chain.
In the third stage, the value added per country now equals the manufacturing volume in each step in the value chain multiplied with the cost share per step in the value chain.

The cleantech ranking is based on the following cleantech segments:

- Wind energy (onshore and offshore)
- Solar PV
- Solar thermal
- CSP
- Geothermal

- Biodiesel
- Bioethanol
- Biogas
- Heat pumps
- Insulation
- LED lighting
- Compact fluorescent lighting
- Electric vehicles
- Fuel cells
- Flywheels
- Micro CHP
- Batteries

No single source with comprehensive data on the cleantech manufacturing industry is yet available. Therefore, the ranking is based on a broad range of sources, including industry trade organizations, broker and industry reports, and the annual reports and investor presentation from the cleantech companies themselves. A complete list can be found below.

- Ansam Abayechi, Lithium-ion Batteries for Electric Vehicles: The US Value Chain, CGGC, October 2011
- Asociación de la Industria Fotovoltaica – Hacia un suministro sostenible de electricidad
- Asociación de la Industria Fotovoltaica – Presentado el Informe anual de ASIF 2009: “Hacia la consolidación de la energía fotovoltaica en España”
- Asociación de la Industria Fotovoltaica – Situación en el mundo
- Axis Research Mind, Biodiesel and Feedstocks – A Global Market Outlook
- Biofuels Platform – statistics
- BMU Greentech 2.0
- Bosch Thermotechnik – The market for thermotechnology
- BSRIA – Super Successful Heat Pumps
- BTM Consult – World Market Update
- Bundesverband Solarwirtschaft – Statistische Zahlen der deutschen Solarstrombranche (Photovoltaik)
- Bundesverband Solarwirtschaft – The Photovoltaic and Solar Thermal
- Center for Agricultural and Rural Development, Ethanol Price 2005-2010
- Central Bureau of Statistics – Statline database

- Chi-Hsun Lin and Mong-Chiao Huang, LED Lighting Industry, ITIS Program, 2010
- Clean Edge – Clean Energy Trends 2008
- Comext – External trade database
- ConvergeNet – UPS Systems: What are the Options?
- CRISI Research, Independent Equity Research, 2011
- Delta Energy & Environment Ltd, Micro-CHP – Historic and Future Sales, October 2010
- Delta Energy & Environment Ltd, Micro-CHP Finally Arrives in Europe - But Future Growth Uncertain, January 2011
- Deutsch Energie-Agentur, Biogaspartner – gemeinsam einspeisen, May 2010
- Earth Policy Institute, U.S. Annual Biodiesel Production, 2000-2009
- Earth Policy Institute, World Annual Biodiesel Production, 1991-2009
- ecoprog & Fraunhofer Umsicht, The Market for Biogas Plants in Europe, June 2010
- Electroiq, PV inverter market: 7m units, $8.5b in 2014, says IMS Research, January 2010
- Emerging Markets Online – Biodiesel 2020: Global Market Survey, Feedstock Trends and Forecasts
- Energy Information Administration, Form EIA-63B, “Annual Photovoltaic Module/Cell
- Energy Information Administration, Office of Integrated Analysis and Forecasting
- ENERS Energy Concept, Production of biofuels in the world” (data 2009)
- ePure, European Production Capacity Installed, August 2010
- EurObserv’ER – Barometer (various versions)
- European Biodiesel Board – statistics
- European Biodiesel Board, 2009-2010: EU biodiesel industry restrained growth in challenging times
- European Commission, Commission Staff Working Document, Accompanying Directive 2005/32/EC with regard to ecodesign requirements for nondirectional household lamps
- European Commission, Strategic energy technologies information system, Geothermal Energy, 2011
- European Heat Pump Association, Outlook 2010
- European Photovolatics Industry Association – Global Market Outlook for Photovoltaics until 2013
- European Photovolatics Industry Association – Solar generation V 2008

