STUDY

Towards a Global Energy Transformation

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- Our energy system is in a crisis: The centuries-long dependence on fossil fuels has led to serious environmental damage, as well as centralized production, distribution, and ownership structures from which only few benefit. At the same time, large parts of the world population have no access to electricity.

- Therefore, we need a global energy transformation. We must move away from fossil and nuclear energy sources, towards 100 per cent renewable energy, a decentralized and locally managed supply, increased efficiency, and a reduction in absolute consumption. However, an energy transformation will not happen without friction, because ownership and power structures have to be fundamentally restructured.

- Only rarely are there immutable facts or technical conflicts that impede or even prevent the expansion of renewable energy. Instead, long-established structures and elites problematize the challenges of an energy transformation and sustain the existing system and their own (market) power with corresponding narratives. The success of an energy transformation will depend on whether a broad alliance of civil society, politics, science, and industry develops a convincing alternative and positive narratives – and implements them against resistances.

Wuppertal Institute
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GERMANWATCH

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1. A Global Energy Transformation

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We are dependent on energy. We need it to produce and prepare food, to heat, and to generate light. It is fuel for our economy and an engine for development. In short: no energy, no modern life.

But our energy system is mired in crisis: the centuries-long dependence on fossil fuels has led to serious environmental damage, as well as centralized production, distribution, and ownership structures from which only a few benefit. At the same time, large parts of the world population either have no access to electricity or have to spend a large part of their income on energy supply due to rising prices. In addition, the world finds itself in a continued fossil growth trajectory with this energy system, which leads to rapidly increasing greenhouse gas emissions and a permanent overexploitation of natural resources. The energy hunger of a growing world population is becoming increasingly bigger and demands new, extreme forms of energy production, because conventional energy sources are becoming more difficult to tap. Consequently, it will be increasingly problematic to achieve the triangular objective of security of supply, environmental sustainability, and energy justice. We urgently need to change course and create energy systems that guarantee a safe and affordable supply for all segments of the population, and at the same time protect the environment and the climate. Otherwise, we will transform our planet into a »broiling, toxic swamp called earth« (Williams 2011).

Therefore, we need a global energy transformation. We must move away from fossil fuels and nuclear energy sources, towards 100 per cent renewable energy, increased efficiency, and a reduction of absolute consumption. However, a global energy transformation goes far beyond the mere shift to renewable energy: it requires a departure from the current economic system and the associated growth paradigm. It also means redistribution, which involves market share, ownership and power structures.

An energy transformation is not only urgently needed, it is also possible and can bring with it great benefits for broad social levels. However, it will not occur without friction, because the opportunities and burdens of the transformation have to be shared between different countries and actors, and the transition has to be shaped in a socially just manner. Its success will depend on whether a broad alliance from civil society, politics, science, and industry develops a convincing alternative – and prevails it against resistances.

The present study analyses,

- what a global energy transformation has to look like in order to create energy systems as sustainable and just as possible (this chapter),
- which framework conditions influence the implementation of a global energy transformation at the international, intergovernmental, national, and sub-national level (Chapter »Energy Transformation in the Multilevel System«),
- where the area of conflict is located in a global energy transformation and what kind of resistance has to be overcome (Chapter »Energy Transformation between Conflicting Interests«).

Because an energy transformation represents a fundamentally different challenge depending on the starting position, the approaches in different countries are considered in addition to three detailed case studies (Chapter »The Status of Energy Transformation – Examples of Tranformative Processes«).

An energy transformation should be part of a fundamental paradigm shift to a sustainable development model. Socially just and ecologically sustainable solutions must be found in order to organize energy supply, the entire industrial production, the transport and heating sector with significantly fewer greenhouse gases. Besides switching to renewable energy, this can also be achieved in the energy sector through increased energy and resource efficiency. In this study, however, we focus exclusively on the field of electric power generation.

This chapter is intended to outline, a) why we need a global energy transformation, b) what this could look like, and c) why it has not yet been implemented.

The Energy Crisis is a Crisis of Justice

Global warming is a man-made problem, and our use of energy, in particular, is a big part of it: a total of 57 per cent of global greenhouse gas emissions come about from the use of fossil fuels (Friends of the Earth International 2013). This is despite the fact that only part of the world's population participates in this energy consumption: While there is a real waste of electrical energy in some regions, large segments of the world's population live in energy poverty. For example, the 20 million residents of New York use just as much electricity in a year as 790 million people in Sub-Saharan Africa (KfW 2011). Worldwide, nearly 1.3 billion people have no access to electricity; an additional 2.7 billion people rely on traditional biomass such as charcoal and firewood. Thus, the energy crisis is not only an environmental, but also a profound crisis of justice. Although the current development model creates wealth in a few regional centres and for a small upper class, in the long term it destroys its own production base in the form of cheap fossil energy, seemingly unlimited available resources, and a continually increased labour productivity. With its dependence on resources and land, our energy system divides the world into importers and exporters, and in many cases leads to political instability, conflict, and corruption. Resource-poor countries often spend a high proportion of their gross domestic product on energy imports, resource-rich countries suffer from the »curse of resources«, which fuel the social, political, and economic problems in their own country. Small farmers or entire villages and indigenous communities lose their land to large corporations or state actors, to create space for dams for hydropower generation or biomass plantations (land grabbing). The combustion of coal leads to air and water pollution, and in many cases serious health damage for workers and the local population. Thus, a balanced social development in line with planetary boundaries is not possible.

