



THE FIRST DECADE: 2004 – 2014



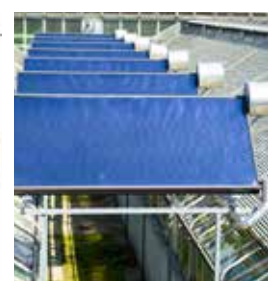
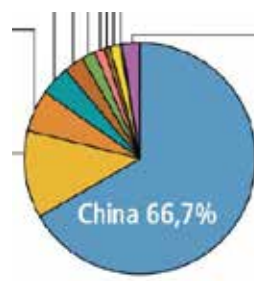
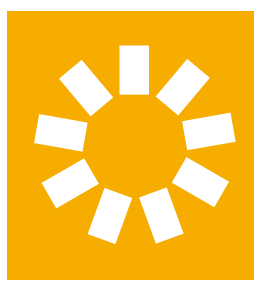
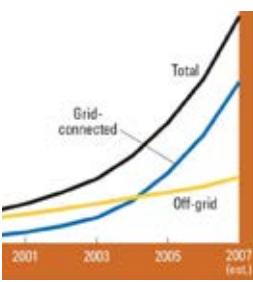
**10 YEARS OF
RENEWABLE ENERGY
PROGRESS**

2005



Table 5. Cumulative Number of Countries Enacting Feed-in Policies

Year	Cumulative Number	Countries/States/Pr
1978	1	United States
1980	2	Germany
1991	3	Switzerland
1992	4	Italy
1993	4	Denmark, India
1994	8	Spain, Greece
1995	8	
1996	8	
1997	9	
1998	10	Sri Lanka
1999	13	Norway
2000	14	Portugal, Norway, Su
2001	14	Thailand
2001	16	France, Latvia
2002	20	Austria, Brazil, Czech
2003	27	Cyprus, Estonia, Huni
		Maharashtra (India)



63	104	120 billion USD
207	240	280 GW
1,020	1,070	1,140 GW
74	94	121 GW
51	75	13 GW
2.5	3.7	6.9 GW
105	126	145 GWth
39	50	67 billion liters
6	9	12 billion liters
	66	73
	49	63
	44	49
	53	55

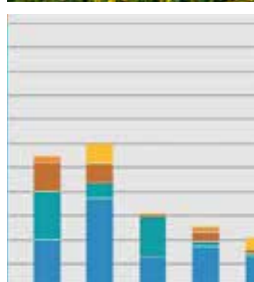
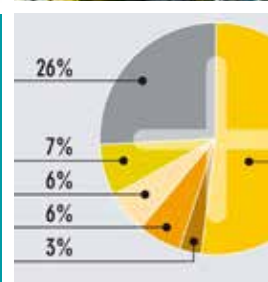





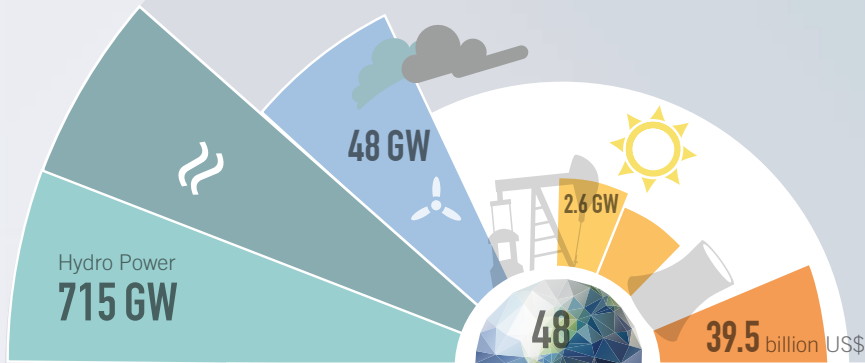


Table of Contents

1	Introduction	5 – 7	
2	Ten Years of Progress	8 – 14	
3	Ten Years of Impact	15 – 21	
4	Renewables in Different World Regions	22 – 35	
5	Lessons Learned from Last Decade	36 – 39	
6	Vision for the Future: The upcoming decade	40 – 42	
	Endnotes	43	
	Acknowledgements	44	
	REN21 Steering Committee	45	
	About REN21	46 – 47	

2004



1,000 GW

Hydro Power

144

countries with policy targets

214.4 billion US\$

annual investment in RE

326 GW_{th}

Solar water heating capacity worldwide

+ 87.2

billion litres

139 GW

Solar PV

318 GW

Wind Power

2014

Introduction

1



The evolution of renewable energy over the past decade has surpassed all expectations. Global installed capacity and production from all renewable technologies have increased substantially, and supporting policies have continued to spread to more countries in all regions of the world.

Developments in the early 2000s showed upward trends in global renewable energy investment, capacity, and integration across all sectors, yet most mainstream projections did not predict the extraordinary expansion of renewables that was to unfold over the decade ahead.

Several factors set the foundation for this rapid growth. The various energy crises—beginning in the 1970s—and the subsequent economic downturns underscored the role of energy for both national and economic security. At the same time, a handful of pioneering countries—such as Germany, Denmark, Spain, and the United States—created critical markets for renewables, which drove early technological advances and economies of scale, setting the stage and helping to fuel the past decade of explosive market expansion. Growing emphasis on mitigating climate change and adapting to its impacts has further contributed to the momentum.

Renewable energy's contribution to the global heat, power and transport sectors has increased steadily. While growth in renewable's share of total energy use has been moderated by increases in both population and world energy demand—most notably in developing and emerging economies—renewable energy markets and technology developments have accelerated quickly, even when compared to other rapidly developing technologies such as mobile phones.

Although the last decade has seen tremendous advances in the electricity sector, the renewable heating and cooling sector has lagged behind. This is despite the marked growth since 2004 in the use of geothermal, solar thermal, and biomass heating technologies for water and space heating, process heat, and cooling. Given that the share of heating and cooling in final energy demand is much larger than that of electricity, fostering growth of renewable energy in this sector is crucial.

In the transport sector, the use of renewable energy in the form of biofuels grew at a rapid pace for much of the past decade. Biodiesel production increased twelve-fold, ethanol production, already at a higher starting point, grew three-fold. Over the same period, a small but growing use of gaseous biofuels in transport emerged, as well as initiatives to link renewable energy with electric transport.

A Decade of Change

Global perceptions of renewable energy have shifted considerably. Ten years ago people widely acknowledged the potential of renewable energy, but large-scale deployment still had to be demonstrated. Now 10 years on, continuing technology advances and rapid deployment of many renewable energy technologies—particularly in the electricity sector—have amply demonstrated their potential.

Today, renewable energy technologies are viewed not only as tools for improving energy security and mitigating and adapting to climate change, but are also increasingly recognised as investments that can provide direct and indirect economic advantages by reducing dependence on imported fuels; improving local air quality and safety; advancing energy access and security; propelling economic development; and creating jobs.

Declining costs have also played a significant role in the expansion of renewable energy deployment in recent years. Several renewable energy technologies are today cost-competitive with conventional generation technologies, even before the environment and other externalities are taken into consideration.

Extraordinary growth in renewable energy markets and their global spread has also led to a significant rise in the number of manufacturers, the scale of manufacturing, an overall increase in number of jobs installing and servicing renewable energy technologies, as well as expansion into new markets. This is particularly true for the solar PV and wind power industries, despite experiencing industry consolidation, driven by decreasing costs.

Ten years ago, deployment and manufacturing of renewable energy were concentrated in Europe, the United States, and Japan. Their early lead in the renewable energy global markets paved the way for technology advances and market expansion through early investment in technology and in policy design.

Since then, markets, manufacturing, and investment have expanded to other regions. China has become the world leader in renewables manufacturing and installed capacity, having increased investment in the sector nearly every year over the past decade. Increasing amounts of money are now flowing to developing and emerging countries across Africa, Asia, Latin America, and the Middle East, in response to rapid growth in energy demand and a growing interest in renewables. Foreign direct investment in renewable energy and the mobilisation of private capital in emerging economies have also contributed to growth across both technologies and regions.

Over the past decade, the share of people who lack access to modern energy services has fallen by nearly 10 percentage points, down from almost 25%, even as the global population has expanded significantly. Renewables have played a role in this improvement. However, these advances are not evenly spread geographically; large areas of Africa are still without access to modern energy services. Renewables are uniquely positioned to provide needed energy services in a sustainable manner, more rapidly and generally at lower cost than their alternatives.



The Evolving Policy Landscape

The global policy landscape has largely driven the expansion of renewable energy technologies by attracting investment and creating markets that have brought about economies of scale and supported technology advances, in turn, resulting in decreasing costs and fuelling sustained growth in the sector. A handful of countries—particularly Germany, Denmark, the US and Spain—have led the way, developing innovative policies that have driven much of the change witnessed over the past decade. Today, Germany’s commitment to the “Energiewende”—the transition to a sustainable economy based on renewable energy and energy efficiency—as well as Denmark’s commitment to 100% renewable energy by 2050, are inspiring other countries around the globe to aim for a renewable energy future.

Since 2004, the number of countries promoting renewable energy with direct policy support has nearly tripled, from 48 to over 140, and an ever-increasing number of developing and emerging countries are setting renewable energy targets and enacting support policies. Policy targets have become increasingly ambitious, and their focus is expanding beyond electricity to include heating, cooling, and transport.

In parallel, policy mechanisms have continued to evolve. These include the use of policy instruments differentiated by technology, as well as the evolution of feed-in policies for premium payments and for use in the heating sector. Globally, renewable energy targets together with feed-in tariffs have had the biggest impact on renewable energy market introduction. Feed-in policies now exist on every continent.

In numerous countries, and particularly in Europe, variable renewables have achieved high shares of penetration in the electricity sector. Given that existing power systems, to date, have not been designed to cope with variable energy sources, renewables policy mechanisms that focus on market design are emerging to balance and increase system flexibility, as well as financial compensation for these services. Policies are also starting to address the need for expanded and improved grid infrastructure, and increasingly include new tools and technologies to support renewables, such as energy storage and smart grids. Regulations that focus on mandatory grid-connection and priority dispatch are becoming progressively important. Policies that encourage local value creation have also appeared in many countries.

The past decade has also witnessed profound change at the local level. Ten years ago, the majority of local governments did not consider the potential role for renewables in their energy supply. Over the past decade, many of them have become leaders in advancing renewable energy, particularly in combination with energy efficiency improvements. Many municipalities regularly exceed efforts of state, provincial and national governments.

Evolving Institutional Landscape

The last decade has also brought a series of institutional changes. REN21—the Renewable Energy Policy Network for the 21st Century—was created as an outcome of the renewables2004 conference in Bonn, Germany. The organisation was established as the multi-stakeholder “coalition of the willing”, bringing together key actors from both the private and public sector to facilitate a rapid global transition to renewable energy. REN21 was the first international organisation to begin tracking renewable energy development after its founding in 2004, and it has continued to provide the most comprehensive global outlook on the state of renewables each year. Results from this tracking are presented annually in the REN21 Renewables Global Status Report (GSR); a report that has become increasingly comprehensive over the past decade as the landscape of renewable energy has become more diverse and complex.

Five years on, the International Renewable Energy Agency (IRENA) was created and, by mid-2014, already counted 135 member countries as its members, demonstrating the high level of global interest in advancing renewable energy. IRENA supports countries in their transition to a sustainable energy future. The intergovernmental organisation encourages governments to adopt enabling policies for renewable energy investments, provides practical tools and policy advice to accelerate renewable energy deployment, and facilitates knowledge sharing and technology transfer to provide clean, sustainable energy for the world’s growing population.

In parallel, the International Energy Agency has considerably scaled-up its analytical work on renewable energy. While founded in response to the 1973/4 oil crisis to help member countries co-ordinate a collective response to major disruptions in oil supply, its expansion into renewables demonstrates the role renewables play in ensuring reliable, affordable and clean energy.

The UN Secretary General’s Sustainable Energy for All (SE4ALL) initiative, launched in 2012, aims to further boost international development in the fields of energy access, renewable energy deployment, and energy efficiency. While some countries had already established targets for 100% energy access, SE4ALL has encouraged many more countries to commit to this goal.

A Promising Future for Renewables

Today the use of renewable energy technologies to provide electricity, heating and cooling, and transportation is now spread across the globe, and recent trends suggest sustained growth worldwide. A decade ago, renewable energy technologies predominately occupied an environmental niche, having a strong appeal to those who were interested in moving away from conventional fuels for environmental reasons. Today renewables demonstrate that, in addition to their environmental benefits, they are also an economic driver, creating jobs, helping to diversify revenue streams, and stimulating new technological developments.

The idea of achieving high shares of renewable energy was radical ten years ago; today it is considered feasible by many experts. The commitment to 100% renewable energy in various sectors by local, regional, and national governments around the world is witness to this.

However, the renewable energy sector still faces numerous challenges. Subsidies for fossil fuels and nuclear power persist, and continue to vastly outweigh financial incentives for renewables. Further advances and investment in renewable energy, as well as improvements in energy efficiency, must continue if the increase in global temperature is to be limited to two degrees Celsius above pre-industrial levels. A rapid de-carbonisation of the energy sector with renewable energy technologies is required to implement the climate targets.

The past decade has set the wheels in motion for this transition, but a concerted and sustained effort will be required to fully achieve it. With increasingly ambitious targets, innovative policies, and technological advances, renewables will continue to surpass expectations and foster a cleaner energy future.



Ten Years of Progress

2



The evolution of renewable energy over the past decade has surpassed all expectations. Global installed capacity and production from all renewable technologies have increased substantially; costs for most technologies have decreased significantly; and supporting policies have continued to spread throughout the world.

The last decade (2004 – 2014) saw a steady increase in the global demand for renewable energy. While overall primary energy supply from renewables in 2004 was 57.7 EJ per year, by 2013 the total supply had grown to 76 EJ annually—an overall increase of 30%. By 2013, renewables supplied approximately 19% of the world’s final energy consumption, a little less than half of which came from traditional biomass. Heat energy from modern renewable sources grew from an estimated less than 1% in 2004 to 10% of total final energy use in 2014; hydropower grew slower

than the overall increase in power demand, with the result that its share dropped slightly to 3.8% in 2014. All other new renewables used for power generation gained ground and increased their primary energy share from 0.5 to 3.5% over the past decade. In 2013, liquid biofuels met around 2.3% of total transport fuel demand. Furthermore, the last decade saw an increase in initiatives to link electric transport systems with renewable energy, particularly at the city and regional levels.

Table 1: Selected Indicators – Summary GSR 2005 to GSR 2014

		2004 ¹	End 2013
Investment in new renewable capacity (annual) ²	billion USD	39.5	214.4
CAPACITIES			
Power Generation Capacity – global total	GW	3800	5800 ¹
Renewable Power Capacity (total, excluding hydro)	GW	85	560
Renewable Power Capacity (total, including hydro)	GW	800	1,560
Hydro Power Capacity (total) ³	GW	715	1,000
Bio Power Capacity	GW	39	88
Geothermal Power Capacity	GW	8.9	12
Solar PV Capacity (total)	GW	2.6	139
Concentrating Solar Thermal Power (total)	GW	0.4	3.4
Wind Power Capacity (total)	GW	48	318
Solar Hot Water Capacity (total) ⁴	GW _{th}	98	326
Ethanol Production (annual)	billion litres	28.5	87.2
Biodiesel Production (annual)	billion litres	2.4	26.3
Total Biofuels (annual)	billion litres	30.9	113.5
POLICIES			
Countries with policy targets	#	48	144
States / provinces / countries with feed-in policies	#	34	98
States / provinces / countries with RPS/quota policies	#	11	79
States / provinces / countries with Biofuels mandates ⁵	#	10	63

i) Preliminary estimation based on IEA WEO 2013 and REN21 data for 2012 and 2013.

Source: Renewables 2014 Global Status Report.

A Decade of Success: Renewable power generation

Out of the three end-use sectors—power, motive, and heating and cooling—renewables’ share grew fastest in the power sector. Total renewable power capacity—excluding large hydro—saw a sevenfold increase during the past decade; from 85 GW in 2004



to 560 GW by the end of 2013. Wind power saw a similar increase moving from a total installed capacity of 48 GW in 2004 to 318 GW in 2014. Solar photovoltaic (PV) power generation grew by a factor of 70, from 2.6 GW to 139GW.

Table 2: Annual Market by Renewable Power Technology

Annual Market in MW/a		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
 Solar Photovoltaic	MW/a	1,052	1,320	1,467	2,392	6,090	7,203	16,817	29,665	29,400	39,000
 Concentrating Solar Power	MW/a	0	13	0	75	55	119	595	500	1,034	885
 Wind power	MW/a	8,207	11,531	15,245	19,866	26,721	38,708	38,850	40,629	44,711	35,467
 Bio Power	MW/a	1,244	1,557	1,974	2,527	806	4,861	7,850	1,069	245	5,000
 Geothermal Power	MW/a	13	165	408	340	280	200	200	200	301	500
 Hydro Power	MW/a	19,490	16,057	17,367	25,925	17,082	9,473	23,359	25,000	27,070	40,000
Total	MW/a	30,006	30,643	36,461	51,125	51,033	60,369	87,471	96,863	102,760	120,852

Note: Geothermal numbers for 2009 – 2011 are drawn from Geothermal Energy Association, 2013 Geothermal Power: International Market Overview.

Total Installed Capacity		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
 Solar Photovoltaic	GW	2.6	3.1	4.6	7.6	13.5	21	40	71	100	139
 Concentrating Solar Power	GW	0.4	0.4	0.4	0.4	0.5	0.7	1.1	1.6	2.5	3.4
 Wind Power	GW	48	59	74	94	121	159	198	238	283	318
 Bio Power	GW	39	41	43	45	46	51	70	74	78	88
 Geothermal Power	GW	8.9	9.8	10	10.4	10.7	11	11.2	11.4	11.7	12
 Hydro Power	GW	715	–	–	920	950	980	935	960	990	1,000

Growth Rates		2004	2005	2006	2007	2008	2009	2010	2011	2012	Estimation 2013
 Solar Photovoltaic	GW	–	35%	32%	40%	44%	36%	48%	44%	29%	28%
 Concentrating Solar Power	GW	–	5%	0%	23%	14%	24%	54%	31%	36%	26%
 Wind Power	GW	–	19%	20%	21%	22%	24%	20%	17%	16%	11%
 Bio Power	GW	–	4%	5%	6%	2%	10%	27%	7%	4%	12%
 Geothermal Power	GW	–	0%	2%	4%	3%	3%	2%	2%	2%	3%
 Hydro Power	GW	–	–	–	–	–	–	–	3%	3%	1%

Note: " – " means that no data are available.

¹ Capacity data are as of the beginning of 2004; other data, such as investment and biofuels production, cover the full year. Numbers are estimates, based on best available information.

² Investment data are from Bloomberg New Energy Finance (BNEF) and include all biomass, geothermal, and wind generation projects of more than 1 MW; all hydro projects of between 1 and 50 MW; all solar power projects, with those less than 1 MW estimated separately and referred to as small-scale projects or small distributed capacity; all ocean energy projects; and all biofuel projects with an annual production capacity of 1 million litres or more. BNEF estimates that, including the unreported investments in hydropower projects >50 MW, total new investment in renewable power and fuels was at least USD 249.4 billion in 2013.