- European Solar Thermal Industry Association – Concentrated Solar Thermal Power – Now!
- Eurostat
- Eurostat – Statistics database
- Exane BNP Paribas, What outlook for insulation players in a more challenging environment?, October 2008
- EzineMark, Wind Turbine Rotor Blades, December 2010
- Fachverband Biogas e.V., Biogas Branchenzahlen 2010
- Farms.com, 2010 Annual Ethanol Production = 13.23 billion gallons
- Freedonia Group, World Insulation Demand by Value, 2011
- GCL-Poly Energy Holdings Limited, 2010 Full Year Results, March 2011
- Geothermal Energy Association – Geothermal Industry Employment: Survey Results & Analysis
- Geothermal Energy Association, Geothermal Energy: International Market Update, May 2010
- Germany Trade & Invest GmbH, Lighting Industry in Germany, April 2009
- Global Wind Energy Council – Global Wind Report 2008
- GlobalData – Global Geothermal Energy Market Analysis and Forecasts to 2012
- GlobalData – Global Solar Thermal Power Market Analysis and Forecasts to 2013
- Globalinsulation magazine – On the Chinese insulation industry
- GTM Research, 2009 global pv Cell and Module Production analysis, May 2010
- Hong Kong Exchanges and Clearing Limited, NVC Lighting Holding Limited
- IEA-SHC - Solar Heat Worldwide Markets and Contribution to the Energy Supply 2006, edition 2009
- IHS Emerging Energy Research, Wind Turbine Component Supply Chain Strategies: 2010-2025, June 2010
- IMS Research, The World Market for Photovoltaic Inverters 2010
- Interconnection Consulting – Thermal Insulation in Europe 2008 Development and Trends
- International Geothermal Association – IGA News 72
- International Institute of Refrigeration, Newsletter no. 45, January 2011
- InternationalEnergy Agency, Renewable Energy Essentials: Geothermal, 2010
- Islandsbanki, U.S. Geothermal Industry Overview, February 2011

- Islandsbanki, United States Geothermal Energy, October 2010
- iWatt, LED Lighting Market Shines Semiconductor Industry, 2010
- J.P. Morgan, NVC Lighting Holdings Ltd, December 2010
- Jefferies – CleanTech Primer
- Jefferies International Ltd., Energy Storage – Battery Technology, 2011
- JRC Scientific and Technical Reports, Renewable Energy Snapshots 2009
- KPMG, World Geothermal Market & Outlook, 2010
- Larouchepac, Biofuels Burn Billions of “Meals Per Gallon”!, March 2011
- LEDinside, BeLight: LED light bulbs to dominate the lighting market, 2010
- LEDinside, Roger Chu, LEDIndustry Outlook in 2011
- Lisa Frantzis & Shalom Goffri, Solar Water Heating Supply Chain Market Analysis, September 2010
- Lux Research – The $41 billion energy storage market: the next big energy investments
- MAKE Consulting – The Wind Forecast – Supply side, Demand side
- MAKE Consulting, Wind Energy Market Share 2010, March 2011
- Manufacturers Survey
- Market Transformation Programme, Insulation industry product and market overview, 2008
- Marketbuzz, Solarbuzz Annual World Photovoltaic Market Review, March 2011
- Markets in Germany – Status Quo and Perspectives
- Morgan Stanley, LED: From TV to Lighting; Upgrade Epistar and Everlight to Overweight, May 2010
- Müll und Abfall, Der Biogasmarkt in Europa kommt bis 2020 in Fahrt – Deutschland bleibt Vorreiter, 2011
- NASDAQ, Newsletter, March 2011
- Navigant Consulting Europe, Ltd., Review of Sales and Inventory Estimates
- NREL, Concentrating Solar Power Projects, June 2010
- Peter Clarke, Wafer sales up 43% in 2010, says SEMI, EE Times, July 2011
- Photon International, Year of the Tiger, March 2011
- Policy Research Institute, Ministry of Agriculture, Forestry and Fisheries, Japan –Biofuels Policies in Asia
- Power Electronics Technology – Energy Storage Device Market to Hit $12 Billion By Decade’s End