Yet this crisis has not just existed since climate change became the focus of public attention. It is much older.

Since the beginning of the industrial age, the human need for prosperity and growth has led to an ever-increasing hunger for energy and resources: Alone in the 20th century, the economy grew by 14-fold, and global energy consumption increased sixfold. Although resource productivity also increased in this period, absolute energy consumption has continued to increase: In just 100 years, people have consumed more energy than during the entire 40,000 years before (Welzer 2012). To satisfy this growing demand for energy, increasingly large amounts of coal, oil, and gas were produced.

From the Limits of Growth to the Planetary Boundaries

How long the resource boom can continue this way is debatable. While some analyses, such as the one from the International Energy Agency (IEA 2013B), see no constraints in the next few years thanks to new technologies, others such as the Energy Watch Group suspect that peak oil has already been reached and natural gas and coal production will probably attain the maximum production around 2020. At any rate, in the case of natural gas and oil, conventional extraction is already in decline. Although the world's coal reserves are still plentiful, coal is only available on the world market from a few exporting countries. Moreover, in many coal states such as China or India, demand is rising faster than domestic production. As a consequence, China has recently changed from being an exporter to being the largest importer of coal, next to Japan. As a result, future supply depends primarily on Australia and Indonesia, which have mainly covered the quickly growing demand in the last ten years. However, this will not go well much longer: In Indonesia, neither the reserves nor the rising domestic demand are sufficient for further expansion of exports. The quality of coal in some regions is already noticeably worse: Indian coal contains up to 70 per cent ash; in South Africa, the poor coal quality has already led to an electricity supply shortage, because the efficiency of the power plants is thereby decreased.

Also nuclear energy, apart from ecological reservations and security concerns, is no solution, because uranium production had already exceeded maximum production in 1980. According to estimates by the Nuclear Energy Agency (NEA), the world's resources are indeed sufficient for a few more decades, but this estimate is rather optimistic. Even though production increases have been recorded since 2000 due to new mines in Kazakhstan, there will already be shortages in this decade because the production requirements are becoming more complex: New mines in Africa already have to resort to mineral ores with a uranium content of less than 0.02 per cent. Therefore, increasingly more energy is required for uranium production. This will especially be a problem when fossil fuels are no longer sufficient and cheaply available (Energy Watch Group 2013, Netzer 2011).

Regardless of these shortage scenarios, it is clear that fossil resources will last much longer than the climate can tolerate. Three figures make this very clear:

- We have to limit the average global warming to 2°C compared with 1990. Otherwise, harm to people and the environment is no longer controllable.

- To achieve this with a 66 per cent probability, greenhouse gas emissions in total cannot exceed the equivalent of approximately 1,000 gigatonnes of carbon. So far, already more than half of this has been released through human activity (Carbon Tracker Initiative 2013).

- The existing stock of fossil energy still in the ground alone encompasses a potential of 2,795 gigatonnes CO_2, thus about five times the amount that we would be allowed to consume (*Deutsches Klima-Konsortium* 2013).

These figures clearly show a change of perspective in energy policy: According to the study published in 1972, »The Limits to Growth« from the Club of Rome, it was assumed that economic growth would be limited due to a scarcity of natural resources. In order to circumvent the limits of growth, ever new sources of raw materials were tapped. From today's perspective, it is much more likely that the planetary boundaries will be reached first. The concept of *Planetary Boundaries* – which was published in 2009 and developed by a group of scientists working with the Swede Johan Rockström (Rockström et al 2009) – identifies nine tipping points in areas that are essential for human survival. The areas include climate change, land use, acidification of the oceans, ozone depletion, loss of biodiversity, freshwater use, as well as the phosphorus and nitrogen cycle. In two areas, biodiversity and the nitrogen cycle, the limits have already been reached; in the area of climate change, we are about to cross the boundary.

The Answer to the Crisis: More of the Same!

As a consequence, the current energy system is no longer sustainable. Nevertheless, we are far from an energy revolution. The global energy supply is still based on 82 per cent on fossil fuels (IEA 2013B); in addition, substantial investments continue to be made in nuclear energy and fossil fuels. The subsidies alone for fossil fuels amounted to 544 billion US dollars in 2012, whereas the subsidies for renewable energy were only 101 billion US dollars (IEA 2013B). Though on the positive side, renewable energy meanwhile now covers 19 per cent of the global energy consumption (Ren 21 2013) and the investment rates in this area are rising continuously. Nevertheless, the issue of limiting absolute energy consumption remains untouched. And: The global share of technological beacons of hope – wind and solar energy – in the global final energy consumption, thus far scarcely reaches 0.2 per cent (Ren 21 2013). Most of renewable energy sources continue to consist of traditional biomass.