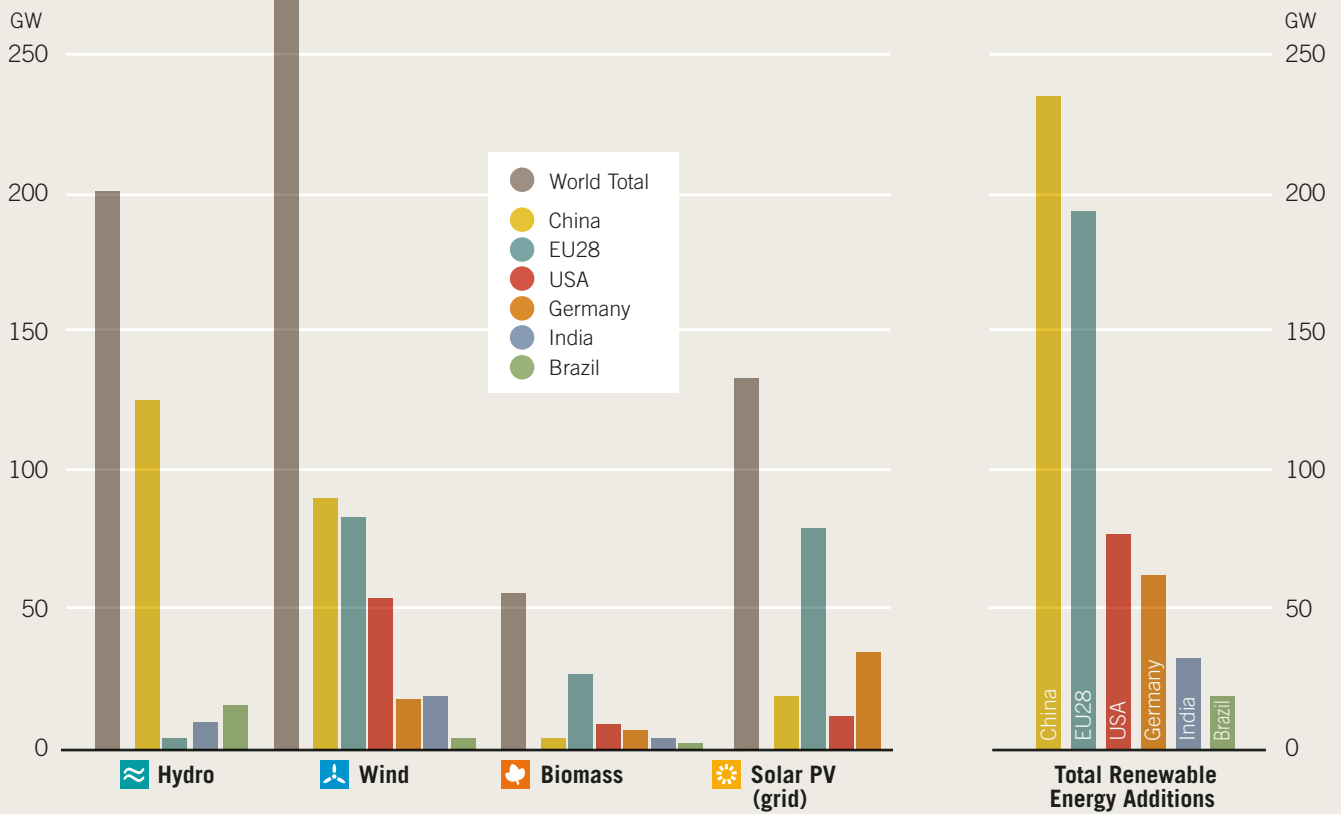
³ The GSR 2013 reported a global total of 990 GW of hydropower capacity at the end of 2012; this figure has been revised downward due to better data availability. Data do not include pumped storage.

⁴ Solar hot water capacity data include water collectors only; including air collectors, estimated totals are 283.4 GW for 2012 and 330 GW for 2013. The number for 2013 is a preliminary estimate. Note that past editions of this table have not considered unglazed water collectors.

⁵ Biofuel mandates include policies at the national or state/provincial level that are listed both under the biofuels obligation/mandate column in Table 3 (Renewable Energy Support Policies) and in Reference Table R18 (National and State/Provincial Biofuel Blend Mandates). Numbers in the table do not include individual state/provincial mandates. The 10 countries identified with biofuels mandates in the “Start 2004” column were actually in place as of early 2005, the earliest year for which data are available.

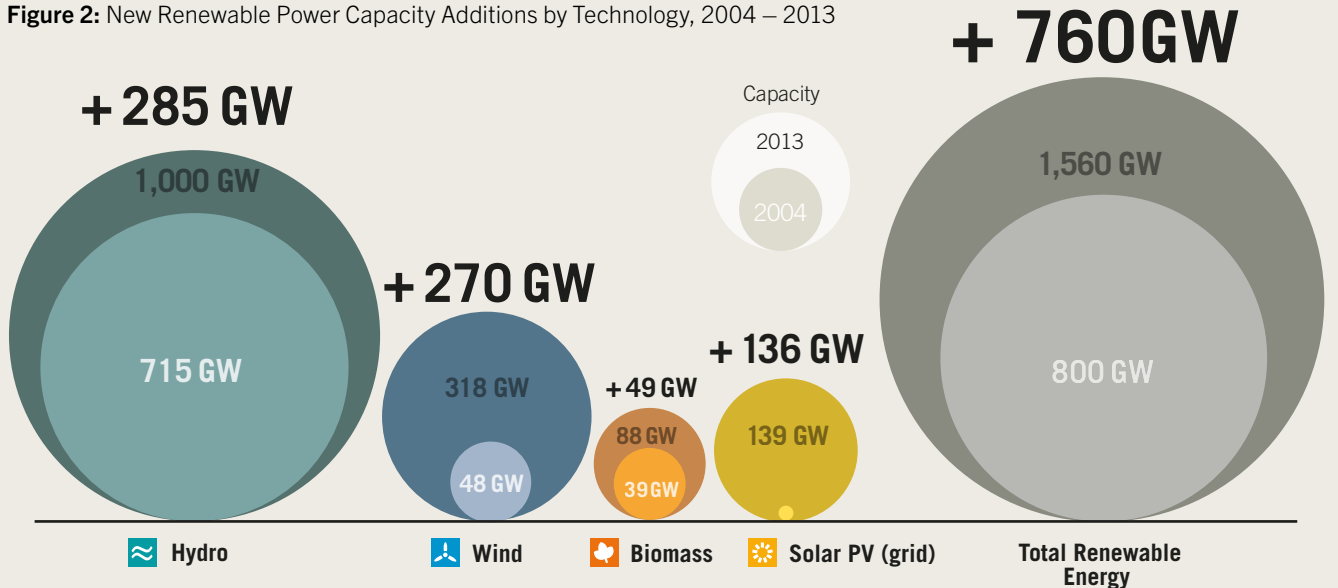
Note: Renewable power capacity (including and not including hydropower) and hydropower capacity data are rounded to nearest 5 GW; other capacity numbers are rounded to nearest 1 GW except for global investment, numbers <15, and biofuels, which are rounded to one decimal point. Policy data for 2013 include all countries identified as of early 2014.

Figure 1: Renewable Power Capacity Additions by Region, 2004 – 2013



Note: Geothermal and CSP are not presented here as their amounts are statistically very small in comparison to the other technologies presented. Geothermal and CSP numbers have been included in the Total Renewable Energy Additions.

Figure 2: New Renewable Power Capacity Additions by Technology, 2004 – 2013



Note: Geothermal figures for 2004 and 2013 were 9 and 12 GW respectively. For CSP, capacity was 0.4 in 2004 and 3.4 GW in 2013. These amounts have been included in the Total Renewable Energy calculation.

SOLAR PV

The total global operating capacity of solar PV crossed the 100 GW milestone in 2012, reaching a total capacity of 139 GW by the end of 2013. Since 2004, the annual market has exploded growing from approximately 1 GW to 39 GW in 2013. Over the course of 2010 more solar PV was installed than the past 20 years combined. While the major growth over the past decade has been in Europe—roughly 70% of all PV installations worldwide are in Europe—China’s market is growing rapidly. China’s annual installed PV capacity grew from 0.3 GW in 2009 to 3.3 GW in 2011 and reached 13 GW by 2013. The result of this spectacular growth in 2013 means that China now accounts for nearly one-third of global capacity added. China is followed by Japan (6.9 GW) and the United States (4.8GW). Germany accounts for 3.3 GW of solar PV with the UK and Italy both contributing 1.5 GW. In Italy, solar PV met 7.8% of total annual electricity demand.

Despite these impressive numbers, the growth to date in the solar PV sector reflects only a very small part of the enormous market potential; several countries from high solar radiation regions such as Africa, the Middle East, Southeast Asia and Latin America, all of which are on the brink of scaling up their solar deployment. Driven by falling prices, solar PV is expanding to new markets, covering Africa and the MENA region to Asia and Latin America. Interest in community-owned and self-generation systems has continued to grow steadily over the past decade while the number and scale of large solar PV projects have also increased.

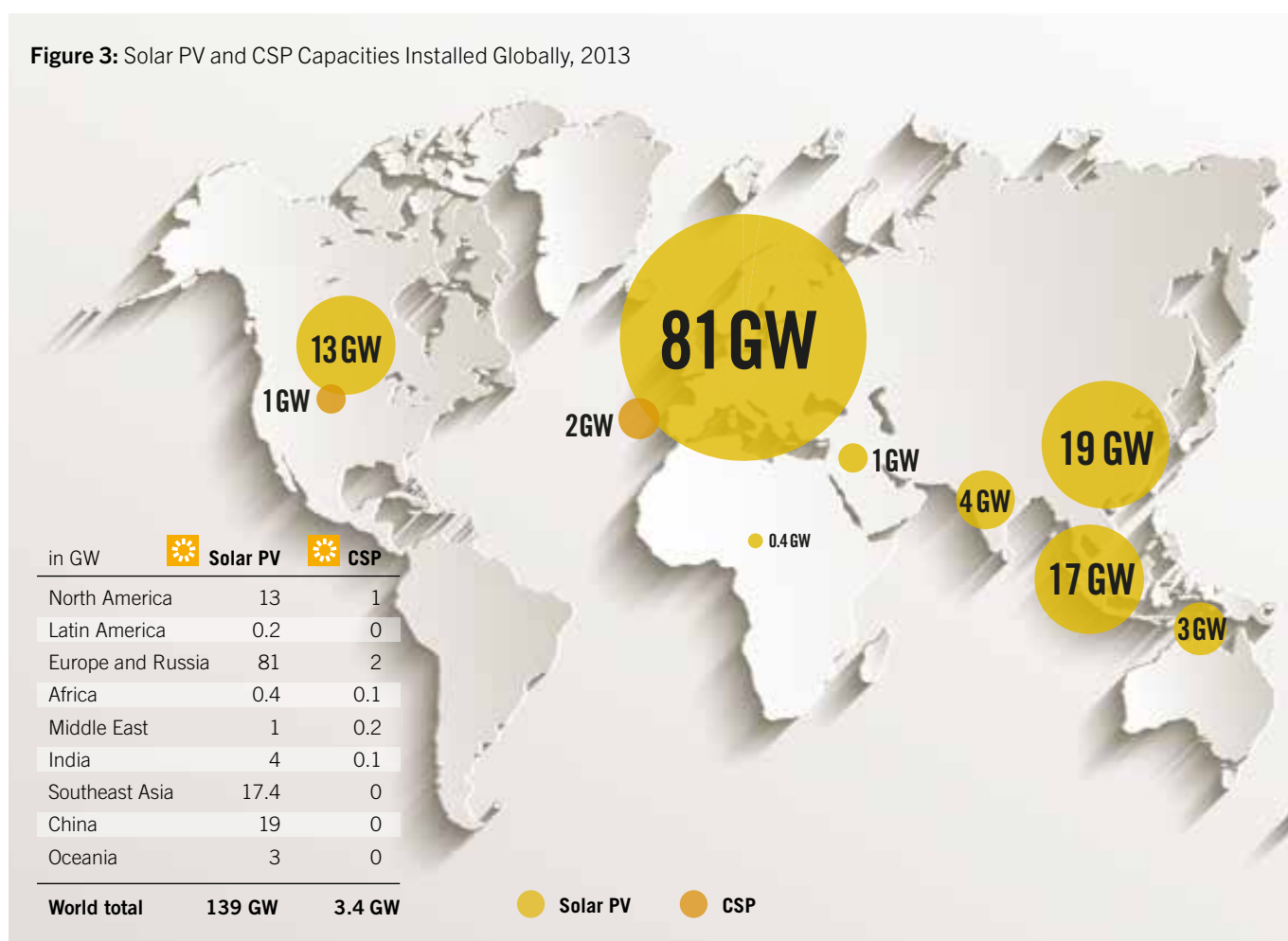
Conversely cell and module manufacturers struggled as extreme competition and decreases in prices and revenue margins drove industry consolidation, resulting in several Chinese, European and U.S. manufacturers going out of business.

CONCENTRATING SOLAR POWER (CSP)

Ever since the connection of the first commercial CSP plant to the grid in 1989 in Arizona/United States, the development of this renewables market has faced challenges. It was the adoption of Spain’s renewable energy law in 2008 which finally brought growth to the industry after a decade of stagnation and no new CSP plant grid connections. The annual market in 2010 reached 0.5 GW, with expansion to just under 1 GW in 2013. The total global CSP capacity increased during the last decade by a factor of 14 to 3.4 GW with the majority of this capacity added in Spain, home to 65% the world’s CSP capacity. Falling PV and natural gas prices, the global economic downturn, and policy changes in Spain all created uncertainty for CSP manufacturers and developers, resulting a slowing in the Spanish market.

Simultaneously increasing interest in CSP in other parts of the world has led to 5 GW projects which are currently under construction, with expansion in Australia, Chile, China, India, the MENA region, and South Africa. The industry is also positioning itself in new sectors such as water desalination, industrial heat supply and dispatchable, solar electricity storage systems.

Figure 3: Solar PV and CSP Capacities Installed Globally, 2013



WIND POWER

By the end of 2013 cumulative global wind capacity was 318 GW, an increase of 270 GW since 2004. However in 2013, after more than 20 years of steady growth, the annual wind market dropped for the first time; down 10 GW to 35.5 GW. This decline was due primarily to the steep drop in US installations, from 13 GW in 2012, to just over 1 GW in 2013. The failure of the US Congress to re-authorise the US Production Tax Credit, which expired end-2012, effectively killed the 2013 market. The United States—which was the largest global market from 2006 to 2008 and in 2012—fell to sixth place behind Canada. However it is likely that it will rise again in 2014; this time to second place behind China.

Elsewhere wind power is expanding. While the roots of the modern wind power industry are in Denmark, Germany and the United States, 2004 saw the wind market spread. From 2004 to 2010 China doubled its wind installations annually from 0.5 GW to 19 GW. It led in annual, yearly installations (except in 2012) and held the top spot in 2011 in terms of cumulative installations. Although the Chinese market dipped to just below 13 GW in 2012, it grew to 16 GW in 2013 and is back on an upward trajectory. In addition to Europe, China, and the United States, Canada, Brazil and India have become important markets with Mexico and South Africa growing rapidly. Falling prices due to high competition and technology improvements make wind power an economically feasible power generation technology competing directly with heavily subsidised fossil fuels in an increasing number of markets. As of 2014 over 240,000 wind turbines are operating in more than 90 countries.

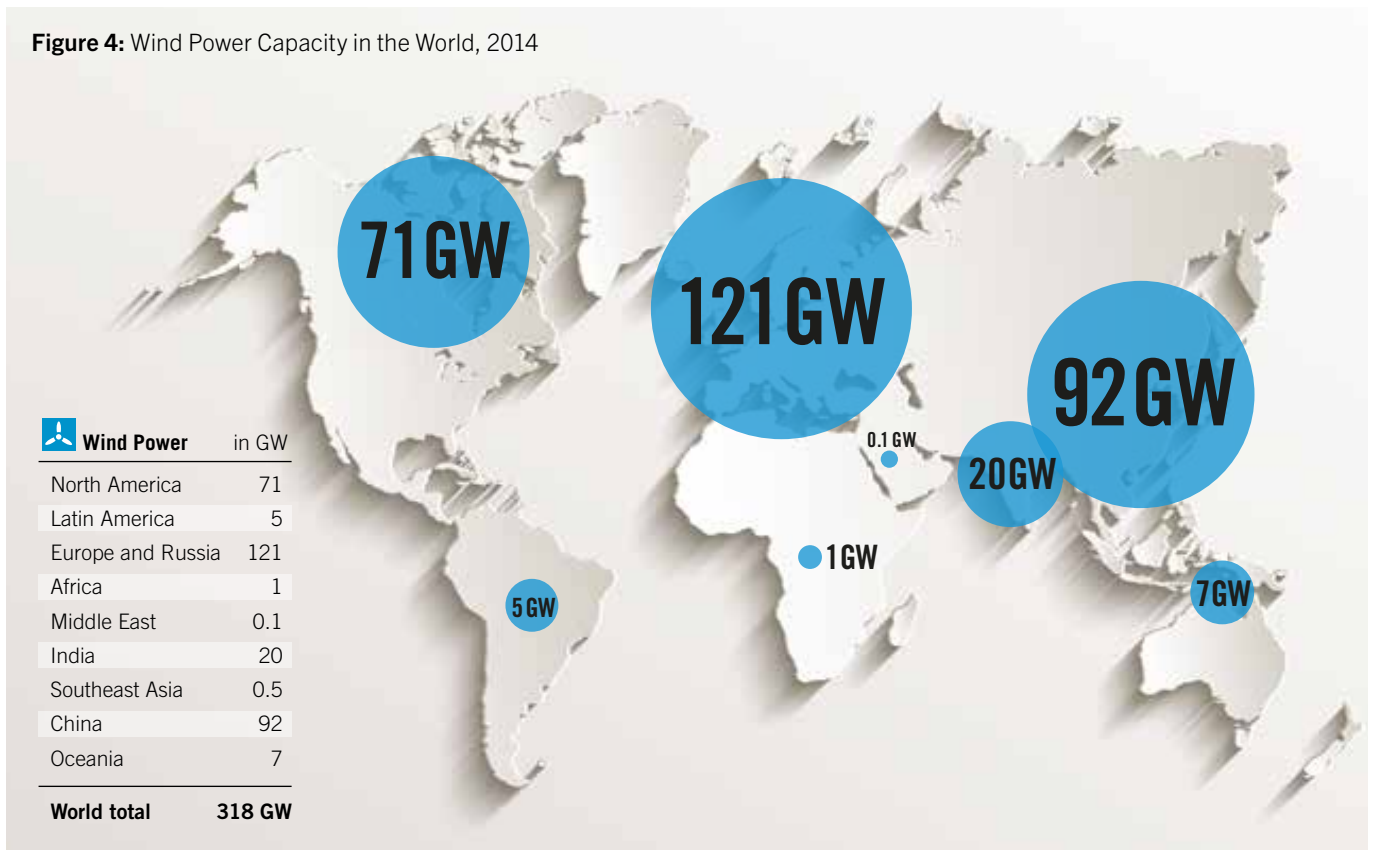
HYDRO POWER

An estimated 285 GW of new hydropower capacity came on-line between 2004 and the end of 2013, increasing global installed capacity from 715 GW to an estimated 1000 GW. Hydropower generation increased from 2,900 TWh to an estimated 3,700 TWh of electricity during 2012. Global power demand increased accordingly, keeping hydropower's share of the global electricity supply at 16%. China led in terms of capacity additions, with the majority of other installations appearing in Turkey, Brazil, Vietnam, and Russia. Joint-venture business models involving local and international partnerships are becoming increasingly prominent as the size of projects and the capacity of hydropower technologies increase. There is also increasing recognition of the potential for hydropower to complement other renewable technologies, such as variable wind and solar power.

OCEAN ENERGY

Ocean energy is still at an early stage of development and can be compared to the state of the wind industry in the early 1980. Ocean energy remains a wild card in the renewable power generation portfolio. There are currently numerous designs available with a correspondingly low standardisation rate; two clear indicators of how young the sector is. Commercial ocean energy capacity was roughly 527 MW by the end of 2013. The tidal power facility in the north of France represents by far the largest part of installed capacity; small-scale projects have been deployed in the United States and Portugal. Governments and regional authorities continued to support ocean energy research and development, while major power corporations increased their presence in the sector, which is seeing measured but steady progress.

Figure 4: Wind Power Capacity in the World, 2014



The Sleeping Giants: Renewables for heating and cooling

While renewable power generation continues to enjoy double-digit growth rates, renewable heating and cooling technologies have grown at a much slower rate. This is partly due to the small-scale nature of this sector as well as the multiple, decision-making processes primarily at the household level. More complex and therefore fewer renewable energy support policies have also hindered growth in this sector (see Chapter 5 on Lessons Learned). Slow growth in this sector is also a result of an increasing number of applications where heat is produced with electricity, e.g. through the use of heat pumps. Moreover, increases in high energy efficient buildings and passive solar architecture reduce heat demand.

GEOHERMAL ENERGY for heating and power generation

Geothermal resources provided an estimated 805 PJ (223 TWh) of renewable energy in 2013, delivering two-thirds as direct heat and the remainder as electricity and representing an increase of a factor of five compared to 2004. While the expansion of geothermal power generation is only in six countries—United States, Philippines, Indonesia, Mexico, Italy and New Zealand—the use of ground-source heat pumps is growing rapidly in a number of countries and reached an estimated 91 GWth of capacity in 2013. Despite two-thirds of global capacity being located in the United States, China, Sweden, Germany, and Japan at least 78 countries currently tap geothermal resources for direct heat. Geothermal electric generating capacity grew by an estimated 456 MW during 2013, bringing the global total to 12 GW and generating at least 76 TWh.