- PV Tech, Chinese firm breaks into VLSI Research's Top 10 PV equipment supplier rankings for 2010, March 2011
- PV Tech, Comtec Solar posts record revenue and wafer shipments in 2010, March 2011
- PV Tech, Daqo reports 2010 polysilicon shipments at 3,650MT: revenue US$242.7 million
- PV Tech, SolarWorld to expand module production to 1.4GW in 2011, March 2011
- Renewable Energy World, Can Europe Solar Thermal Compete?, March 2011
- Renewable Fuels Association – statistics
- Renewable Fuels Foundation, 2011 Ethanol Industry Outlook
- Roland Berger – various reports
- Rommert Schram & Oscar Kibazohi, Bioenergy and Food Security Project: Final Consultation, May 2010
- Ruggero Bertani, Geothermal Power Generation in the World 2005–2010 Update Report, April 2010
- Sarasin – Sustainability report
- Sarasin, Solar energy 2008 – Stormy weather will give way to sunnier periods
- Sascha Rentzing, A dime a dozen, new energy, March 2010
- SemiconductorTODAY, Chinese burn into LED market driving MOCVD, September 2010
- SenterNovem, Bioethanol in Europe, 2007
- Shuming Hua, Current Situation of CFL Product in China, June 2008
- SMC, Havells see nature in electricity, 2011
- Societe Generale – Green New Deal
- Solar Energy Industry Association – US Solar Industry in Review 2008
- Solarbuzz - Marketbuzz 2009
- SolarServer, GCL-Poly revenues grow 274% to 2.37 billion in 2010, March 2011
- SolarServer, LDK Solar revenues soar 36% in 4Q 2010 to USD 921 million, March 2011
- Sonne Wind & Wärme – Der Markt wächst
- Stephen Lawrence, Geothermal Energy, Leeds School of Business, 2008
- Sun & Wind Energy, Vacuum tube industry on an upward trend, December 2009
- The Wall Street Transcript, 2015 Lithium-ion Battery Market, February 2011
- U.S. Commercial Service China, HVAC Industry Overview, 2011

- U.S. Energy Information Administration, Form EIA-22M, “Monthly Biodiesel Production Survey” and EIA-22S, “Supplement to the Monthly Biodiesel Production Survey”
- U.S. Energy Information Administration, Geothermal Heat Pump Manufacturing Activities 2009
- U.S. Energy Information Administration, Solar Thermal Collector Manufacturing Activities 2009, December 2010
- US Environmental Protection Agency, agSTAR, 2010
- USDA Foreign Agricultural Service, Brazil Biofuels Annual, July 2010
- VITO, Lot 19: Domestic lighting, October 2009
- VLSI Research, Top 10 PV Equipment Suppliers 2010
- Vrinda Bhandarkar, World Status of SSL Manufacturing, Strategies Unlimited, April 2010
- Werner B. Koldehoff, Climate Change and Renewable Energies, February 2011
- Worldwatch Institute – Strong Growth in Compact Fluorescent Bulbs Reduces Electricity Demand
- Zia Eftekhar, The Transformation of the Lighting Industry, March 2011

Investor presentations, annual reports, press releases, websites of and broker reports on various companies:

- AIXTRON
- AMG Advanced Metallurgical Group N.V.
- Amtech Systems
- Bosch
- CHSTE Group
- CRH
- Danfoss
- Enel
- GE
- Hansen Transmissions
- Kingspan
- LM Wind Power
- NEM
- NPC
- Ormat Technologies
- Osram
- Owens Corning
- Philips
- Philips Lighting

- Power-one
- Recticel
- ReneSola Ltd.
- Rockwool
- Saint Gobain
- Satcon
- Schott Solar
- Siemens
- SMA Solar Technology
- Solel
- Synbra
- Veeco
- Vestas