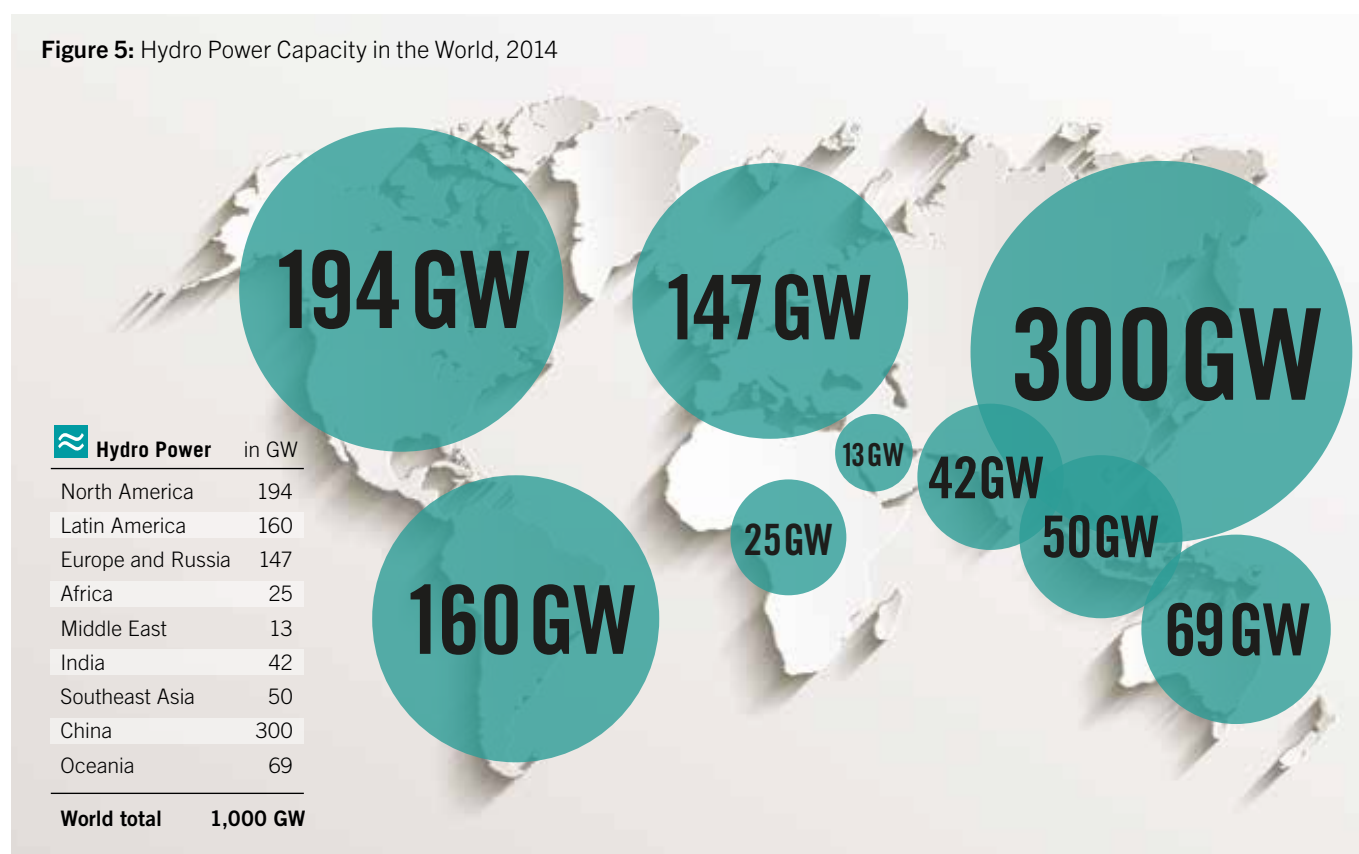
SOLAR THERMAL HEATING AND COOLING

By the end of 2013, global solar thermal capacity reached an estimated 326 GWth for all collector types, with glazed water collectors representing around 90% of the total installed capacity and a factor six increase compared to 2004. China accounted for 86% of the world market for solar thermal heating technologies by end 2013 and 64% of the total installed capacity (283.4 GWth). Solar space heating and cooling are gaining ground, as are solar thermal district heating, solar cooling, and process heat systems. The industry continues to face challenges, particularly in Europe, and was, throughout the last, several years, marked by acquisitions and mergers among leading players, with rapid consolidation continuing in China. Automation of manufacturing processes increased in 2013, with, in parallel, innovation spanning from adhesives to materials and beyond.

BIOMASS for heat and power

Use of biomass in the heat, power, and transport sectors increased 20% over the past 10 years to an estimated 55.6 EJ. Heating accounted for the vast majority of biomass use, including traditional biomass. Between 2004 and 2014 modern biomass heat capacity rose about 73 GWth to an estimated 296 GWth. The last decade also saw global bio-power capacity grow from 39 GW in 2004 to approximately 88 GW, with notable increases in some BRICS countries. Over the course of 2013 an estimated 405 TWh of electricity were generated from biomass. Current demand for modern biomass is driving increased international trade, particularly for biofuels and wood pellets. Global production and transport of wood pellets exceeded 23.6 million tons in 2013 compared to around 4.5 in 2004.

Figure 5: Hydro Power Capacity in the World, 2014



Renewable Energy in the Transport Sector: Fuel change and electrification

Due to limited solutions, the transport sector is the most difficult sector to substitute fossil fuels for renewables. Energy efficiency, via smaller and lighter vehicles, transport mode changes from individual to public transport and the introduction of e-mobility paves the way increasing renewable energy supply in the transport sector. E-mobility however does not only mean electric vehicles, but also electric powered trains, subways, buses and taxis. Throughout the world, there are limited but increasing initiatives to link electric transport systems with renewable energy, particularly at the city and regional levels.

BIOENERGY for the transport energy

Liquid biofuels met around 2.3% of total transport fuel demand in 2013, with small but increasing use by the aviation and marine sectors. By the end of 2013 use of liquid biofuels has increased by a factor of three compared to 2004 levels. Global production of fuel ethanol grew steadily from 32.6 billion liters in 2004 to 116.5 billion liters in 2013. For the past four years, annual production of liquid biofuels has remained roughly equal to 2010 levels. New ethanol and biodiesel production facilities opened in recent years, although many ethanol plants continue to operate below capacity.



Ten Years of Impact

3



The rapid growth of renewable energy markets throughout the world resulted in significant investment volumes, in creation of jobs as well as in a significant reduction of renewable energy cost due to economies of scale, thereby opening new markets for renewable energy technologies in developing countries where there is strong need for new generation capacities and where energy demand is increasing.

Evolution of Global Investment in Renewable Energy: A decade retrospective

Global new investment in renewable power and fuels grew steadily from USD 39.5 billion in 2004 to USD 279.6 billion in 2011. Investment decreased in 2012 from this all time high down to USD 249.5 billion and further decreased to USD 214.4 billion in 2013. Total investment decreased by 11% in 2012 and was down 23% in 2013, in comparison to 2011 levels.

This decline in investment—after several years of steady growth—resulted from uncertainty over support policies in Europe and the United States, as well as from actual retroactive reductions in support. However the decrease in investment also resulted from a sharp reduction in technology costs—especially solar PV. Even as global investment in solar PV in 2013 declined nearly 22% relative to 2012 levels, new capacity installations increased by more than 32%. These steep cost reductions in the wind and solar PV sectors make renewables attractive for new markets, particularly in developing countries where there is strong need for new electricity generation capacities to satisfy increasing energy demand.

Figure 6: Global Investment, 2004 – 2013



Table 3: Global Investment in Renewable Energy by Region, 2004 – 2014

		2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
USA	billion USD	5.7	11.9	28.2	34.5	36.2	23.2	34.7	53.4	39.7	35.8
America (excl. USA and Brazil)	billion USD	1.4	3.4	3.4	5.0	5.6	5.9	11.5	8.7	9.9	12.4
Brazil	billion USD	0.5	2.2	4.2	10.3	12.5	7.9	7.7	9.7	6.8	3.1
Middle East and Africa	billion USD	0.6	0.6	1.2	1.7	2.7	1.7	4.3	3.2	10.4	9.0
Europe	billion USD	19.6	29.4	38.4	61.7	72.9	74.7	102	115	86.4	48.4
India	billion USD	2.4	3.2	5.5	6.3	5.2	4.4	8.7	12.6	7.2	6.1
China	billion USD	2.6	5.8	10.2	15.8	25.0	37.2	36.7	51.9	59.6	56.3
Asia and Oceania (excl. India and China)	billion USD	6.7	8.3	8.9	11.0	11.5	13.2	20.7	25.3	29.5	43.3
Total	billion USD	39.5	64.8	100	146.3	171.6	168.2	226.7	279.6	249.5	214.4

Note: Data include government and corporate R&D.

Source: BNEF and UNEP. Reference see endnotes.

Including the unreported investments in hydropower projects larger than 50 MW, by the end of 2013 total new investment in renewable power and fuels was at least USD 249.4 billion. Total new installed renewable energy capacity in 2013 was 120 GW, the highest ever and a factor of four above 2004 levels. Since 2004, USD 1.6 trillion has been invested in the field of renewable energy.

Commercial banks were just starting to enter the renewable energy sector in 2004, at a time when the majority of financiers and other investors considered most renewable technologies to be unproven and too risky. Today commercial banks are joined by pension funds, insurance companies, major corporations including several from outside the energy industry, and others looking for stable, long-term returns.

Now that renewables are becoming economically competitive and investors are increasingly recognising their value, a key to further development will depend on the design of effective financing tools to overcome the initial investment cost. Several financial innovations have been developed since 2004. Recently, investment firms have introduced tools such as Sustainable Yield Bonds in the United States, Green Bonds in France and the United States, and the Renewable Financing Company Bonds in the United Kingdom. Further innovations, ranging from crowd funding to new ownership models, are making it possible for individuals and communities to invest in renewable energy.

Figure 7: Investment by Region

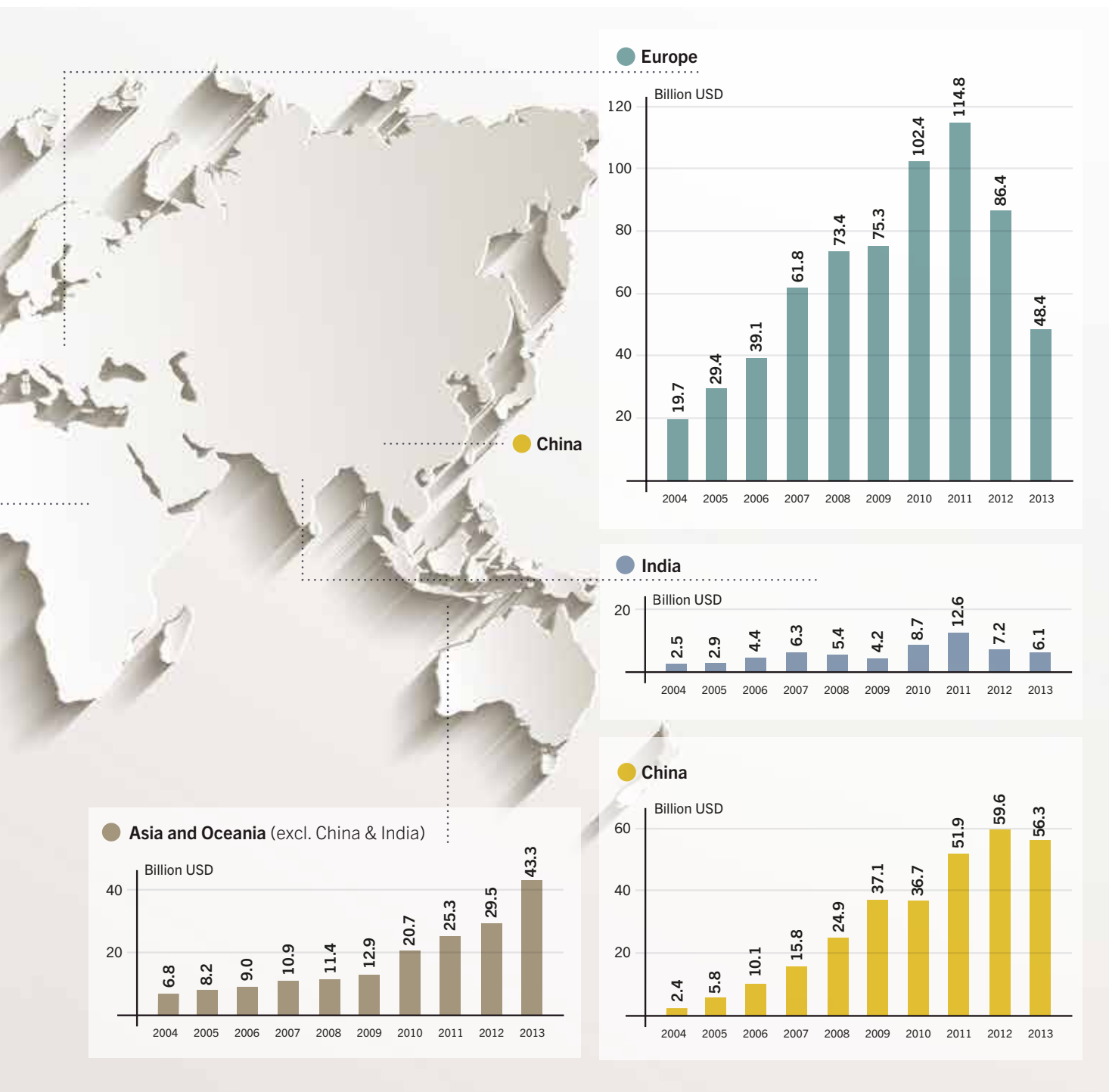


Investment by Region

Since 2004 China and Europe have experienced the most reliable and steady growth in the renewable energy market.

In 2012 Europe's renewable energy investment was down 44%; China continued to grow, albeit at a slower pace. Even with an overall decline in investment, China—for the first time—invested more in renewable energy than all of Europe combined, with the result that it invested more in renewable power capacity than in fossil fuels. Despite China's impressive growth, Europe still has the largest market volume for renewables worldwide.

In 2004 India and China were roughly even with regards to investment levels however India failed to establish a reliable investment climate for renewables, with the result that eight years later China's renewable energy market was 10-fold that of the Indian market volume. In 2012, the Middle East and Africa overtook India and are now important markets for the renewable industry. By the end of 2013 investment in renewable energy was also on the rise in Latin America as well as South-East Asia and Oceania.



Working for Renewables

New technologies open new market opportunities and create new jobs. The global renewable energy workforce encompasses a broad variety of jobs and occupations, ranging from low- to very high-skilled. Global statistics about renewable energy employment by country and technology are incomplete and methodologies inconsistent however, an estimate about based on documented employment indicates that between 2004 and 2014 the level of employment doubled, from about 3 million in 2004 to approximately 6.5 million by the start of 2014.

Renewable Energy Jobs by Region

Although a growing number of countries is investing in renewable energy, the bulk of employment remains concentrated in a relatively small number of countries: China, the United States, Brazil, India and member states of the EU—especially Germany. These countries are major equipment manufacturers as well as producers of bioenergy feedstock.

Employment is growing in other countries with an increasing number of jobs (technicians and sales staff) in the off-grid sector in developing countries. For example, the sale, installation

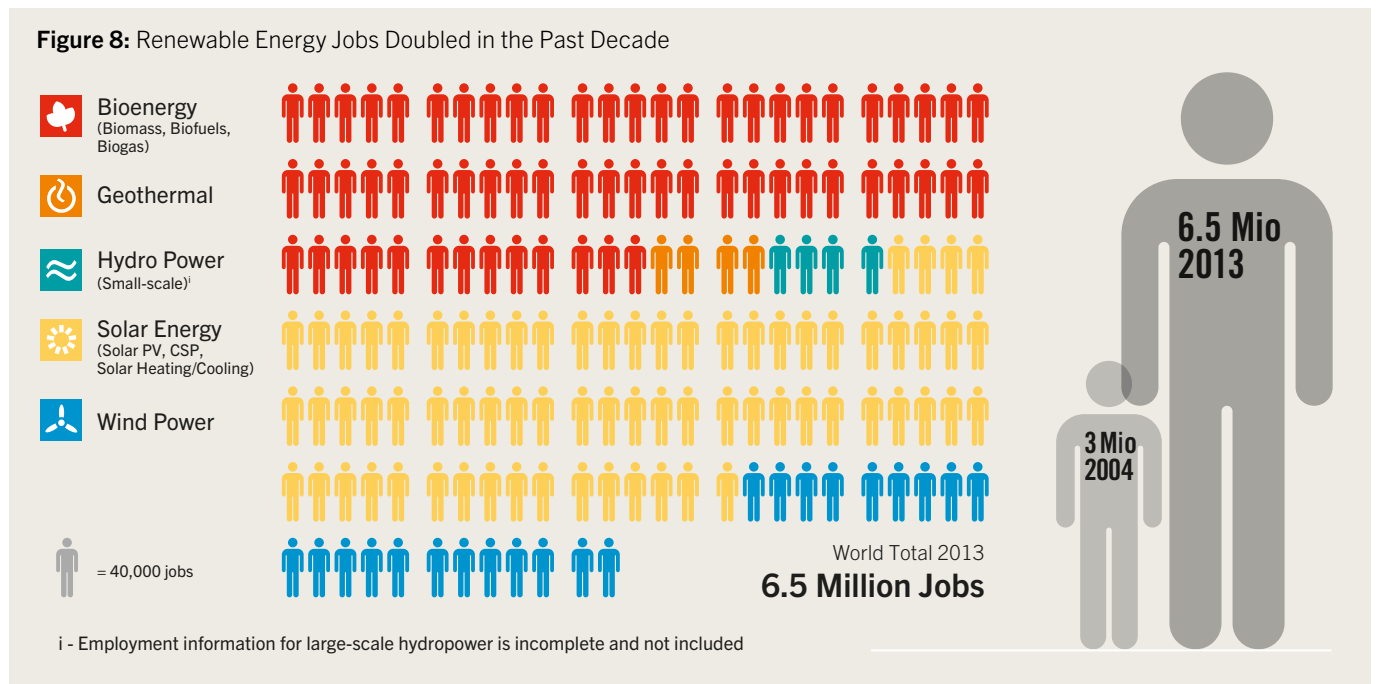


Table 4: Renewable Energy Jobs by Technology and Region, 2014

	GLOBAL	China	EUROPE				Brazil	USA	India
			EU Total	Germany	Spain	Rest of EU			
Thousand Jobs									
Biomass	782	240	306	52	44	210	–	152	58
Biofuels	1,453	24	111	26	3	82	820	236	35
Biogas	264	90	69	49	1	19	–	–	85
Geothermal	184	–	100	17	1	82	–	35	–
Hydro Power	156	–	33	13	2	18	12	8	12
Solar PV	2,273	1,580	220	56	11	153	–	114	112
CSP	43	–	29	1	28	0	–	17	–
Solar Heating	503	350	43	11	1	31	30	12	41
Wind Power	834	356	328	138	24	166	32	51	48
Total	6,492	2,640	1,238	363	114	761	894	625	391

Note: " – " means that no data are available.

Source: IRENA 2013. Reference see endnotes.












and maintenance of small solar PV panels in rural Bangladesh provide livelihoods directly for as many as 70,000 people with another 80,000 employed indirectly.

Over the past decade there has been a noteworthy shift along segments of the value chain, moving from manufacturing to installation and maintenance.

Renewable Energy Jobs by Technology

Each stage of the value chain—from planning and financing to installation, from operation to maintenance and renewable electricity sales and grid management—involves many different jobs. However the past decade showed that each technology has its own typical employment requirements. Table 5 provides an overview how many jobs are created by technology and by skill set.

Table 5: Employment Factors by Technology

	Construction Times	Construction + Installation	Manufacturing	Operation + Maintenance	Fuel Supply
	Years	Job years / MW	Job years / MW	Jobs / MW	Jobs / PJ
 Hydro Power	2	6.0	1.5	0.1	
 Wind onshore	2	2.5	6.1	0.2	
 Wind offshore	4	7.1	10.7	0.2	
 Solar PV	1	9.0	11.0	0.2	
 Geothermal	2	6.8	3.9	0.4	
 Solar thermal	2	5.3	4.0	0.4	
 Ocean	2	9.0	1.0	0.3	
 Geothermal – heat			6.9		
 Solar – heat			7.4		
 Biomass	2	14.0	2.9	1.5	32.2
 Biomass CHP		15.5	2.9	1.5	32.3

Source: Jurovitz 2013. Reference see endnotes, Table 5.