Appendix B – Literature

- Ackerman, Frank and Elizabeth Stanton (2006), Climate Change – the Costs of Inaction, Report to Friends of the Earth England, Wales and Northern Ireland
- Aki, Helen, Zachary Arnold, Genevieve Bennett, Jesse Jenkins, Chris Knight, Ashley Lin, Taj Walton and Adam Zemel, Case Studies in American Innovation – A New Look at Government Involvement in Technological Development The Breakthrough, Breakthrough Institute, 2009
- Amos, J., Proceedings of the ICE – Engineering, Sustainability Denmark's sustainable energy future, 156(9), 2009
- Andersen, Per Dannemand Review of Historical and Modern Utilization of Wind Power, 1999
- Andersen, Per Dannemand, Mads Borup and Michael Holm Olesen, Innovation in energy technologies, Risø Energy Report 5, 2006
- Ansam Abayechi, Lithium-ion Batteries for Electric Vehicles: The US Value Chain, CGGC, October 2011
- Beintema, N. M., A. F. D. Avila, and P. G. Pardey. Agricultural R&D in Brazil: Policy, Investments, and Institutional Profile. Washington, D.C.: IFPRI, Embrapa, and FONTAGRO, August 2001
- Biodiesel magazine, Global Biodiesel production and market report, 2010
- The Breaktrough Institute, "Rising tigers, sleeping giants", 2009
- Bundesministerium für Bildung und Forschung, die Hightech Strategie zum Klimaschutz, 2007
- Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit, Greentech made in Germany 2.0,Verlag Franz Vahlen München, 2009
- Cleantech Group, Global Investment Trends and the Rise of Cleantech in South Korea, 2011
- Climate Policy Initiative, Survey of Photovoltaic Industry and Policy in Germany and China, 2011
- The Climate Group/HSBC, Delivering low carbon growth, 2011
- Colares, Juscelino F., A Brief History of Brazilian Biofuels Legislation (June 25, 2008). Syracuse Journal of Law & Commerce, Vol. 35, No. 2
- Commissie van Wijzen ICES/KIS Advies van de Commissie naar aanleiding van de Midterm evaluatie van de Bsik-projecten, 2008
- Deutsche Bank, The German Feed-in Tariff for PV, 2011
- European Biodiesel Board, 2009-2010: EU biodiesel industry restrained growth in challenging times
- European Commission, Investing in the Development of Low Carbon Technologies, SET plan, 2009

- European Union, Directive 2009/28/EC of the European Parliament and of the Council, 2009
- Faninger G.H. Solar Thermal systems in Austria, status report 2005 presented to the IEA Solar Heating and Cooling Program, 2005
- Fulley, Laura, State Renewable Portfolio Standards and Energy Efficiency Resource Standards, presentation of American Council for an Energy-Efficient Economy
- Garnaut, R., The Garnaut Climate Change Review, Cambridge University Press, Cambridge, 2008
- HSBC, "Climate investment update", 2010
- Innovatieplatform/Roland Berger, Stimulering van de economische potentie van duurzame energie voor Nederland, 2010
- IPPC, Fourth assessment report: Climate change, 2007
- Jacobson, S., and V. Lauber, The Politics and policy of energy system transformation – explaining the German diffusion of renewable energy technology, Energy Policy, 34, pp. 256-276, 2004
- Kamp, L.N., Learning in wind turbine development: a comparison between the Netherlands and Denmark, University of Utrecht, 2002
- Karplus, V.J., Innovation in China's Energy Sector, Working paper #61, Stanford University, 2007
- Kemfert, Claudia (2005). "Global Climate Protection: Immediate Action Will Avert High Costs." DIW Weekly Report 1(12): 135-141.
- Korea Capital Market Institute, System Architecture for Effective Green Finance – Korea's Case, 2011
- Korea Energy Management Corporation, IEA DSM Task 22 Presentation, 2010
- Kristinsson, Kari and Rekha Rao, Learning to Grow: A Comparative Analysis of the Wind Energy sector in Denmark and India, DRUID Working Paper No. 07-18, 2007
- Krohn, S. Wind Energy Policy in Denmark Status 2002, Danish Wind Energy Association, 2002
- Krohn, S. Wind Energy Policy in Denmark: 25 years of Success – What now? Danish Wind Energy Association, 2002
- Lauber, V., L. Metz, Three Decades of Renewable Electricity Policies in Germany, Energy and Environment,15(4), pp 599-623, 2004
- Lewis, J.I. and Ryan H. Wiser, "Fostering a Renewable Energy Technology Industry: An International Comparison of Wind Industry Policy Support Mechanisms," Energy Policy 35, no. 3 (March 2007): 1844–1857