Rapid Decrease of Cost of Renewable Energy Technologies

The improved competitiveness of renewables is being driven by a virtuous circle in which the rapid deployment of renewables, encouraged by support policies to overcome barriers to their use, is leading to significant and rapid reductions in cost for many renewable technologies.

Solar PV costs are declining rapidly due to high learning rates for PV modules and the current rapid deployment; costs for solar photovoltaic generators declined by around 50% between 2010 and 2014. If these trends continue, grid parity with residential electricity tariffs will soon be the norm in many countries, rather than the exception.

Wind power is now one of the most competitive renewable technologies and, in developed countries with good wind resources, onshore wind is often competitive with fossil fuel-fired generation. The wind turbine prices fell in the 1990s and remained steady over the past approx. 10 years. However the average capacity factor steadily grew over the past decade. More efficient turbines generate more electricity per turbine leading to an overall reduction of generation costs.

CSP is increasingly being deployed at scale and costs are coming down. Solar towers are emerging as a particularly important generation option in areas with high direct solar irradiation, while CSP systems can also help with the integration of variable

renewables when they are used in combination with low-cost thermal energy storage to generate electricity when there is no sun.

Hydropower capacity additions in the five-year period end-2008 to 2013 were significantly greater than during the earlier part of the decade. Hydropower now has a global installed capacity of around approximately 1,000 GW by 2013 and, is currently the largest renewable power generation source. At good sites it provides the cheapest electricity of any generation technology. Many biomass power generation technologies are mature and biomass is a competitive power generation option wherever low-cost agricultural or forestry waste is available. In addition, new technologies are emerging that show significant potential for further cost reduction.

Distributed renewable technologies, such as rooftop solar PV and small wind, can provide new capacity without the need for additional transmission and distribution investment and therefore cannot be directly compared with large utility-scale renewable solutions.

Data collected to date suggest that the cost of supporting renewables with well-designed support packages is declining over time and is much cheaper than a static analysis of costs would suggest.

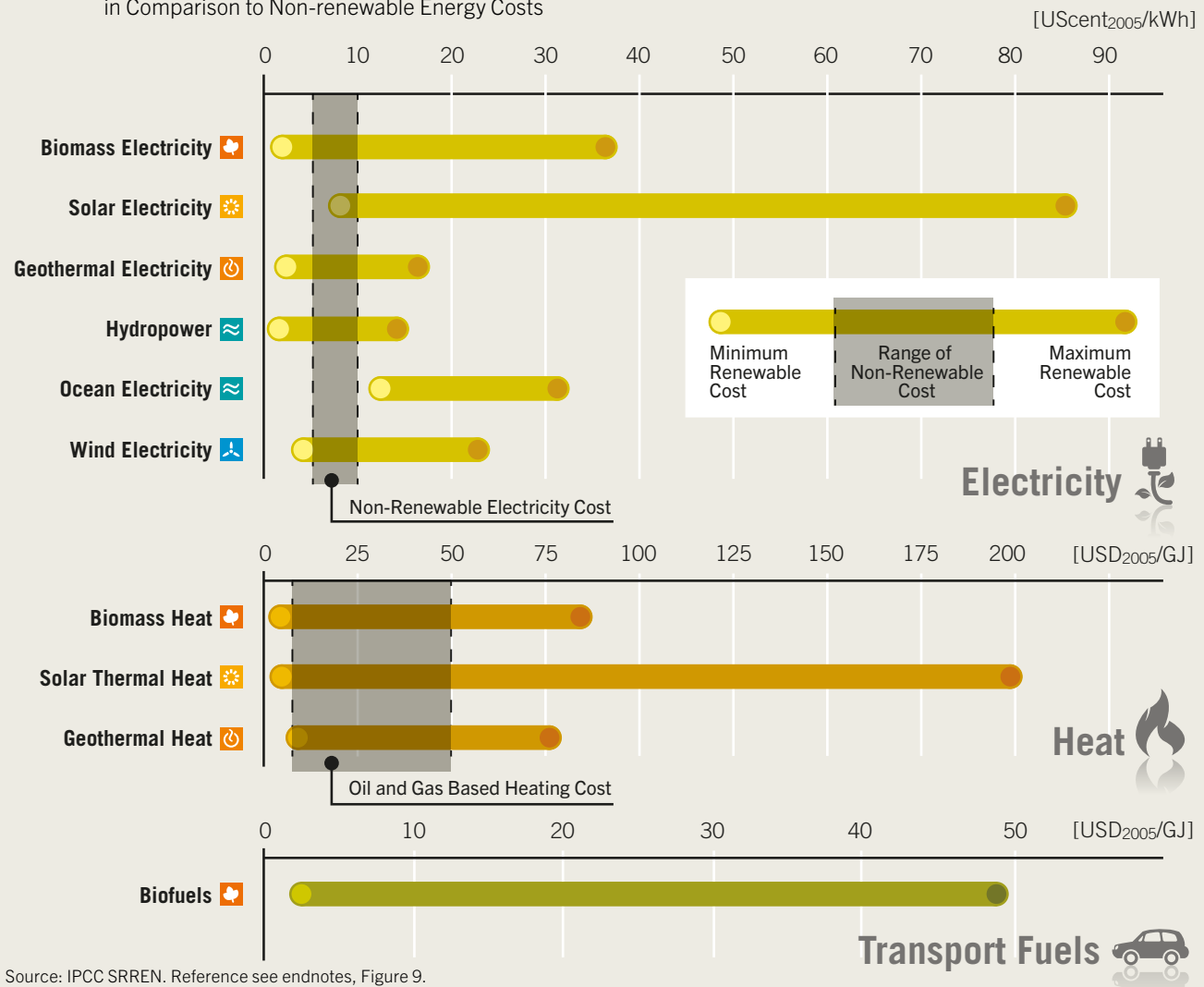
Global Expansion of Renewable Energy

By early 2014, at least 144 countries had renewable energy targets and 138 countries had renewable energy support policies in place, up from 48 countries in 2004. Developing and emerging economies have led the expansion in recent years and now account for 95 of the countries with support policies, up from 15 in 2005.

Most renewable energy policies enacted focus on the power sector. Feed-in tariffs and renewable portfolio standards are the most popular instruments; public competitive bidding or tendering, gained further prominence, with the number of countries turning to public auctions rising from 9 in 2009 to 55 as of early 2014. Targets and policies supporting renewable energy heating and cooling are steadily increasing.

Policy mechanisms continued to evolve, with some becoming more differentiated by technology. Feed-in policies in many countries evolved further towards premium payments in the power sector, and continued to be adapted for use in the heating sector. Recently, new policies are emerging to advance or manage the integration of high shares of renewable electricity into existing power systems, including support for energy storage, demand-side management, and smart grid technologies.

Figure 9: Range in Levelised Cost of Energy for Selected Commercially Available Renewable Energy Technologies in Comparison to Non-renewable Energy Costs



Source: IPCC SRREN. Reference see endnotes, Figure 9.

BENEFITS OF RENEWABLE ENERGY: CASE STUDY OF GERMANY

Germany was one of the “first mover countries” that developed and implemented renewable power generation, especially in onshore wind and solar photovoltaic. Between 2000 and 2013, the Ministry for Environment undertook a detailed and unique effort to document the effects of the implementation of renewable energy sources. This section summarises the five key benefits of the German **Energiewende**, the German word for **Energy Transition**.



1. GREEN HOUSE GAS EMISSIONS

The increased market for renewable energy deployment reduced greenhouse gas as well as dust emissions throughout Germany. Table 6 shows specific emission reductions. The values relate to the current energy mix and thus will vary according to mix and country.

Based on the numbers in Table 6 the overall greenhouse gas emission reductions add up to 148 million tons for 2012. The biomass sector offered the largest percentage share of CO₂ off-set, reducing 40% of 148 million tons CO₂ equivalent in 2013. The wind and solar PV sectors each saved an equivalent of 28 and 16% of greenhouse gas emissions respectively. Hydropower, biofuels, solar thermal, and geothermal heating collectively saved 17%.

2. FOSSIL FUEL SAVINGS

Using renewable energy source for power generation, heat supply or as a transport fuel reduces fossil fuel demand and—in an energy resource poor country like Germany—decreases imports of fossil fuel. In 2012 alone, over 40 million tons of coal, 12 billion cubic meter of gas and 8 million liters of oil, diesel and gasoline were saved.

3. FOSSIL FUEL IMPORT COSTS

Germany imports most of its oil, gas and coal. With the increased penetration of renewable energy the overall cost for imported fossil fuels decreased steadily over the past decade. In 2011 avoided fossil fuel imports totaled Euro 6.6 billion, with the greatest savings in the power sector. By 2012, the fossil fuel cost savings were just over Euro 10 billion with the heating sector surpassing the power sector by Euro 1 billion.

4. COST OF RENEWABLE ENERGY

Germany’s pioneering role in the development and deployment of renewable energy technologies led to a global drop in costs. Cost for renewable energy technologies—onshore wind, solar collectors, bioenergy—decreased significantly. Solar photovoltaic module prices decreased by one order of magnitude; prices in 1980 were an average of USD 30/W_{peak} dropping 97% to UScent 90/W_{peak} in 2013. (See Figure 10.) In Germany, cost reductions were achieved primarily due to the Feed-in Law.

5. INVESTMENTS IN NEW TECHNOLOGIES

Increased investment in new renewables translates into new jobs in the renewable energy industry. According to the German government, the overall investment in 2012 renewable energy technologies was Euro 19.5 billion.

Table 6: Specific Emission Reduction from Renewable Energy Sources in Germany

Greenhouse House Gases	Power Generation Replacement Factor [g/kWh]	Heat Supply Replacement Factor [g/kWh]	Biofuels Replacement Factor [g/kWh]
CO ₂	708	275	210
CH ₄	0.52	0.03	(– 0.26)
N ₂ O	(– 0.06)	(– 0.02)	(– 0.16)
CO₂ Equivalent	710	271	154

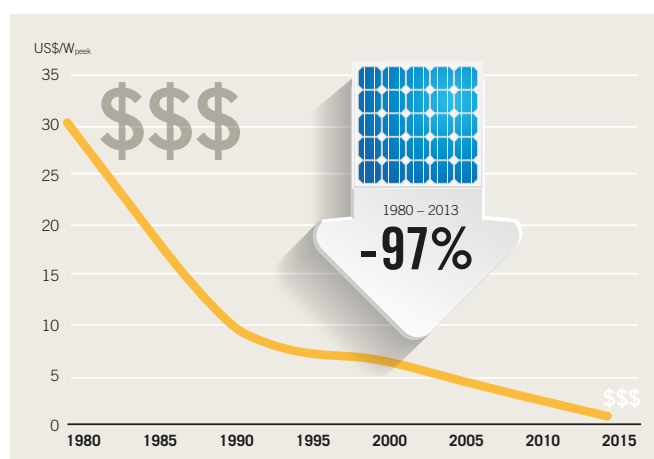
Source: BMU 2013. Reference see endnotes.

Table 7: Avoided fuel imports (in billion €)

	Power	Heat	Transport	Total
2011	2.5	3.3	0.8	6.6
2012	3.9	4.9	1.2	10

Source: BMU 2013. Reference see endnotes.

Figure 10: Development of Solar Photovoltaic Module Prices, 1980 – 2013



Renewables in Different World Regions

4



Over the past decade, renewables have grown worldwide at different speeds and stimulated by various drivers. This section is based on interviews with REN21's network partners. It provides a snapshot of the main drivers of, and challenge for renewable energy deployment in the respective world regions.

A decade ago, markets for modern renewable energy technologies were concentrated primarily in Europe and the United States. Over the course of the past decade, renewables deployment has reached all continents. This section provides a broad

overview of the current state of renewable energy deployment in different world regions,ⁱ of existing policy frameworks, milestones of the past decade as well as main challenges facing increased renewable uptake.



AFRICA: SUB-SAHARAN

■ GENERAL OVERVIEW

Over the past decade the population growth in sub-Saharan Africa (SSA) has outpaced electricity access efforts. By the end of 2013, only 43% of the SSA population had access to electricity, with the result that the increase in demand did not match expansion plans for renewable energy across all sectors. This remains one of the main challenges across the sub-Saharan region. The strong interconnection between climate change and energy access policy is not reflected adequately in the political debate yet. Unstable policy frameworks and rapidly changing renewable energy support schemes have led to financing challenges as investors are wary of regressive policies and the negative effect they have on investments. However over the past five years an increasing number of SSA countries are establishing policy frameworks, which are leading to substantial increases in national renewable energy markets.

The overall perception of renewable energy in SSA is generally positive. Nonetheless in many SSA countries technologies such as solar PV are still seen primarily as off-grid tools which are expensive and marginal for grid-connected generation, and with little potential to deliver large quantities of needed electricity. Large hydropower stations have also sparked opposition for a number of reasons. Some forms of biofuels—especially Jathropha—have caused disappointment in their ability to deliver because of unanticipated farming difficulties and overestimated potentials.

■ MAIN DRIVERS FOR RENEWABLES

Drivers for the expansion of renewable energy are numerous and vary from country to country. Access to energy, the creation of local jobs and security of supply are among the main drivers for

ⁱ) The OECD classification of regions has informed the grouping of certain countries in this section. Groupings are presented alphabetically.

renewables on the continent. In South Africa, the pressure to reduce CO₂ emissions, the need to diversify energy supply due to supply shortages and the fast deployment possibility of renewable energy projects are driving the renewable energy market.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

The policy framework across SSA is diverse with many different forms of FITs, bidding and direct subsidy programmes.

In **East Africa** renewable energies play a vital role in the region's socio-economic development. However, in order to successfully compete with often highly subsidised conventional electricity production, supportive frameworks are necessary. Renewable energy market creation requires the development of regulations. National and regional dialogues on sustainable energy futures are required in order to foster nations and regions development strategies and goals. Tanzania, for example, opened its electricity market to independent power producers in 1992. Kenya introduced its Renewable Energy Feed-in Tariff (REFiT) policy in 2008. Changing rainfall patterns due to climate change—making hydropower less feasible—and a growing energy demand drove this process.

South Africa moved away from the REFiT framework to a criteria-based bidding approach for proposals to finance, construct, operate, and maintain renewable energy generation facilities. Under this system, submitted proposals are evaluated and contracts assigned based on various criteria, including the potential for the creation of a local industry, job creation, black economic empowerment, and technology transfer. Three of the five proposed bidding rounds have already occurred with the aim of procuring 6,724 MW of renewable capacity from independent power producers by 2016. By August 2014, 64 projects totalling 3,916 MW are at various stages of development—financial close, construction, and initial operation—making South Africa the fastest growing renewable energy market on the continent in 2014. Competitive bidding was the chosen policy tool to help transition the South African economy from its current coal-based energy system to one that is composed of 17,800 MW of renewables by 2030. While the overall contribution of renewable energy has increased, there is still relatively modest progress in the area of decentralised renewable energy technologies such as small-scale, roof-top PV, and off-grid systems.

West Africa also known as the ECOWAS regionⁱⁱ is composed of 15 Member States with a regional population of just over 334.6 million, representing approximately one-third of the sub-Saharan African population. Between 2000 and 2010, West Africa added an estimated 50 million people to the grid. However, in its 2030 energy scenarios, The ECOWAS Center for Renewable Energy and Energy Efficiency (ECREEE) projects that without significant investment in expansion of electricity access, energy poverty will continue to have considerable negative consequences on regional economies and societies. Access to modern cooking fuels is also severely limited in ECOWAS Member States. Across the whole of SSA, the average share of national populations relying on solid fuels for cooking is just over 79%; within ECOWAS,

this figure rises to 85.7%. The positive correlation between energy access and human development has been widely noted. ECOWAS governments have recognised the limitations that energy poverty poses on development and have committed to improving access rates and reliability of modern energy services, notably by working with ECREEE to develop Action Plans for Renewable Energy and Energy Efficiency for each Member State by December 2014.

■ DEPLOYMENT OF RENEWABLES

The deployment of wind technologies has grown since 2005 with the result that governments and the private sector have recognised its value. Examples of successful wind deployment include 110 MW installed in Ethiopia, 10 MW in Kenya with 500 MW in the pipeline and 50-100 MW of wind in the pipeline in Tanzania. Several wind projects in MENA countries as well as several successful bidding rounds in South Africa are also underway. The on-grid renewables development in SSA has been largely driven by FITs coupled with an increase in demand for electricity and the decreasing cost of wind technology.

During the last couple of years, solar PV has started to be deployed in SSA, however still with limited scope compared to its vast potential. Development of “pico-solar” is bringing minimal power to the base of the energy pyramid. Ten years ago there were barely any solar PV installations; currently 100,000 new systems are being implemented annually. Geothermal energy is being deployed in Kenya, Tanzania and Ethiopia. Biomass still a central part of the SSA energy equation, however most of bioenergy used is traditional biomass with its related negative health and environmental impacts.

■ MILESTONES OF THE PAST DECADE

Over the past decade renewable technologies on the African continent have matured, and have become reliable and cost competitive. The diversification of available capacity sizes and the modularity of the technology have made renewables a serious player within the African energy debate. Countries as diverse as Morocco, South Africa and Ethiopia champion the development of wind power on the continent in order to expand a secure power supply and to reduce their dependence on a single fuel source; notably hydropower or fossil fuel.

■ MAIN CHALLENGES FOR RENEWABLES

While the past decade brought many improvements in terms of renewable energy legislation, there are still many uncertainties across SSA. Lack of information on best practices about successful renewable policy schemes is a major barrier for renewables uptake in SSA. Without long-term planning security and bankable renewable energy schemes, financing also remains a main challenge. The relative long-term finance requirements for energy projects in terms of the pay-back period as well as the high interest rates in most SSA countries represent major barriers for new project developers. There also needs to be better collective awareness about renewable energy finance, what it entails.

ii) Benin, Burkina Faso, Cabo Verde, Côte d'Ivoire, The Gambia, Ghana, Guinea, Guinea Bissau, Liberia, Mali, Niger, Nigeria, Senegal, Sierra Leone, and Togo.



AUSTRALIA OCEANIA

■ GENERAL OVERVIEW

Australia Oceania covers a huge area with range of divergent countries. Australia,ⁱⁱⁱ New Zealand,^{iv} South Korea and Japan as well as the 15 Pacific Island States are very different in terms of geographical and climatic conditions, as well as the economic situation. However the entire region is blessed with extraordinary potentials of renewable energy and the low population density in all countries of this region makes renewable energy a natural choice for decentralised generation technology.

Australia has among the largest renewable potentials worldwide. According to the IPCC Special Report Renewable Energy, Australia could deliver the country's current demand more than 50 times over from renewable energy sources alone. Solar and wind are the main renewable energy sources for growth, on top of the existing hydroelectricity and bioenergy.

New Zealand was an early adopter of several alternative energy technologies, particularly hydroelectricity and geothermal energy. Its mature geothermal sector places New Zealand among the top countries for geothermal power capacity. The country also has a large potential for wind, solar and ocean energy.

Like New Zealand, Japan has good geothermal potential and a rapidly expanding PV sector. Renewables have been slower to develop in South Korea but tidal power and CSP are emerging as renewable leaders.

The vast majority of electricity demand of the Pacific Islands is generated via diesel generators which are among the most expensive technologies to produce electricity. While solar PV electricity generation would be the cheapest technology to generate power almost across all the island states, the largest barrier is still limited know-how and access to technology. However many of the island states recognise the huge opportunity that renewable energy represents and have developed support programmes over the past five years.

■ MAIN DRIVERS FOR RENEWABLES

Grid-connected solar PV and wind power have established themselves as the lowest cost renewable energy options for Australia. In Australia, 75% of the population wants more renewable energy demonstrating an inherent understanding of the importance of renewable energies. Australia's ageing coal power plant fleet provides further impetus. However, policy uncertainty remains

a challenge in Australia, particularly for large scale renewable energy project deployment. Drivers for renewables in New Zealand include diverse resource development, environmental responsibility, efficient use of energy and secure and affordable energy. For the Island States, security of supply, access to energy services and independence from fuel costs are the main drivers.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

A decade ago, Australia's renewable industry was dominated by large-scale hydro power. The single most important policy that has helped drive the maturation of the country's renewable industry since 2001—particularly in the field of large scale on-shore wind and residential PV installations—was the Renewable Energy Target (RET).

The RET obligates electricity retailers and large wholesale consumers to source at least 20% of electricity from RE sources by 2020. The review of the RET scheme is currently underway, causing significant uncertainty for large-scale investment at present.