- Lewis, J.L., “ Technology Acquisition and Innovation in the Developing World: Wind Turbine Development in China and India”, St Comp Int Dev, 2007
- Lipp, J., Energy Policy, Lessons for effective renewable electricity policy from Denmark, Germany and the United Kingdom, 2007
- Lohse, Ulf, Developments in the German PV sector technology advances and cluster building, Eclareon GmbH, 2009
- Martinot, E., and L. Junfeng, Powering China’s Development: The Role of Renewable Energy, Worldwatch Institute, 2007
- Nederlands Observatorium Wetenschap en Technologie, Wetenschaps- en Technologie Indicatoren Rapport 2008, 2008
- Nielsen, Jens Buurgaard and Donald Pols et al., Investing in climate change: Dutch banks compared 2007, Profundo, 2007
- Nordbo, J., Technology Action Programs as a way forward, WWF Global Climate Policy Discussion paper, 2008
- NPC, Summary of Financial Results for the Fiscal Year Ended August 31st, 2010, October 2010
- NVP, Ondernemend vermogen 2010
- Odyssee/Mure, Energy Efficiency Profile Netherlands, 2008
- OECD/IEA, CO2 emissions from fossil fuel combustion – highlights, 2010
- OECD/IEA, World Energy Outlook 2008, 2008
- OECD/IEA, World Energy Outlook 2009, 2009
- OECD/IEA, World Energy Outlook 2010, 2010
- OECD/IEA, IEA Wind 2004 Annual Report, 2004
- OECD, OECD Compendium of Patent Statistics 2008Pinxteren, H., W. Segeth, A. van Stel, Accenten in Funderend Energieonderzoek, Nederlandse Organisatie voor Wetenschappelijk Onderzoek, 2009
- PriceWaterHouseCoopers/Decisio, Monitoring publiek gefinancierd Energieonderzoek 2005-2009
- SER, Meer chemie tussen groen en groei, 2010
- Stern, Nicholas. 2006: The Stern Review on the Economics of Climate Change
- Vaekstfonden, The Energy Industry in Denmark – perspectives on entrepreneurship and venture capital, 2006
- Watkiss, Paul, Tom Downing, Claire Handley and Ruth Butterfield (2005). The Impacts and Costs of Climate Change. Brussels, European Commission DG Environment.
- Watts, Jonathan, China makes renewable power play to be world’s first green superpower, The Guardian, 2009

- Wrobel, Paul, Clean Energy: The Brazilian Ethanol experience, 2007: Embassy of Brazil, London
- Wüstenhagen, R. and M. Bilharz, Green Energy Market Development in Germany, working paper, University of St. Gallen, 2004
- WWF/Ecofys, The Energy report, 2011

Appendix C – Contributors

Expert committee

Gerard van Baar, Holland Financial Centre
Daan Dijk, Rabobank
Charlie Droste, FME
Hein Greven, Eneco
Chris Hellinga, TU Delft
Harm Jeeninga, ECN
Kees van der Klein
Kees van der Leun, Ecofys
Meiny Prins, Priva
Hans van der Spek, FME
Jan Westra, Priva

Sounding Board

Johan van der Gronden, WWF
Arjan ten Elshof, Eneco
Daniël Povel, Triodos
Jan Kamminga, FME
Manon Janssen, Ecofys
Daan Dijk, Rabobank

Jury

Gerard van Baar, Holland Financial Centre
Ward van den Berg, Roland Berger Strategy Consultants
Daan Dijk, Rabobank
Charlie Droste, FME
Hein Greven, Eneco
Chris Hellinga, TU Delft
Kees Stap, Ecofys
Donald Pols, WWF
Meiny Prins, Priva
Simon den Uijl, ECN
Jan Westra, Priva

Contact information:

Roland Berger Strategy Consultants
World Trade Center, Strawinskylaan 581
1077 XX Amsterdam, The Netherlands

Telephone: +31 20 7960 600
Internet: http://www.rolandberger.nl

Amsterdam
Bahrain
Barcelona
Beijing
Berlin
Brussels
Bucharest
Budapest
Casablanca
Chicago
Detroit
Düsseldorf
Frankfurt
Hamburg
Hong Kong
Istanbul
Kyiv
Lisbon
London
Madrid
Milan
Moscow
Munich
New York
Paris
Prague
Riga
Rome
São Paulo
Shanghai
Stuttgart
Tokyo
Vienna
Warsaw
Zagreb
Zurich

www.rolandberger.com