Various state governments have introduced FITs for rooftop solar. Tariffs have been generous but have wound down significantly over the past years as the cost of solar PV has come down, in turn leading to a reduction in the number of rooftop installation because of reduced incentives.

Unlike many other industrialised countries, explicit support schemes for renewable energies are minimal in New Zealand in part because renewable energies are already competitive with fossil-fuelled equivalents. Most renewable electricity projects rely on existing market mechanisms while some sectors, such as solar water heating, receive low levels of support. In recent years the development of renewables has lagged that of other countries, particularly in fields such as wind power.

In 2008, renewable sources of energy provided 33% (5.6 M toe) of total primary energy supply (TPES) a share that has changed little since then. New Zealand currently has a target of 90% electricity from renewable energy by 2025 despite not having any specific renewable energy policy in place.

Japan's feed-in-tariffs were first introduced in 2012, in response to help plug the gap caused by the loss of nuclear capacity as well as aiming to utilise Japan's vast geothermal resources, estimated at over 20 GW.

Japan introduced its first feed-in-tariffs in 2009. It replaced voluntary net-metering, which was offered by regional electric utilities,

iii) Source: Clean Energy Council 2013. Reference see endnotes.

iv) Source: Energy-in-New Zealand. Reference see endnotes.

and was limited to roof-top solar PV. In 2012 in an attempt to help plug the gap caused by the loss of nuclear capacity, the feed-in-tariff was broadened to include all renewable energy technologies. Additionally, the government hoped to thus encourage the exploitation of Japan's vast renewable energy potential, which is estimated to be over 1800 GW for wind (including off-shore), 200 GW for solar, and over 20 GW for geothermal resources.

In response to the 2012-enacted feed-in-tariff, Japan has seen a rush to increase solar PV capacity, resulting in the addition of 7.0 GW in the financial year 2013 and bringing the country's solar PV capacity to 13.6 GW. Under the new feed-in tariff 0.1 GW of biopower was added ending 2013 with an estimated 3.4 GW for the sector.

■ DEPLOYMENT OF RENEWABLES

The Australian wind power market grew steadily since 2008 with an annual increase of 200 – 400 MW to reach an installed total installed capacity of 3239 MW by the end of 2013.

From 2004 to 2008, the Australian annual solar PV market lacked the necessary policy support resulting in installations that were only in the low, double-digit MW range. With falling prices and the implementation of state based FIT programs alongside the RET, the solar PV annual market grew from around 100 MW in 2009 to almost 400 MW in 2010, and doubled to 800 MW the year after with 2012 setting a new record with 1038 MW of installed capacity. Despite a slowdown in installed capacity by the end of 2013 the sector reached 3,300 MW. Today, well over one million Australian households have solar PV systems and almost another million have installed solar hot water systems.

By the end of 2013, almost 15% of Australia's power generation was from renewables with hydro providing 58% of all renewable electricity followed by wind (26%), biomass (8%) and solar PV (8%).

New Zealand is a country which, for its size, has an unusually large endowment of renewable energy potential. In 2004 approximately 30% of New Zealand total primary energy supply was supplied by renewables; by 2014 it was close to 40%. Electricity generation from renewable sources was just over 70% in 2004 with a peak of approximately 75% in 2011 followed by a slight decrease in subsequent years, due to a decline in hydropower.

The contribution of renewable sources to the primary energy mix supply decreased 2% in 2012—down from 39% in 2011—primarily because of drop in hydropower's contribution. In 2013 the share of renewables in the primary energy mix were geothermal (over 50%) hydropower (close to 25%) followed closely by bioenergy and solar with a small contribution (less than 5%) from wind.

By 2005, Japan had just over 6GW of renewable electricity capacity, supplied predominately from hydropower with minor contributions from bioenergy and geothermal; solar PV contributed 1.2 GW. By 2013 Japan had an overall renewable energy capacity of 17 GW, the majority of which is supplied by solar PV.

Although Japan's installed wind power capacity experienced strong growth rate (approximately 30%) until 2006, the rate of wind power annual installation capacity has slowed since due to

various constraints, including unclear support policies, problems related to site conditions, priority of grid connection and local opposition due to environmental concerns.

South Korea has good tidal potential as seen with its 254 MW Sihwa plant and is developing it capacity in CSP with the recent installation of a small pilot CSP plant.

Additionally, Palau, Cook Islands, Niue, Micronesia, Kiribati, Samoa, Solomon Islands, Marshall Islands, Vanuatu, Tonga, Fiji, Tuvalu created national targets. Both Tonga and Fiji failed to meet goals for 100% of final energy from renewables; subsequently, Fiji reduced its targets to 100% of electricity and 23% of final energy from renewable sources by 2030. Niue, Tuvalu and the Cook Islands are aiming for 100% renewable energy electricity by 2020.

■ MILESTONES OF THE PAST DECADE

During 2008, Australia crossed the 1 GW mark for total installed wind capacity and 2013 set a new record for wind with 655 MW of new capacity installed during the year.

Solar photovoltaic has enjoyed steady growth due to Australia's strong solar resources, steady cost decline and government incentives. By 2012, Australia crossed the one million solar PV roof-top milestone, making solar systems increasingly mainstream. In 2011 the total investment in renewables added up to 5.5 billion Australian Dollars (AUS\$). The finance sector showed increased interest in the renewable industry leading to AU\$ 5.301 billion in renewable energy investment in 2012 and AU\$ 5.187 billionⁱⁱ in 2013.

The most notable development in the region was in Japan, where investment in renewable energy (excluding research and development) increased by 80% relative to 2012 levels. An increase of 76% in 2013, to USD 23 billion, made Japan the top country for investments in small-scale distributed renewables.

■ MAIN CHALLENGES FOR RENEWABLES

The main challenge for renewables in Australia is the political instability of its energy and renewable energy policy. With the fast up-take of solar PV and wind in some regions, renewable power systems have reached a scale which requires new grid integration policy and regulation; the current electricity market framework also needs to change in order to reflect these new developments.

Overall, policy incentives in New Zealand are less than in other countries such as Germany and the United States, which have adopted a more proactive renewable energy development policy stance. The lack of concrete and 'bankable' incentives not only limits development overall, but also limits the extent of strategic industrials development. Achieving the target of 90% electricity from renewables will depend largely on the effectiveness with which government policy is developed.

Despite the rise of the large-scale market in Japan, many more projects were approved than built, primarily due to shortages of land, funds, grid access, qualified engineers and construction companies, and Japanese-brand equipment. Further development of renewable energy in Japan will require significant investment in supporting services such as education and construction.



CHINA

■ GENERAL OVERVIEW

Over the past decade, China has established itself as the global renewable energy champion: double-digit economic growth rates, rapidly increasing energy demand and the establishment of the largest wind industry globally. Between 2004 and 2010 China managed to double each year its newly installed capacity for wind, achieving an average annual market growth of well above 15,000 MW. Increased air quality problems due to the large expansion of the coal industry over the same time period drove even a faster deployment of renewable energies. In addition to wind, China has the largest expansion of hydropower in the world. During the second half of the past decade, solar PV production capacities were developed and which in 2013 represented well over half of the world's production capacities for solar PV and about one third of the global annual PV market.

■ MAIN DRIVERS FOR RENEWABLES

The expansion of the renewable energy industry is of strategic national importance in the context of upgrading its existing industrial infrastructure and is recognised as an important sector for the creation of future value-added jobs. Meeting the demand of surging export markets for renewable energy technologies—mainly solar PV—was a major driver for the Chinese government. Diversification of the energy supply and security of supply both play an important role. Air pollution, in particular across Eastern China, has recently emerged as an important driver for new renewable energy expansion plans in that region. An equally important driver is the need to foster decentralised/distributed power generation capacities to avoid the enormous financial expenditures associated with relying entirely on long-distance transmission lines, which otherwise would have to transmit power generated in West China to East China.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

Between 2004 and 2006, a renewable energy law—based closely on the German Renewable Energy Sources—was developed. Since its entry into force in January 2006, the renewable energy legislation has been constantly changed and adapted to reflect the realities of the market while minimising any disruptive impact on the domestic renewable energy market. Initially the FIT focused on the wind industry but expanded in 2011: the solar PV industry was added to the political roadmap and quickly became another strategic technology under development. In the beginning, solar PV support programmes used tendering schemes for utility-scale projects and capital subsidies. Due

to major problems and a low deployment rate, solar PV, in July 2011, received a feed-in tariff, which helped the solar market become as dynamic as the wind market.

Technology targets for wind and solar were established under the 11th Five-Year Plan (2006 – 2010), the 12th Five-Year Plan (2011 – 2015), and most recently in the “Air Pollution Prevention Plan 2014 – 2017” released by the National Development and Reform Commission (NDRC) in June 2014.

■ DEPLOYMENT OF RENEWABLES

The economically exploitable hydropower potential in China is estimated to be 402 GW. To date, 280 GW have been installed with an average annual expansion rate of around 20 GW. Given the anticipated energy consumption of the country new renewable energy technologies such as wind and solar PV in the power sector and solar water heating play (and will play) an increasingly important role. Between 2004 and 2014 90 GW of wind and 20 GW of solar PV were installed. While the solar photovoltaic industry is generally privately owned, public and private entities, including the five biggest utilities in China, are actively involved in the development of utility-scale solar PV power plants. Similarly, large-scale wind farms are primarily developed by public entities.

■ MILESTONES OF THE PAST DECADE

The Renewables2004 conference in Bonn, June 2004 was widely seen as the “kick-off event” for China's new renewable energy programmes for wind and solar PV. Activities undertaken after the event led to China's commitment for a domestic renewable energy law as well as the establishment of a renewable energy development fund. In the beginning, “pico-hydro”, small scale wind and solar PV formed the basis for decentralised projects. On January 1, 2006, China's renewable energy law came into force and kick-started the breath-taking development of China's wind, and later solar PV industries.

The establishment of the China National Renewable Energy Centre—developed in close cooperation with Denmark—is another national milestone. This national institution assists China's energy authorities in renewable energy policy research and industry policy development.

The Initial Public Offering (IPO) of Suntech in 2005 on the New York Wall Street Stock Exchange marked the beginning of China's solar PV-orientated export industry. The rapidly expanding manufacturing capacity of solar equipment fed global demand; ironically domestic use of solar PV was low until 2010. China's

12th Five-Year Plan (2011 – 2015)—launched in 2010—identified renewables as a so-called Strategic Emerging Industry for the first time.

■ **MAIN CHALLENGES FOR RENEWABLES**

Over 20 million people annually move from China’s rural areas to its large cities. Electrification programs for rural areas as well as energy and infrastructural technologies for mega-cities are of

huge importance. Renewable energy needs to grow faster than the socio-economic megatrends of the country, representing a major challenge for the expansion of know-how, energy markets, and training of a workforce skilled in operation and maintenance as well as energy infrastructure development. Rapid expansion can also cause quality problems which in turn increases the operation and maintenance costs of renewable energy projects.



EUROPE

■ **GENERAL OVERVIEW**

Throughout the last decade, Europe was at the forefront of renewable energy policy design and deployment, developing a strong and vibrant renewable energy industry. Europe’s binding target of a 20% share of total final energy from renewables by 2020, coupled with feed-in-tariffs and other strong support policies predating 2004, have been instrumental in making Europe a global leader in renewable energy.

While the European example has inspired many countries throughout the world, renewable energy targets have been revised downwards and support has been reduced in several European countries, sometimes retroactively. This has occurred especially in countries with high shares of renewables in the power system, where they are directly competing with incumbent fossil and nuclear sources, in answer to declining electricity demand resulting from the economic slowdown and an overcapacity of conventional and nuclear power.

With its Climate and Energy Policy, the European Union has been a front-runner in international renewable energy policy design for the 2020 horizon. Current discussions on a 2030/2050 renewable energy policy framework are ongoing; the outcome of these discussions will give an indication as to whether the European Union will manage to keep its leading position in international renewable energy development.

■ **MAIN DRIVERS FOR RENEWABLES**

The European Union’s energy sector is based mainly on fossil fuels, almost two-thirds of which are imported. If the current trends continue, import levels will reach more than 70% of the European Union’s overall energy needs by 2030. The development of renewable energy sources began with the 1970 oil crises and the stark realisation that fossil resources would, one day, run out. Additionally the European Union acknowledged that successful development of the renewable energy sector required strong, continued and smart political commitment.

Five years after the 1992 Earth Summit, climate change was at the center of international debate in advance of the upcoming Third Conference of the Parties to the United Nations Framework Convention on Climate Change being held in Kyoto, Japan, December 1997. The European Union recognised the urgent need to tackle climate change. It also adopted a negotiating position of a 15% greenhouse gas emissions reduction target for industrialised countries by the year 2010, down from 1990 levels. To facilitate European Union Member States attainment of this objective, the Commission, through its 1997 Communication on the Energy Dimension of Climate Change, identified a series of energy actions, including a prominent role for renewables. Together with the binding 20% renewable energy target by 2020, the EU also adopted a target of 20% improvement in the EU’s energy efficiency as well as a 20% greenhouse gas reduction target (respectively 30%, if other industrialised countries commit to similar ambitions) by 2020.

■ **RENEWABLE ENERGY POLICY DEVELOPMENT**

Development of renewable energy has for some time been a central component of European energy policy; as early as 1986 the European Council listed the promotion of renewable energy sources among its energy objectives. The 1997 Communication from the Commission “Energy for the Future: renewable energy sources – White Paper for a Community Strategy and Action Plan” set an indicative target of doubling the share of renewable energy of the European Union’s overall gross internal energy consumption from 6% to 12% by 2010, an ambitious but realistic objective.

Further to the Commission’s White Paper, a European legislative framework to promote renewable energy was established in the electricity and the transport sector, with two specific European Commission directives that established growth targets for renewable energy in these respective areas, both at the community and national levels, as well as a series of specific measures

and monitoring schemes. This framework was further developed and integrated in the Energy and Climate package, which was adopted in 2009. It contained a Directive on the promotion of the use of renewable energy sources, setting the objective of reaching 20% of the European Union's energy consumption through renewable energy sources by 2020. For the first time, this piece of legislation incorporated all three energy sectors: electricity, heating and cooling, transport. The European Union targets were translated into binding national renewable energy targets as a share of final energy consumption. Each Member State is required to meet these minimum targets by 2020.

■ DEPLOYMENT OF RENEWABLES

2013 was the sixth year of dominance of renewables in new power capacity in Europe with renewables in European Union accounting for 72% of electric capacity additions, compared to the global average of 56%. The 72% share in 2013 is in stark contrast to a decade earlier, when conventional fossil generation accounted for 80% of new capacity in the EU-27 plus Norway and Switzerland.

When looking at total renewable capacity installed per capita, the European Union leads; 42% of global non-hydro renewables capacity is in Europe, compared to less than 17% of global electricity demand. Variable renewables are achieving high levels of penetration in several countries. For example, throughout 2013, wind power met 33.2% and 20.9% of electricity demand in Denmark and Spain respectively; in Italy, solar PV met 7.8% of total annual electricity demand. These high renewable shares increase the need for smart policy decisions to transform the energy system towards a flexible mix of centralised and decentralised production and consumption.

The European Union's heating and cooling sector offers an immense yet widely untapped potential for renewable energy deployment. Heat from biomass, solar and geothermal sources makes up a significant portion of the energy derived from renewables. The sector is slowly evolving as countries begin slowly to develop and enact supporting policies and to track the share of heat derived from renewable sources.

Renewable energy is currently used in the transport sector in the form of gaseous and liquid biofuels and in electric cars; in 2012 liquid biofuels provided about 4.7% of European Union's



transport fuels. There are still limited but increasing initiatives to link electric cars and transport systems with renewable energy, particularly at the city and regional levels.

Since 2004, the share of renewable sources in gross final consumption of energy in all sectors grew in all Member States, though not as fast as in the electricity sector^v. The largest increases over this ten year period were recorded in Sweden (from 38.7% in 2004 to 51% in 2012), Denmark (from 14.5% to 26%), Austria (from 22.7% to 32.1%), Greece (from 7.2% to 15.1%) and Italy (from 5.7% to 13.5%).

Germany continued to be at the forefront of renewables deployment globally. In 2011, Germany voted to phase-out nuclear power by 2022 and pledge to accelerate the "Energiewende", the project to transition Germany's energy portfolio to one dominated by renewable energy, energy efficiency and sustainable development. By 2013, renewables provided 25.4%^{vi} of electricity consumption (up from 11.6% in 2006), 10.2% of heating demand (up from 6.2%), and 5.9% of transport fuels (excluding air traffic). By 2013, like in 2012, renewables provided 12.3% of Germany's final energy consumption.

■ MILESTONES OF THE PAST DECADE

The main milestone in Europe over the past decade is the climate and energy package which contains a set of binding minimum targets and legislation which aims to ensure the European Union meets its climate and energy targets for 2020. These targets, known as the "20-20-20" targets, set three key objectives for 2020 : 1) a 20% reduction in EU greenhouse gas emissions from 1990 levels; 2) raising the share of EU energy consumption produced from renewables to 20%; and 3) a 20% improvement in the EU's energy efficiency.

The targets were set by European Union leaders March 2007, when they committed Europe to become a highly energy-efficient, low carbon economy. The targets were subsequently enacted through the climate and energy package in 2009. The 20-20-20 targets represent an integrated approach to climate and energy policy that aims to combat climate change, increase the EU's energy security and strengthen its competitiveness.

To date, it is uncertain whether the European Union is on track to meet its member-agreed binding target to increase the share renewable energy of final energy consumption to 20% by 2020. Although three European Union Member States (Bulgaria, Estonia, and Sweden) already reached their nationally binding 2020 targets in 2012, other countries have fallen short of their obligations, due to policy changes and lack of ambition.

■ MAIN CHALLENGES FOR RENEWABLES

In recent years, as the shares of renewables have increased in the European Union, they have also faced increasing obstacles in the member countries. After a decade of growth, Europe's renewable energy investment in 2013 was down 44% from 2012.

A central challenge is in the electricity sector, where relatively inflexible, conventional power plants and grid systems must be

v) Source: Eurostat. Reference see endnotes.

vi) Source: BMWi. Reference see endnotes.

integrated with intelligent, flexibility-driven systems so as to support rising shares of variable and dispatchable renewable energy. Increasing the use of electricity for transportation, heating, and cooling must also be addressed.

Today, the penetration of renewables is no longer a question of technology or economics but one of clear policy decisions for developing more flexible markets and smarter energy systems. Thus the policy focus should be on transforming the energy system, not only power grids, to be more flexible. There needs to be an increase in demand-side integration and in the integration

of power systems with transport, buildings, industry, and the heating and cooling sectors. Regulation, business and finance models as well as a new market design, particularly in the electricity sector, but also integrating the other sectors, are needed to facilitate and underpin system transformation.

The challenges the renewables sector currently faces in Europe should be turned into an advantage by developing cutting-edge technological, policy and regulatory solutions that will be of utmost relevance for Europe and for the rest of the world.



INDIA

■ GENERAL OVERVIEW

The positive perception of renewable energy in India increased significantly over the past decade. Renewables are now seen as mature technologies; correspondingly markets are developing slowly but steadily. However India's population growth and the increased energy demand have outpaced the expansion rate of renewables by an order of magnitude. There continues to be resistance from conventional power and finance sectors to renewable energy development. Rapidly changing regulations and differing Union and State government approaches create uncertainties and barriers, which increase investment costs due to the perception of high risk.

■ MAIN DRIVERS FOR RENEWABLES

Energy security is a key driver for energy diversification in India. India ranks as one of the largest importer of oil, and of petroleum products and liquid natural gas (LNG). The increased use of indigenous renewable resources is expected to reduce India's dependence on expensive imported fossil fuels. The rising cost competitiveness of renewable energy technology is another driver as lower costs make renewables a viable option for expanding energy access while also diversifying the country's energy supply. The distributed and scalable nature of renewables also makes renewables well-suited to meet the energy needs of remote areas, which lack grid and road infrastructure. Favourable foreign investment policies and active government support in the form of incentive are also sending positive signals to the market, which in turn is driving uptake and creating local jobs.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

India was an earlier mover in renewable energy sector. In 1993 it was the first developing country to adopt a FIT scheme. By 2004,

India established a biofuel target of 10% and three states had adopted a FIT scheme. At the same time, there were other policy initiatives for renewables ranging from Renewable Portfolio Standards to various forms of capital subsidies and recurring incentives, tax breaks and public bidding processes.

In 2004, the market size of India and China were on an equal footing. Over the next decade India maintained a huge variety of policy mechanisms, which led to the development of a large portfolio of programmes that differed across states and between cities. The result was that the Indian market grew at a significantly slower rate than China's, which focused on FITs. For global renewable energy companies, India's rapidly changing legislation is difficult to understand and thus market development has been slow compared to the vast renewable energy potential of the country.

■ DEPLOYMENT OF RENEWABLES

The primary focus of renewable energy deployment over the past 10 years has been on the power sector. Large hydropower, onshore wind and solar PV are the leading technologies. India has been an important market for the development and deployment of solar water heating systems on a large scale. While India hosts a number of international companies that deal with renewable energy technologies, the domestic deployment rates are well below the country's potential. Local production, local value chain creation and employment play a huge role in the Indian renewable energy debate.

■ MILESTONES OF THE PAST DECADE

The most important milestones in India's renewable energy history include the introduction of the first FIT schemes in 2004. Generation-based incentives for wind and PV solar across India in 2007 and the introduction of the Renewable Energy Certificate

(REC) mechanism can also be considered as milestones. The establishment of renewable energy targets in 2012 and the 2010 launch of the Solar Mission programme can also be considered as landmark initiatives of the past decade.

■ MAIN CHALLENGES FOR RENEWABLES

The perception of renewables as being mainly small scale and filling predominantly rural electrification needs hinders the expansion of this sector towards utility-scale projects. Power

transmission and grid integration capacities are still missing; rapid policy changes as well as a lack of coordination between Union and State Governments represent major obstacles to sustainable growth in the renewable energy industry. Limited access to financing for renewable energy projects and the bad financial health of India's power utilities, which are mostly publically held, are further key barriers, as they affect investor confidence and motivation.



LATIN AMERICA

■ GENERAL OVERVIEW

The situation of Latin America's energy industry is as diverse as the 17 countries across the continent.^{vii} However over the past decade the region's countries have increasingly changed their legislation to be more renewable energy-friendly, particularly in countries with poor, low or no fossil fuel reserves and/or in those countries with a rapidly increasing power demand. Recently improved market conditions for renewable electricity generation and biofuels accelerated market developments of these renewable energy sectors across Central America. The implementation of renewable energy projects however is still a challenge due to a lack of bankable renewable energy schemes in most of the region's countries. The lack of public acceptance for large scale renewable energy – mainly hydro – is also an issue in some countries and has sparked controversy among indigenous people and non-governmental organisations.

■ MAIN DRIVERS FOR RENEWABLES

Rapidly growing demand for transport fuel and electricity has opened up business opportunities for renewable energy projects both in the field of biofuels and renewable electricity. In addition to large hydropower, onshore wind projects have grown the most rapidly over the past decade followed by solar energy. While locally available renewable energy sources allow for increased security of supply and a level of independence from world market fossil fuel prices, the deployment rate for renewables in Latin America is currently lower than the increase in demand and expansion of fossil fuels.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

With the rapid expansion of renewable electricity projects—especially onshore wind—the infrastructure for power transmission has increasingly become a bottleneck. Faster and more carefully planned expansion of power grids is needed in order to bring more renewable energy generation projects online as is illustrated by current demand out-pacing the expansion rate of both power line and power projects.

Presently Brazil, Chile, Mexico, and Uruguay are the leading renewable energy champions within Latin America. A highlight of the past decade has been the introduction of renewable auctions in Brazil, resulting in highly competitive electricity prices from wind. The past decade has also seen Brazil expanding its biofuel, large hydro and—since 2009—onshore wind sectors. One of the first renewable energy policies of Brazil was the Program of Incentives for Alternative Electricity Sources (PROFINA), a feed-in-tariff (FIT)-like scheme developed in 2002, which in 2009, evolved into a renewable energy auction system.

■ DEPLOYMENT OF RENEWABLES

The past ten years have seen a steep increase in solar PV project development in the region; several large scale systems have been completed and others are under development. According to some early forecasts over 2 GW of solar PV could be installed across the region in the near future. Concentrating solar power (CSP) has been slower to take hold in the region. A 14 MW hybrid solar/gas plant was commissioned in Mexico in 2011 with an anticipated operational date of late 2014. Chile ventured into the field of CSP in 2013 with the launch of a competitive tender for a 50 – 100MW plant.

vii) For the purposes of this publication, Latin America is defined as those countries located in North, Central and South America: Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay, and Venezuela.

Wind power has experienced the fastest growth in recent years, with Brazil and Mexico leading the way. Generation costs have fallen rapidly in large part due to the entry of more efficient designs and larger tower capacities. Since 2004, the hydropower sector in the region has matured considerably. In Central America, the need for a diversified electricity mix to reduce vulnerability to a changing hydrological profile is driving interest to invest in other abundant renewable energy resources. In Brazil, hydropower expansion is expected to become increasingly constrained by environmental sensitivity and the remoteness of much of the remaining water resource. However big hydropower projects continue to be developed; Argentina in particular has plans for some big projects; smaller scaled projects are planned in Peru and Uruguay.

Geothermal remains a viable resource that has not been fully tapped. Mexico is currently the world's fifth largest producer of geothermal electricity with almost 1 GW of installed capacity. Collectively Costa Rica, El Salvador, Guatemala, Honduras, and Nicaragua have almost 500 MW of installed capacity. There have been no geothermal projects developed to date in South America, although Argentina is planning a 100 MW plant and Colombia, Ecuador and Panama are actively exploring developing this resource.

■ MILESTONES OF THE PAST DECADE

The public sector call for new, grid-connected renewable capacity was a milestone in the region. Funding provided by the Brazilian development bank (BNDES) and the Interamerican Development Bank (IADB) coupled with some investment from local and national banks (through the issuing of bonds) helped spur grid integration of renewables across the region. National government commitment to renewables first, through the development of FITs in early 2000s, followed by targets led to increased renewable energy capacity in Argentina, Brazil, Chile, Peru and to a lesser degree, in Uruguay.

■ MAIN CHALLENGES FOR RENEWABLES

Increasing interest in renewable energy in the Latin America region is reflected in ambitious targets and policy support, which have in turn led to rapidly growing investments in renewables, beyond the traditional hydropower sector. By early 2014, at least 23 countries in the region had renewable energy policies, and at least 23 had renewable energy targets, mostly for electricity generation. However to-date, differences in electricity market structures and regulations have constrained efforts to integrate electricity markets regionally; a lack of transmission infrastructure has also delayed the development of some projects. Increased cooperation and sharing of experience are needed to help support the penetration of renewable energy technologies in the region.



MIDDLE EAST AND NORTH AFRICA (MENA)

■ GENERAL OVERVIEW

There has been a substantial shift in the interest in and deployment of renewable energy in the MENA region in the last five years. Historically, renewables have played a minor role in the region due to its abundance of low-cost and typically subsidized oil and gas. However, as fossil-fuel prices have skyrocketed, the region's net oil and gas importing countries (NOGICs) have turned to renewables to reduce energy costs and increase energy security. Significantly, net oil and gas exporting countries (NOGECs) now also have a strong business case for renewables. Greater use of renewables would free up oil and gas supplies for export, which would otherwise be sold at submarket rates domestically. As a result, since 2008 modern renewable electricity production has grown at a much faster rate than conventional sources. Tellingly, the six Gulf Cooperation Council countries alone have

announced over 60 GW of solar, wind, geothermal, and waste-to-energy projects. The MENA region has accordingly also seen a rapid evolution of renewable energy markets and policy frameworks – a trend that is likely to intensify in the foreseeable future.

■ MAIN DRIVERS FOR RENEWABLES

Energy costs and security concerns have been the main driver for the expansion into renewable energy in the MENA region. Oil and gas prices have reached unprecedented highs, while renewable energy costs have decreased significantly.

For countries that burn oil for power, renewables are substantially cheaper – and can allow increases in lucrative oil exports. This is all the more important owing to the region's exponential growth in energy demand. Population increases, urbanisation trends, and economic progress have led to high exposure to fossil fuel

prices, as well as threats to exports. A landmark think-piece by Chatham House in late 2011 flagged that Saudi Arabia could become a net importer of oil by 2038 if domestic consumption continued to increase at the same rate.

Renewables are furthermore seen as a way to increase economic diversification, generate new employment opportunities, promote technology transfer, and build local and national value chains.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

The renewable energy policy landscape in the MENA region has undergone a dramatic shift since 2004, when only four countries had renewable energy policies and/or targets. Today, 18 out of the 21 countries in the region have set renewable energy targets. Most targets are technology-specific, focussing on solar PV, CSP and wind capacity, or shares of renewables in electricity supply. If realised, existing targets would result in over 100 GW in installed capacity in the MENA region by 2030. To achieve this, more and more countries have started to enact support policies. Over the last decade, the number of countries with incentive schemes has increased five-fold from three in 2004 (Algeria, Malta, and Israel) to 15 in 2014.

While the early adopters focused on FIT tariffs and tax reduction instruments, the breadth of policy instruments has increased. However, FIT tariffs and tax reduction are still among the most popular support mechanisms in addition to tendering and public investment. Local content requirements have recently emerged, with Saudi Arabia calling for 85% to support employment and industrial development.

■ DEPLOYMENT OF RENEWABLES

Over the past decade hydropower and traditional biomass for cooking and heating have been the dominant renewable energy sources in the region, but wind, PV and CSP have recently emerged as the three preferred technologies. Power generation from non-hydropower renewables more than doubled between 2008 and 2011 to reach 3 TWh and outpaced growth in conventional energy sources. This trend is expected to continue in the foreseeable future with over 7.5 GW in renewable energy (particularly wind and solar) projects in the pipeline as of April 2013.

Among non-hydro renewables, wind energy is the most common source of renewable electricity in the region with more than 1 GW installed capacity and an average annual growth rate of 27%. Wind power capacity increased fourfold between 2005 and 2010.

Compared to wind, the share of solar energy technologies in the region is still modest. However solar PV, CSP, and solar water heating (SWH) systems have been expanding rapidly in the region. Solar PV is an integral part of energy plans in almost all MENA countries, and the average annual growth rate of solar PV production was at least 112% between 2008 and 2011. CSP, while not as widespread, can be found in Algeria, Egypt, Iran, Morocco Saudi Arabia, and the UAE. SWH already plays an important role in the region; in 2012 there was about 9 million m² of capacity installed.

Among the least exploited sources in the region are geothermal power, modern biomass power, and biofuels.

■ MILESTONES OF THE PAST DECADE

In 2009, the UAE kicked off the renewable energy trend in the Gulf with a 10 MW PV project. This marked the beginning of a phase of intensive wind and solar energy deployment. Wind energy expanded notably in Egypt, Morocco, and Tunisia, while Tunisia's PROSOL and other SWH programmes in Mediterranean countries saw the cost-effective roll-out of non-hydro renewables. In 2013 the United Arab Emirates inaugurated the world's then-largest CSP plant, the 100 MW Shams 1. In terms of policies and targets, Morocco has stood out for its successful renewable policy framework, which resulted in 200 MW of wind being completed in 2013 and major interest in CSP tenders. Jordan has activated its feed-in-tariff, which has seen nearly 200 MW of projects announced in the last year. In 2013, Saudi Arabia also announced a target of 54 GW of renewable electric capacity by 2032, which gained global attention. Of equal note, Algeria met its target of installing 10 MW of additional wind capacity in 2013.

Notably, the 168-country International Renewable Energy Agency (IRENA) also opened its doors in Abu Dhabi in 2009, officially coming into being in April 2011.

■ MAIN CHALLENGES FOR RENEWABLES

In addition to the political instability in the region following the Arab Spring, awareness of renewable energy cost-competitiveness and fossil fuel subsidies are key barriers to accelerated deployment of renewables. Many energy companies and consumers have minimal experience with renewables and/or only see the subsidized price of fossil fuels (rather than the actual net cost to the government and economy), encouraging continued investment in more expensive oil and gas-fired generation.

Despite a challenging political climate in parts of the region, some countries are reevaluating or reforming existing energy subsidy. The success of tariff and integrated planning reforms, in addition to greater public awareness, will have a significant impact on the future of renewable energy policy and deployment in the MENA region.





NORTH AMERICA

■ GENERAL OVERVIEW

Over the past decade, North America has become one of the top regions for renewable energy in terms of installed capacities. The United States in particular dominates the country rankings for installed capacities and is considered to have the largest installed renewables power capacity with and without hydropower after China. Much of this has been driven by the decreasing costs of wind energy, cheap hydropower, diverse renewable energy resource potential, and the active role states, provinces and communities have played in promoting renewable energy. Overall, the continued expansion of renewable capacity has allowed the United States to remain among the top countries for employment in the renewable energy sector. Despite the advancements in terms of installed capacity, the United States' share of renewables in overall power generation is still minimal, especially when benchmarked against other countries.

Developments have been accompanied by a gradual shift in the perception of renewables among electric industry professionals. In the early 2000s, non-hydro renewable energy sources were generally still considered to be minor contributors to the energy mix, and were often termed “alternative” energy sources. Ten years later, electric utilities and grid operators increasingly recognise renewables as serious contributors to the energy mix and are investing in both increasing shares of renewables, and the technologies and institutions needed to accommodate the variability of wind and solar energy. Sub-national entities played an important role in changing this perception, with states such as California and Texas taking the initiative early on. While the federal governments in the United States and Canada have enacted renewable energy support policies, significant activity also exists on the sub-national level. Fluctuations in federal initiatives have caused policy uncertainty in the United States and have led to swings in market size, partially accounting for the steep decrease in wind energy investments in 2013. Strong oil, gas and coal lobbies as well as the recent extraction of shale gas may further affect the future growth of renewables in both countries.

■ MAIN DRIVERS FOR RENEWABLES

As President Barack Obama highlighted in his inaugural speech in 2009, energy security and climate change are two of the main drivers of the expansion of renewable energy in North America. These concerns have been prevalent among federal policymakers, and among state and provincial governments. Additional reasons, both on a sub-national and national level, are the creation of new jobs and the potential to become a technical leader in the industry, thus boosting trade and economic activity. Over the past ten years additional drivers such as the low cost of wind and the declining cost of solar, as well as policy incentives and government programs have aided in accelerating the deployment of renewables.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

The North American policy landscape is characterised by a strong involvement of state and provincial governments in the setting of targets and enactment of policies. Targets for renewables exist predominantly on the sub-national level, though the United States has set some national targets for the use of renewables by the federal government. These also extend to the military, which is the country's single largest energy consumer. In terms of the use of regulatory policies, state governments have remained frontrunners as federal governments have focused on fiscal policies and public investment. An exception to this is biofuel mandates and tendering, which were already being developed by the Canadian federal government at the beginning of the decade and by the United States towards the second half of the decade.

The advancement of renewables in the United States has been driven primarily by two types of policies: federal tax incentives, particularly the Federal Production Tax Credit (PTC) and Investment Tax Credit (ITC), and state-level renewable portfolio standards (RPS). The cycle of expiration and short-term renewals of the PTC and ITC, as well as the political pressure on state RPS and net metering policies, have led to significant market uncertainty. At the same time there is hope that the proposed Clean Power Plan, as proposed by the US Environmental Protection Agency (EPA), will be implemented, thus encouraging more investment in renewables.

■ DEPLOYMENT OF RENEWABLES

Over the past decade North America has become a leader in renewable power capacity, with the United States as number two in the global country ranking for capacity, including and excluding hydropower and Canada ranking fourth for capacity including hydropower. In terms of renewable energy shares in electricity production, Canada leads the region and is among the top countries worldwide with 53% (2012). In comparison the United States only generated 13% of its electricity from renewables in 2012, up from 9.2% in 2006.

Over the past decade, North America maintained its leadership position in the hydropower sector, though little new capacity was added in the last decade. The most significant developments were observed in the wind, solar PV, and bioenergy, notably the biofuel sector. The wind market in the United States was particularly strong throughout the decade, reaching 61.1GW in 2013 thanks to falling costs and policy drivers. Though the wind industry took a hit 2013, due mainly to policy uncertainty, more capacity was under construction in 2014 than ever before. North America also became the top producer and consumer of bioethanol with production increasing from 14 billion liters in 2004 to more than 50 billion liters in 2013. Over the past decade, the US overtook Brazil to become the top producer of bioethanol and took the lead from Europe in the production of biodiesel. Simultaneous growth in the biomass sector over the past decade has led to an increased production and use of biomass for heat and electricity production. Today the US is the top producer of bio power, while North America is ranked number one for wood pellet exports.



In the United States, solar PV increased from 0.2GW to 12GW between 2005 and 2013 and in 2013 became the second largest source of new electricity generating capacity. Despite these gains in PV deployment, the solar PV manufacturing industry in North America took a hard hit towards the end of the last decade as competition from Asia started to increase and crowd out American and European companies. Other solar technologies such as CSP and solar thermal heating and cooling (mostly unglazed systems for heating swimming pools) gained market penetration. CSP capacity has increased significantly over the past years, despite siting challenges and increasing competition from solar PV. With installed CSP capacity having more than doubled, it is anticipated that the United States will become the top market for CSP in 2014.

■ MILESTONES OF THE PAST DECADE

Over the past decade North America witnessed several important milestones of national and global significance. On a national level, the cost of wind power in the US declined by 43% between 2009 and 2013, making unsubsidised on-shore wind cost-competitive or nearly so with new coal- and gas-fired plants in some regions of the country. Wind power had a milestone year in 2010 with Canada becoming one of the top 10 countries for installed wind capacity. The region also saw the emergence of innovative yield-orientated finance mechanisms and crowd funding, which are influencing global investment in renewables. A landmark ruling of the World Trade Organisation over-turned the Local Content Requirement (LCR) of Ontario's FIT.



On a sub-national level, milestones were varied. Some highlights include Texas becoming the largest wind market in the United States and New Jersey developing a strong solar market based on a renewable energy certificate trading mechanism. California also celebrated the success of its Solar Initiative. The program is well on its way of reached its goal of installing 3.000MW of distributed solar energy by 2016, making California the state with the highest level of distributed solar generation in the United States.

■ MAIN CHALLENGES FOR RENEWABLES

Two main challenges for renewables in North America are policy and market share uncertainty and the resultant lack of investment. The uncertainty surrounding the US tax incentive scheme has resulted in continual boom and bust cycles particularly in the domestic wind market. Further policy-related barriers include possible changes to net metering rules and state RPS programs, and barriers in siting and permitting for renewable energy projects in some regions of the country. The recent exploitation of new oil and cheap shale gas reservoirs in the United States and Canada are challenging the deployment of renewables, and may divert investment away from renewables.



SOUTHEAST ASIA

■ GENERAL OVERVIEW

The past decade was dominated by the development of renewable energy policies across Southeast Asia. The first promising markets were developed in Thailand and Malaysia, followed by the Philippines and Indonesia. Energy demand—both for transport fuels and for electricity generation—continues to grow faster than the deployment of renewables. While the mainland states of Southeast Asia rely heavily on gas and coal for power generation, the island states such as the Philippines and Indonesia still use a large number of diesel generators on their smaller islands. Renewable energy potentials are diverse across the region; solar, wind, hydro, and biomass as well as geothermal and ocean energy can be utilised. The geographical situation favors decentralised distributed power generation and mini-grids.

■ MAIN DRIVERS FOR RENEWABLES

Security of supply, access to energy and the diversification of the energy supply structure are the main drivers for renewable energy deployment across South East Asia. In Indonesia for example, where approximately 50 million people have no access to energy services, off grid renewable energy solutions represent a strategically important technology.

■ RENEWABLE ENERGY POLICY DEVELOPMENT

The policy landscape across South East Asia is diverse. Over the past decade many different forms of policies have been launched, tested and changed, using renewable energy legislations from Europe and the United States as a basis to develop national mechanisms. Several countries have established renewable energy targets for electricity and/or transport fuels. Thailand raised its overall renewable energy target to 25% of its final energy consumption by 2021. Existing targets for biomass, waste-to-energy, solar PV and wind were also increased. Renewable energy support funds have been established, including a USD 120 million fund to encourage state agencies to deploy solar PV systems on their buildings. Indonesia established a renewable electricity target of 26% by 2025 and a feed-in tariff for biomass and geothermal. Two Indonesian cities have developed low-emission strategies. Malaysia established a FIT scheme with rates to decline by 8% annually for plants smaller than 24kW and by 20% for larger plants and a biofuel target. The Philippines established a FIT in 2012 for all renewable power technologies.

■ DEPLOYMENT OF RENEWABLES

Geothermal energy, small hydropower, solar PV, wind and bio energy are expanding across Southeast Asia. Indonesia and the Philippines have the largest market for geothermal power plants in the region, while Thailand and Malaysia host the largest capacity of solar PV installations. Taiwan, South Korea and Thailand have the largest wind market in the region followed by Vietnam and the Philippines.

■ MILESTONES OF THE PAST DECADE

Malaysia established a significant production capacity for solar PV and supports a domestic market via a FIT. Vietnam focuses on the expansion of large hydropower, while Indonesia and the Philippines prioritised the support of utility-scale geothermal power plants. Thailand has successfully introduced bankable renewable energy schemes, reducing financing challenges still experienced by other regions in Southeast Asia.

■ MAIN CHALLENGES FOR RENEWABLES

In contrast to a consistent renewable energy scheme in Thailand, rapid policy changes in the Philippines and Indonesia have had a negative impact on the financing of renewable energy projects. Construction permits and grid codes for renewable energies are diverse and often unclear across the region. In Indonesia for example a photovoltaic installation requires up to 500 permits, making project development extremely difficult, if not impossible. The Asian Development Bank has established a renewable energy programme which provides technical assistance. Although this programme eases access to finance for project developers, obtaining funding for the growing renewable energy project pipeline still remains challenging.

Lessons Learned from Last Decade

5



The past decade has shown that countries which put in place stable and predictable policy frameworks benefit the most from renewable energy deployment and related economic benefits such as increased employment, investment etc. Although there have been significant developments in the electricity sector, progress in the heating and cooling as well as the transport sectors needs to be further supported and galvanised.

Policy Stability and Predictability are Key

Globally, policies have largely driven the expansion of renewable energy. Since 2004, the number of countries promoting renewables through direct policy support has nearly tripled, and an ever-increasing number of developing and emerging countries is setting renewable energy targets and enacting supporting policies. However, recent years have also seen policy regression, with some countries reducing renewable energy support, at times retroactively, slowing market and industry development. Stability and predictability of policy frameworks are needed to underpin sustained deployment of renewable energy. The industry needs predictability of policy frameworks in order to build up production capacities, to develop new technologies and to expand skilled employees in many countries. The last decade has shown that those countries which developed stable and predictable renewable energy policy frameworks are those that were most successful in building a local renewable energy sector and workforce.

Moreover there is a close correlation between supporting policies and the cost of renewable energy technology. The increase in the number of renewable energy policies saw the renewable energy market diversify into over 140 countries. As the number of countries with renewable energy policies and renewable energy markets increases there is a parallel decrease in risk for the technology. In 2004 the wind industry was in less than 10 countries; by the end of 2013 over 40 countries now have fully established wind markets.

Bigger markets also result in economics of scale, lowering costs—especially for wind and solar PV—as was clearly seen over the last decade. As solar, wind, biomass, and other energy sources gain market share, the levelised cost of energy (LCOE) is becoming an important metric in the decision-making process for building new power generation. Strong policy signals from governments are essential to ensure that renewables are a central component of national energy supply chains.

Renewable Power: First sector to be mainstreamed

Renewable power generation technologies have arrived in the mainstream market. In 2004, when REN21 began operating, the global market share of new renewable-based power plants was only 8%; by 2013 this market share increased 29% (excluding large hydro) or 40% including large hydro.

The Renewable Heating and Cooling Sector Lacks Progress

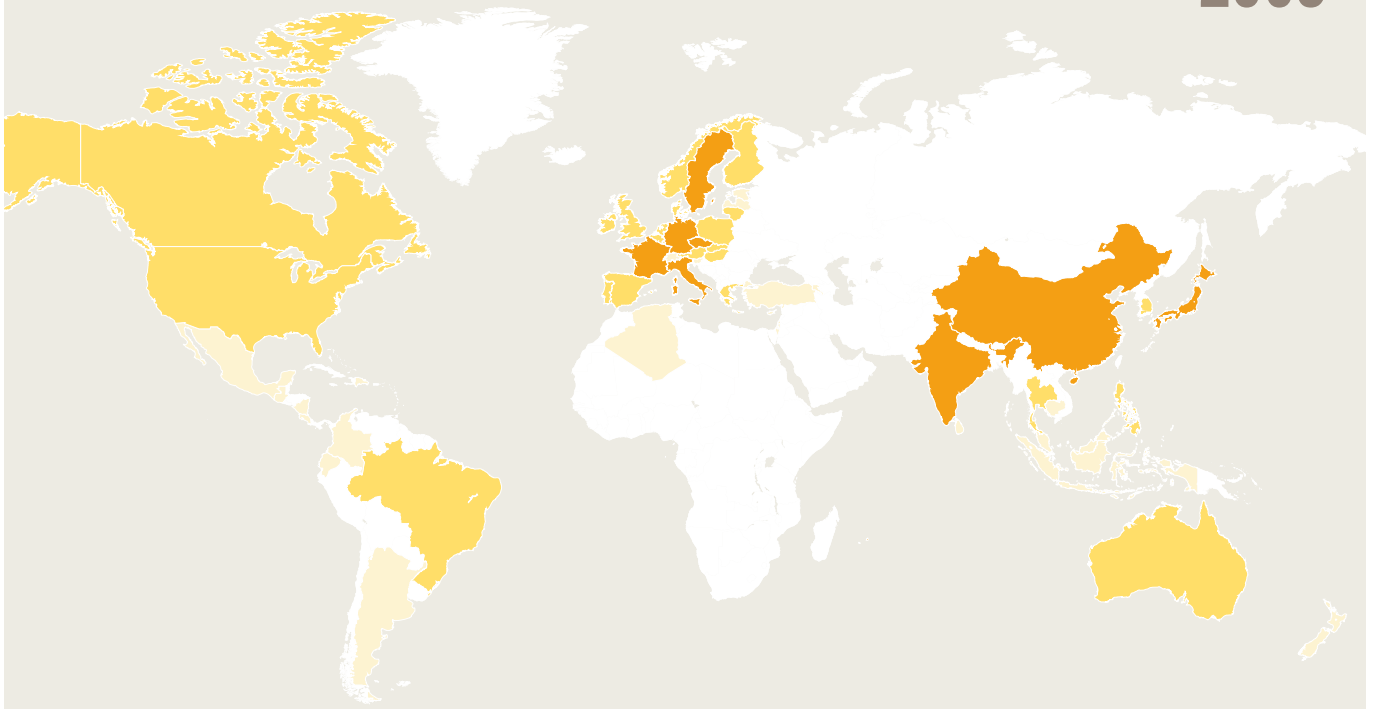
To achieve the transition towards renewable energy, more attention needs to be paid to the heating and cooling and transport sectors, as well as to integrated approaches that facilitate the use of renewables in these sectors. Globally, heating and cooling accounts for almost half of total global energy demand. However, this sector continues to lag far behind the renewable power sector when it comes to policies that support technology development and deployment. Experience has shown that well-designed support policies have been highly effective in increasing the market expansion of renewable heating and cooling technologies. Mandatory regulations in the building sector can help increase the penetration of renewable heating and cooling technologies. Improving the accuracy of national data collection on heating and cooling supply and demand is also important. The distributed nature of heat supply and local demand make it difficult to know what sources are available and what is needed; this information is crucial for good policy development.

Facilitating More-rigorous Adaptation of the Energy System to Increase Shares of Renewable Energy

Today, the penetration of renewables is no longer a question of technology or economics but one of developing more flexible markets and smarter energy systems. Thus, the policy focus should be on transforming power grids to become more flexible, increasing demand-side integration, and integrating power systems with transport, buildings, industry, and heating and cooling sectors, with the support of regulations, business, and finance models.

Figure 11: Countries with Renewable Energy Policies, 2005

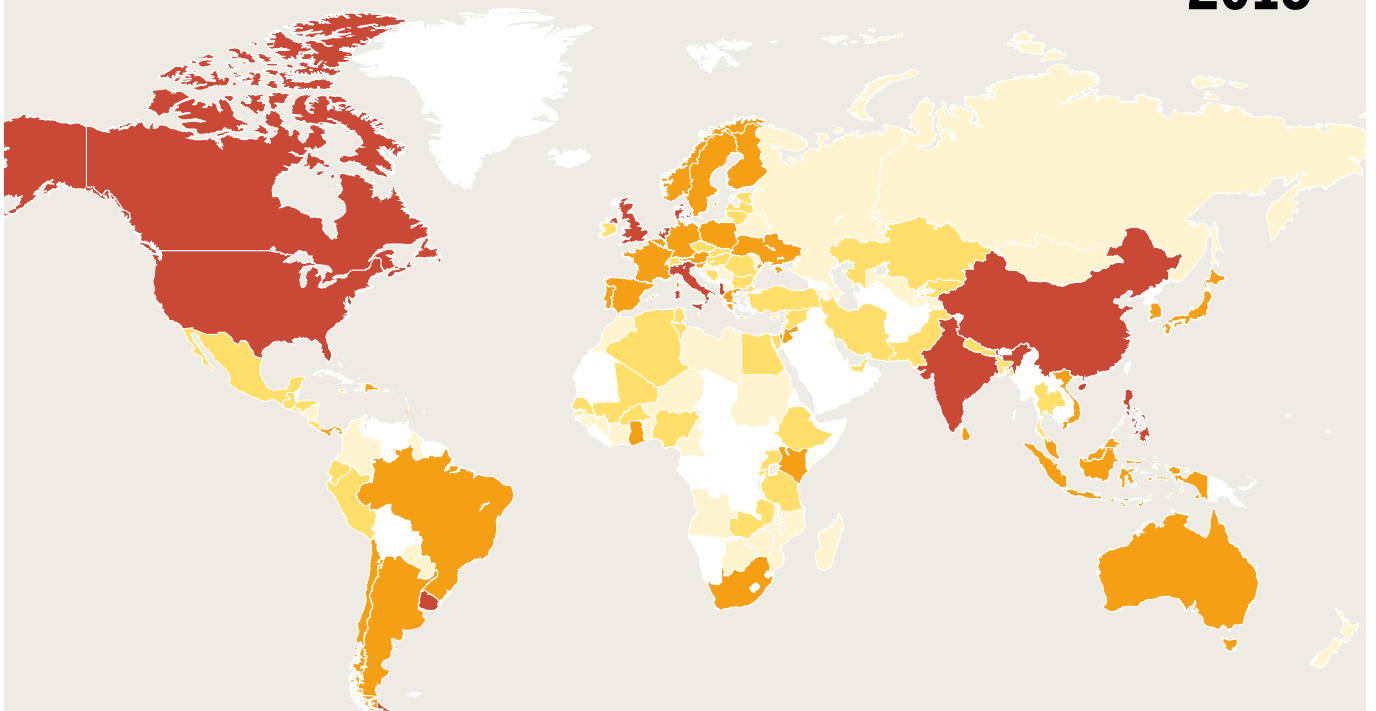
2005



Number of Policy Types Enacted ■ 9–13 ■ 6–8 ■ 3–5 ■ 1–2 ■ no policy or no data

Countries with Renewable Energy Policies, 2013

2013



Number of Policy Types Enacted ■ 9–13 ■ 6–8 ■ 3–5 ■ 1–2 ■ no policy or no data

Support policies such as feed-in-tariffs or premiums have been primary drivers of renewable energy market growth so far and have proven to be excellent market-introduction policies. With increasing renewable energy shares, however, support policies need to evolve. New policies are needed to restructure the electric power and heating markets, and to develop regulations to provide a fair and efficient basis for blending centralised and distributed generation with demand-flexibility measures. Thus, thinking about future energy systems needs to focus on how existing infrastructure must be adapted and enhanced with ongoing integration of large shares of renewable energy—not whether or not this should be done.

Creating a Level Playing Field for the Entire Energy Sector

Global subsidies for fossil fuels and nuclear power remain high despite reform efforts. The exact level of subsidies is unknown; estimates range from USD 544 billion (World Bank) to USD 1.9 trillion per year (International Monetary Fund), depending on how “subsidy” is defined and calculated. Whatever number is chosen, the fact is that subsidies for fossil fuels and nuclear power are significantly higher than financial support for renewables. Frequently, governments do not know how much they spend to subsidise fossil fuels, as many forms of support are often not quantified. Where information does exist, it is often scattered across various ministries, making it difficult to assess. These problems are exacerbated by poor budgetary transparency and limited resources for data gathering. Creating a level playing field can lead to a more efficient allocation of financial resources, helping to strengthen initiatives for the development and implementation of energy efficiency and renewable energy technologies. Removing fossil-fuel and nuclear subsidies globally would better reflect the true cost of energy generation.

Increasing Sustainable Energy Access for All

There is an urgent need to address the issues related to the lack of access to energy services and inefficiencies in the supply of energy services to both the urban poor and rural communities. Improved energy access is a crucial means of advancing the quality of life and socioeconomic status of these populations. This, in turn, will help to improve their contribution to economic growth and environmental sustainability, at local and national levels. Renewables have a key role to play in increasing access through decentralised solutions.

Stand-alone cooking and electricity systems based on renewables are often the most cost-effective options available for providing energy services to households and businesses in remote areas. As a result, an increasing number of countries is supporting the development of decentralised renewable energy-based systems to expand energy access. For example, recent technical advances that enable the integration of renewables in mini-grid systems, combined with information and communication technology (ICT) applications for power management and end-user services, have allowed for a rapid growth in the use of renewables-powered mini-grids.

With the rising awareness that off-grid, low-income customers can provide fast-growing markets for goods and services, and with the emergence of new business and financing models for serving them, rural energy markets are increasingly being recognised as offering potential business opportunities. Despite some progress on expanding energy access in different parts of the world, there are still about 1.3 billion people without access to electricity and more than 2.6 billion people rely on traditional biomass for cooking and heating with the related negative health impacts. In order to support the expansion of these rural energy markets to all by 2030—as promoted by SE4ALL—the public and private sector need to actively work together to ensure the financing of distributed renewable energy by developing and implementing support policies, establishing broader legal frameworks, and ensuring political stability.

Harnessing Local Action to Ensure Global Renewable Energy Uptake

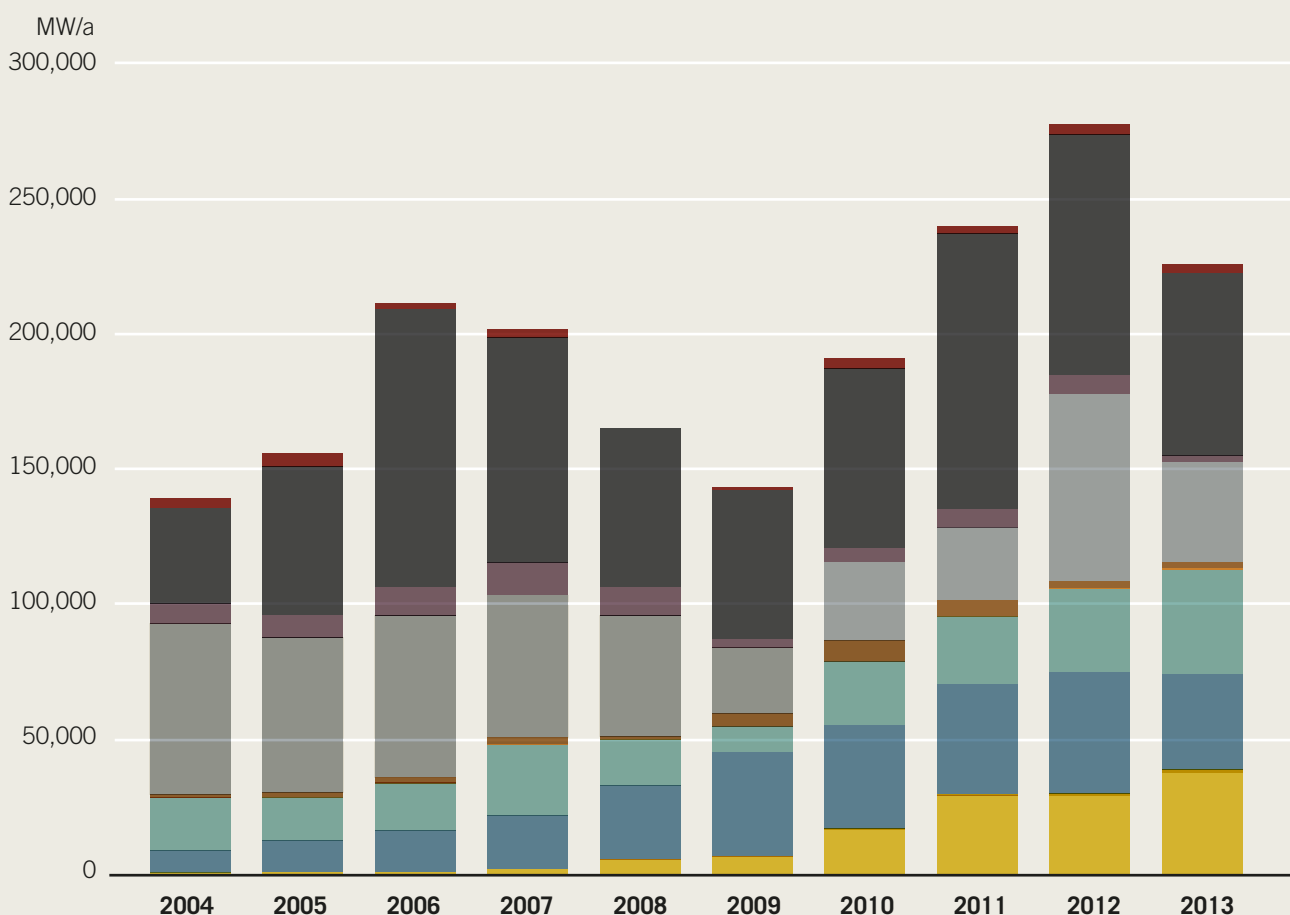
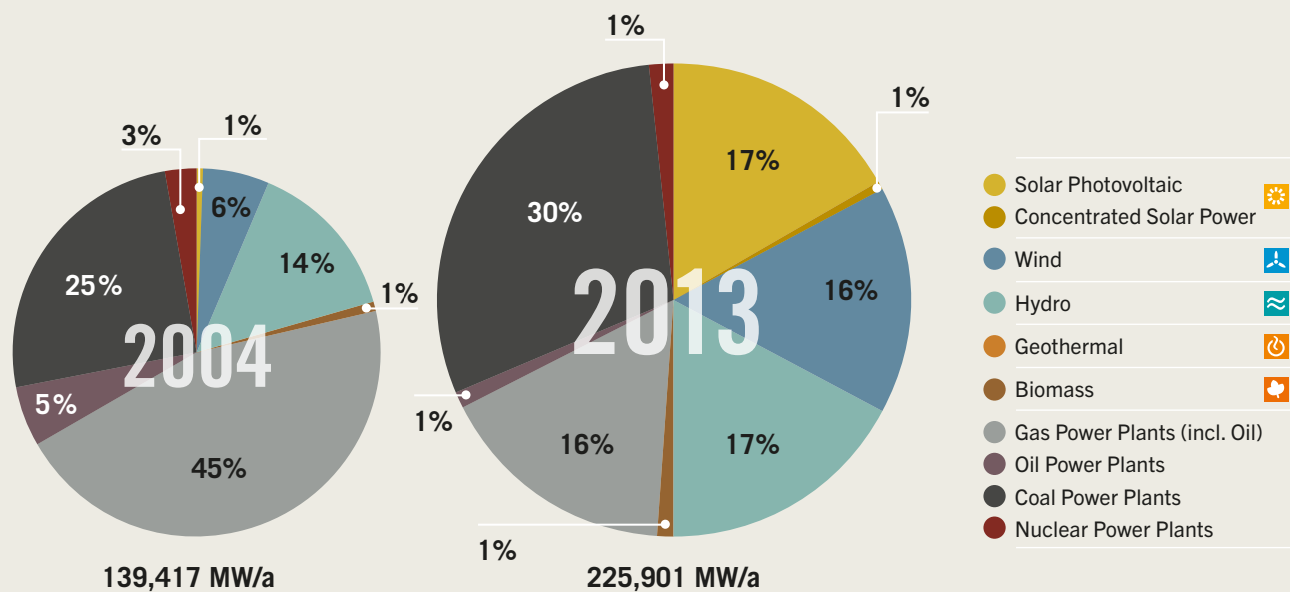
Over the past decade, local governments have become leaders in the advancement of renewable energy—particularly in combination with energy efficiency improvements—regularly exceeding efforts taken by state, provincial, and national governments. Motivated to create local jobs, reduce energy costs, address pollution issues, and advance their sustainability goals, hundreds of local governments worldwide have set renewable energy targets and enacted fiscal incentives or other policies to foster the deployment of renewables. Around the world, governments at the community, city, regional, island, and even country levels have begun to forge their own transition pathways towards a 100% renewable energy future. A better linking of local renewable energy developments with those at the national level will be key to driving the energy transition.

Accurate Energy Data are Crucial to Monitor Advancements in Achieving a Renewable Energy Transition

Reliable, timely, and regularly updated data on renewable energy are essential for establishing energy plans, defining targets, designing and continuously evaluating policy measures, and attracting investment. The data situation for renewable energy has improved significantly in recent years. Better record-keeping and accessibility, and advances in communication and collection methods have contributed greatly to this development. Nonetheless, a number of significant challenges still remain.

Untimeliness as well as poor data availability, accessibility, and quality cause data gaps, especially for technologies characterised by small-scale installations and a distributed nature. To overcome some of these existing data gaps, it is essential to develop innovative and collaborative approaches to data collection, processing, and validation. Until recently, “acceptable data” have been limited to official statistics (formal data). For an accurate and timely understanding of the status of the renewable energy sector, official renewable energy data need to be supplemented by informal data from industry as well as NGOs etc. The addition of informal data can improve coverage of sectors and regions and helps resolve the lack of data.

Figure 12: Global Power Plant Market Shares in % and MW/a, 2004 – 2013



Visions for the Future: The upcoming decades

6



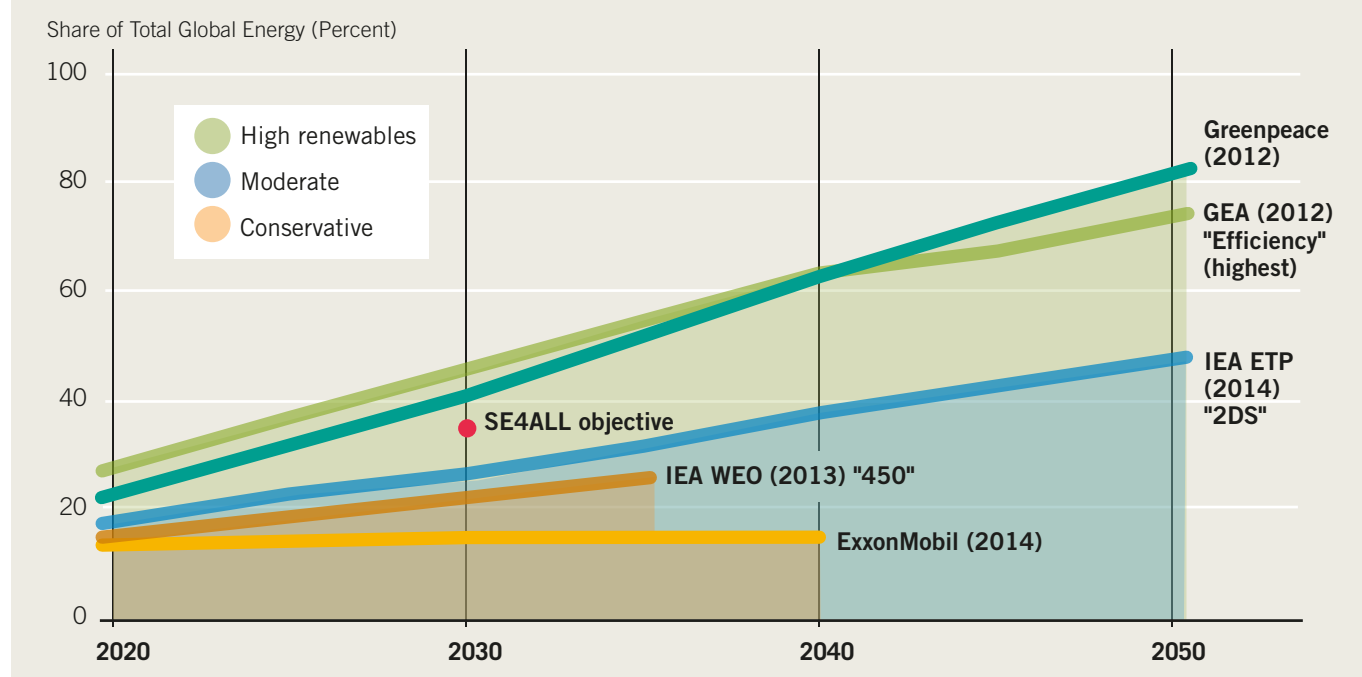
Global perceptions of renewable energy have shifted considerably during the last decade; renewables have arrived in the mainstream. Despite impressive achievements, greater efforts and closer collaboration between the public and the private sector are needed to double the global share of renewables by 2030 and about ensuring access to clean and sustainable energy for all people by 2030 outlined by Sustainable Energy for All.

Over the past decade, renewable energy technologies have moved into the mainstream. However, compared to the vast global potential of all renewable energy sources, the current market volume reveals only a glimpse of what it could be in the future. Progress was most spectacular in the electricity sector; heating and cooling as well as transport still lack behind. However, despite the remarkable growth of many renewable energy technologies, the overall share of renewable energy in total final energy consumption remained relatively stable from 1990 to 2013 due to increasing energy demand and the central role of traditional biomass, which accounts for roughly 50% of the renewable energy share in total final energy consumption. In order to double the share of renewable energy in final energy

consumption as outlined by SE4ALL (from 18% in 2010 to 36% in 2030), significant efforts in up-scaling the deployment of modern renewable energy sources including hydropower need to be made; system integration and sustainability concerns need also to be addressed.

As stated in REN21's Renewables Global Futures Report, given technology and economic trends the future of renewable energy is fundamentally a choice, not a foregone conclusion. The context for that choice includes the present situation—high levels of current investment and more than a decade of dramatic market growth, proliferation of support policies, and cost reductions in renewable energy. The context also involves a growing diversity of motivations, such as energy security, climate and environment,

Figure 13: Conservative, Moderate, and High Renewable Energy Scenarios to 2050



Source: IEA ETP 2014; IEA WEO 2013. Reference see endnotes.

industrial and economic development, financial risk mitigation, flexibility, and resilience.

Many existing energy companies, especially those with a vested interest in the status quo, project conservative future shares of renewable energy and emphasise cost hurdles and variability challenges. These companies continue to believe that the future will be dominated by fossil fuels. Such “conservative” outlooks project that the share of renewable energy in global energy supply will remain below 20% in the future, not much higher than today.

● **“Moderate” outlooks**—as concluded by experts and scenarios—project renewable energy shares of 30 – 45% by 2050, including electricity, heating/cooling, and transport. In such outlooks, renewable electricity is integrated into power grids as high shares i.e., 50 – 80%, using a variety of options such as demand-response, balancing with natural gas, new market structures for balancing services, and some energy storage. Transport employs modest but growing amounts of biofuels, along with electric vehicles and plug-in hybrids, partly charged from renewable electricity, and some modal shifts of freight to higher proportions of electric transport.

● **“High renewables”** outlooks project 50 – 95% of energy shares by 2050. Such shares are cited by many experts, and are detailed in scenarios, typically produced by public advocacy organisations. However the International Energy Agency (IEA), which has traditionally produced more conservative projections, has published in recent years a series of scenarios that show high penetration of renewables by mid-century. High-renewables projections typically outline some combination of significant and continued renewable energy cost reductions, along with aggressive and long-term support policies for renewable energy, and major transformations in energy markets and infrastructure.

● **“High renewables”** projections also illustrate up to 100% shares of renewable electricity—thus not counting heating or transport. These high shares come from a portfolio of renewable technologies, coupled with a balancing and grid-strengthening of measures, energy storage, and evolving electricity market rules. In transport, large shares of biofuels and electric vehicles are projected—even for freight transport—such as biodiesel and electric trucks and electric rail. The use of electric vehicles for grid-balancing purposes is enhanced through smart-grid interactions and “vehicle-to-grid” (V2G) and “vehicle-to-home” (V2H) concepts. Buildings are designed, constructed, and heated/cooled in a different paradigm. The use of renewables integrated building materials becomes ubiquitous, “low energy” or “passive” buildings with high energy efficiency and low heating requirements become the standard, and many forms of renewable heating and cooling are used, including solar thermal, geothermal, and biomass.

One common attribute of many high-renewables scenarios is a constrained, carbon emission future. Such high-renewables carbon constrained scenarios typically model aggressive energy efficiency improvements, can model carbon capture and storage for fossil fuels, and typically model little or no nuclear power. Such scenarios may also include some type of carbon price incorporated into energy markets.

Table 8: Sectorial Shares of Renewable Energy in Recent Global Scenarios

Scenario	by year	Electricity	Heat	Transport
by 2030 – 2040				
Exxon Mobil Outlook for Energy: a View to 2040	2040	16%	–	–
BP Energy Outlook 2030 (2012)	2030	25%	–	7%
IEA World Energy Outlook (2013) <i>New Policies</i>	2035	31% ⁱ	12% ⁱⁱ	6% ⁱⁱⁱ
IEA World Energy Outlook (2013) <i>450</i>	2035	48% ^{iv}	16% ^v	15% ^{vi}
Greenpeace (2012) Energy [R]evolution	2030	61%	51%	17%
by 2050				
IEA Energy Technology Perspectives (2014) <i>2DS</i>	2050	65% ^{vii}	–	29% ^{viii}
GEA Global Energy Assessment (2012)	2050	62%	–	30%
Greenpeace (2012) Energy [R]evolution	2050	94%	91%	72%
WWF (2011) Ecofys Energy Scenario	2050	100%	85%	100%

i) As share of total generation.

ii) As share of total final heat demand; excludes traditional biomass.

iii) Biofuels as share of total transport.

iv) As share of total generation.

v) As share of total final heat demand; excludes traditional biomass.

vi) Biofuels as share of total transport.

vii) As a percentage of gross electricity generation. NB, under the 2DS High Renewables scenario, renewables as a percentage of gross electricity generation are 80%.

viii) Biomass as a share of final energy demand in the transport sector.

Note: “–” means that no data are available.

Finance is key. Forecasts envisage the presence of new sources of financing such as insurance funds, pension funds, and sovereign wealth funds, along with new mechanisms for financial risk mitigation. Numerous new business models will also emerge to support local energy services, utility services, transport, community and cooperative ownership, and rural energy services. Some forecasts of annual investment in renewables by 2020 are in the range of USD 400–500 billion, up from USD 250 billion in 2013. Projections of average annual investment in the coming decades range between USD 300 billion and USD 1 trillion. Public support for renewables—in both direct and indirect forms as estimated by the IEA—stood at about USD 90 billion in 2011; this is expected to increase through the 2020s in a growing number of countries. However anticipated amounts are expected to remain at levels significantly lower than public support for fossil fuels.

With the dramatic growth of renewable energy markets over the past decade and economies-of-scale in the manufacturing sector, there have been dramatic technology improvements and cost reductions. Recent growth rates reflect a “take-off” phase that has seen many renewable energy technologies become mainstream investments and undergo dramatic advances in performance, cost, and scale. Hydropower, geothermal, and biomass power and heat are the most mature, and most projections show continued growth that reflects this status.

Among other renewables, onshore wind power is closest to commercial maturity. There are numerous examples of unsubsidised wind power that are already competitive with conventional energy (in specific locations); additional projections of further technology and cost evolution have also been made. While offshore wind power is more expensive than onshore, offshore has large—although uncertain—potential for cost reductions, not just for turbines, but also for logistics and long-term operations and maintenance costs.

Solar PV has seen dramatic cost reductions in recent years. Projections show continued cost decreases, many possible technology advances, and full competitiveness with retail electricity prices without subsidies. This so-called “grid parity” will occur in many jurisdictions soon—although according to some is already taking place—and will be more common worldwide by 2020. Concentrating solar thermal power (CSP) still has a large cost-reduction potential, with future opportunities for bulk power supply, for dedicated applications such as industrial heat supply and desalination, and for power grid balancing using multi-hour and multi-day embedded heat storage.

While debates about the sustainability of so-called “first generation” biofuels continue, many projections show large future markets for “advanced” biofuels from agricultural and forestry wastes, and from crops grown on marginal or otherwise unproductive lands. A wide variety of new approaches to using biomass is also projected, such as growing international commodity markets for wood pellets and bio-heating oil, greater use of biogas in a variety of applications, new types of “biorefineries” in agriculture and forestry, and greater use of biomass in heat supply.

Numerous experts point to the fact that future policies will evolve over time and will remain an essential part of renewable energy futures. The next decade will undoubtedly see a range of future policies to support renewable heating and cooling in buildings. New policies for electric power system integration will emerge, including market rules for balancing services, demand response, net metering, consolidation of grid balancing regions, transmission planning and access, and others. Policies for transport, industry, and rural energy will be key to the future integration of renewables.



Endnotes

Unless otherwise referenced, all data in this publication have been taken from REN21 documents— notably its Renewables Global Status Report series and its Global Futures Report—copies of which can be found at:

www.ren21.net/gsr and www.ren21.net/gfr respectively.

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IEA World Energy Outlook 2006

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IEA World Energy Outlook 2013

<http://www.worldenergyoutlook.org/publications/weo-2013/>

International Renewable Energy Agency (IRENA), Renewable Energy Jobs & Access (Abu Dhabi 2013)

Table 5: Employment Factors by Technology

Numbers drawn from:

Hydro (large): Employment factors are from a US study (Navigant Consulting, 2009).

Wind onshore: The installation factor used is from the European Wind Energy Association (EWEA). The manufacturing factor is derived using the employment per MW in turbine manufacture at Vestas from 2007 to 2011 (Vestas, 2011), adjusted for total manufacturing using the ratio used by the EWEA (European Wind Energy Association, 2009). For further detail, see Rutovitz & Harris, 2012a.

Wind offshore: All factors are from a German report (Price Waterhouse Coopers, 2012).

Solar PV: The Solar PV employment factors are all from the JEDI model (National Renewable Energy Laboratory, 2011)

Geothermal: The construction and installation, and O&M factor is derived from a study conducted by Sinclair Knight Merz (2005). The O&M factors are the weighted averages from employment data reported for thirteen power stations totalling 1050 MW in the US, Canada, Greece and Australia (some of them hypothetical). The manufacturing factor is derived from a US study (Geothermal Energy Association, 2010).

Solar thermal power: Construction and O&M jobs were derived from a weighted average of eight reported power plants (1512 MW) in the US (Rutovitz & Harris, 2012a). The manufacturing factor came from the European Renewable Energy Council, 2008, page 16.

Ocean: The construction factor used in this study is a combined projection for wave and tidal power derived from data for offshore wind power (Batten & Bahaj, 2007). A study of a particular wave power technology, Wave Dragon, provided jobs creation potential for that technology, and the O&M factor used here is based on that report (Soerensen, 2008).

Geothermal and heat pumps: One overall factor has been used for jobs per MW installed. This is derived from analysis of a US industry survey in 2012, which reported 9,088 total jobs in 2012, including 2,611 manufacturing jobs (Battocletti & Glassley, 2012). Shipments of heat pumps during that year came to 1,314 MW.

Solar thermal heating: One overall factor has been used for jobs per MW installed, as this was the only data available on any large scale. This may underestimate jobs, as it may not include O&M. The global figure comes is derived from the IEA heating and cooling program report (Weiss & Mauthner, 2011).

Bioenergy: Employment factors for construction, manufacturing and O&M use the average values of studies from Greece, the UK, Spain, USA, and Europe wide (Kjaer, 2006; Moreno & López, 2008; Thornley, 2006; Thornley et al., 2009; Thornley, Rogers, & Huang, 2008; Tourkolias & Mirasgedis, 2011). Fuel employment per PJ primary energy is derived from five studies (Domac, Richards, & Risovic, 2005; EPRI, 2001; Hillring, 2002; Thornley, 2006; Upham & Speakman, 2007; Valente, Spinelli, & Hillring, 2011).

Figure 9: Range in Recent Levelised Costs

Numbers drawn from: IPCC SRREN, Renewable Energy potential analysis: Technical renewable energy potentials reported here represent total worldwide and regional potentials based on a review of studies published before 2009 by Krewitt et al. (2009). They do not deduct any potential that is already being utilised for energy production. Due to methodological differences and accounting methods among studies, strict comparability of these estimates across technologies and regions, as well as to primary energy demand, is not possible. Technical RE potential analyses published after 2009 show higher results in some cases but are not included in this figure. However, some RE technologies may compete for land which could lower the overall RE potential; also consulted:

IRENA, http://costing.irena.org/media/2769/Overview_Renewable-Power-Generation-Costs-in-2012.pdf

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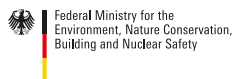
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REN21 releases issue papers and reports to emphasise the importance of renewable energy and to generate discussion on issues central to the promotion of renewable energy. While REN21 papers and reports have benefitted from the considerations and input from the REN21 community, they do not necessarily represent a consensus among network participants on any given point. Although the information given in this report is the best available to the authors at the time, REN21 and its participants cannot be held liable for its accuracy and correctness.

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RENEWABLE ENERGY POLICY NETWORK FOR THE 21st CENTURY

REN21 is the global renewable energy policy multi-stakeholder network that connects a wide range of key actors. REN21's goal is to facilitate knowledge exchange, policy development and joint action towards a rapid global transition to renewable energy.

REN21 brings together governments, nongovernmental organisations, research and academic institutions, international organisations and industry to learn from one another and build on successes that advance renewable energy. To assist policy decision making, REN21 provides high quality information, catalyses discussion and debate and supports the development of thematic networks.



*Global Status Report:
yearly publication since 2005*

Global Futures Report

Regional Reports

www.map.ren21.net

REN21
publications:

2004

REN21
events: renewables
2004, Bonn

First GSR
published

2005

BIREC,
Beijing
International
Renewable Energy
Conference

2006

2007

2008

WIREC,
Washington
International
Renewable Energy
Conference

Chinese Renewable
Energy Status Report

2009

→ PROVIDE HIGH-QUALITY INFORMATION TO DRIVE INFORMED POLICY DECISIONS

Using its multi-stakeholder network, REN21 facilitates the collection of comprehensive and timely information on renewable energy. This information reflects diverse viewpoints from both private and public sector actors, serving to dispel myths about renewable energy and catalysing policy change.

Renewables Global Status Report (GSR)

First released in 2005, REN21's *Renewables Global Status Report* (GSR) has grown to become a truly collaborative effort, drawing on an international network of over 500 authors, contributors, and reviewers. Today it is the most frequently referenced report on renewable energy market, industry, and policy trends.

Thematic Reports

REN21 produces thematic reports which aim to provide in-depth analysis about a topic and stimulate discussion:

- Renewables Global Futures Report (GFR)
- Local Renewable Energy Policies Status Report
- 10 Years of Accelerating the Global Energy Transition
- Mini-Grid Policy Toolkit

Regional Reports

These reports detail the renewable energy developments of a particular region; their production also supports regional data collection processes and informed decision making.

Renewables Interactive Map

The Renewables Interactive Map is a research tool for tracking the development of renewable energy worldwide. It complements the perspectives and findings of the GSR by providing constantly updated market and policy information and detailed exportable country profiles.

→ INITIATE DISCUSSION AND DEBATE TO DRIVE POLITICAL COMMITMENT

International Renewable Energy Conferences (IRECs)

The International Renewable Energy Conference (IREC) is a high-level political conference series. Dedicated exclusively to the renewable energy sector, the biennial IREC is hosted by a national government and convened by REN21. SAIREC 2015 will be held in South Africa, 4–7 October 2015.

Renewables Academy

The REN21 Renewables Academy provides an opportunity for lively exchange among the growing community of REN21 contributors. It offers a venue to brainstorm on future-orientated policy solutions and allows participants to actively contribute on issues central to the renewable energy transition.

Thematic workshops, panel discussions and webinars

REN21 convenes and participates in a series of workshops, panel discussions, and webinars to spread information on renewable energy globally.

→ STRENGTHEN AND LEVERAGE REN21'S MULTI-STAKEHOLDER BASE

- Broad dissemination of activities of the REN21 Secretariat as well as network members through four editions of the REN21 newsletter.
- In-depth information for members through the REN21 newswire.
- Dynamic interaction with key institutional partners such as IEA, IRENA, SE4ALL, and UNEP.

Indian Renewable Energy Status Report

2010

DIREC, Delhi International Renewable Energy Conference

Global Status Report on Local Renewable Energy Policies

2011

2012

Global Futures Report
MENA Renewable Energy Status Report

2013

ADIREC, Abu Dhabi International Renewable Energy Conference

ECOWAS Renewable Energy and Energy Efficiency Status Report

2014

First REN21 Renewables Academy, Bonn

EAC and SADC Renewable Energy Status Reports

2015

SAIREC, South Africa International Renewable Energy Conference

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