Instead of accepting renewable energy sources as a real alternative and reducing absolute energy consumption in affluent societies, this consumption is further increased with the help of new technologies and development areas. However, much of the unconventional gas deposits – such as shale gas, coalbed methane, tight gas, as well as methane hydrates and unconventional oil from tar sands, oil shale, heavy oil, deep-sea oil, polar oil, or liquefied petroleum gas – are highly controversial due to feared or already occurring environmental damage. Examples are the current fracking boom in the USA[1] or the recovery of oil from tar sands, which has experienced a boom in Canada in the last few years – with disastrous consequences. On the one hand, a huge primeval forest had to be cleared for the mining of the tar sands. On the other hand, 1,49 000 km^2 of land – an area larger than Austria and Switzerland combined – was as a result transformed into a desert of toxic sludge; because in the separation of oil and sand, almost two million barrels of toxic broth accumulate, which contains, among other things, arsenic and mercury.

Although the use of fossil resources leads to massive environmental problems and they are more difficult to exploit, the crisis of conventional energy sources has so far not led to a radical rethink. The supposed solution strategies are in fact the expression of a growth-focused economic and social model, which is furthermore hardly ever questioned. Above all, societies in Europe and North

1. This is a technique in which liquid is injected into deep layers of rock, so that oil and gas can be more easily accessed.

America achieved their present-day prosperity in the past centuries through a development model based on the exploitation of finite and dirty resources and raw materials, on growth fixation, and on overconsumption. In recent decades, this expansive and energy-intensive way of life has been increasingly copied by a growing middle and upper class in emerging and developing countries, which makes a change of course increasingly more difficult.

Renewable Energy: A Sustainable and Just Alternative?

Renewable energies can represent a sustainable, development-promoting, and democratic alternative to the current fossil energy system. They have fewer emissions than conventional energy sources, they reduce the dependency on energy imports, and they provide the opportunity to create wealth and jobs. Already today, 5.7 million workers are active in the renewable energy sector; in 2030 the figure could grow to 16.7 million through the implementation of appropriate policies, according to the International Renewable Energy Agency (IRENA). The International Labour Organization (ILO) estimates that 14.3 million green jobs in renewable energy could be created worldwide. Because 11.7 million of these jobs are being created in developing countries, this simultaneously offers the potential to reduce social inequalities. Moreover, the renewable energy sector can create good jobs, because many of the positions require higher qualifications. In addition, renewable energy, combined with a decentralized energy structure, can contribute – particularly in developing countries – to large segments of the population gaining access to energy and jobs in disadvantaged regions being created. And the potential is huge: According to IEA, in the period 2013 to 2035, just to cover the additional demand and shut down outdated power plants, a global investment of 17 billion US dollars in the energy sector is needed – an enormous window of opportunity to transfer to renewable energy paths. This should be used, because with each new US dollar that is invested in fossil technologies, the effect of the carbon lock-in[2] strengthens and prevents the widespread adoption of renewable energies.

2. The term »carbon lock-in« was first used in 1999 by US scientist Gregory C. Unruh. It refers to the state of industrial economies, which are locked in a system of fossil-based energy systems through a process of technological and institutional co-evolution. This lock-in prevents governmental and private efforts from investing in alternative forms of energy.

Table 1: Lifecyle Greenhouse Gas Emissions by Power (Authors' own compilation based on Moomaw 2011.)

Technology	**Description**	**Gram CO_2 / kWh** (Average)
Hydropower	Dam	4
Wind	Onshore	12
Atomic energy	Different Generation II reactor types	16
Biomass	Various	18
Solar heat	Parabolic trough collectors	22
Geothermics	Hot Dry Rock method	45
Solar PV	Solar cells	46
Natural gas	Various combined power stations without CO_2 scrubbing	469
Coal	Various generator types without CO_2 scrubbing	1,001

In addition to the positive effects on the economy and labour markets, an energy transformation can help to democratize energy systems. In most countries, the electricity market is characterized by a centralized structure in which a few power generators produce most of the electricity. This leads to a situation in which there is little competition, and a few companies have considerable power – also to influence energy policy decisions. The transition to renewable energy is often associated with decentralized energy systems and will therefore change relationships between societies, economies, and the nation state, as well as local and regional structures. Not least, they can change ownership structures, because municipalities, public utilities, and civic associations have the opportunity to organize their energy supply independently.

An Energy Transformation Presents Challenges

The shift to renewable energy is a complex undertaking: production systems have to be adapted, new infrastructures built up, product innovations created, and labour relations as well as consumer behaviour changed. Furthermore, several problems ensue, for which socially acceptable solutions have to be found:

First, the shift to renewable energy will inevitably lead to economic losses in the traditional energy sectors, upon which jobs are also dependent: Seven million people alone are employed worldwide in the coal industry (IRENA 2014). This makes it clear that a poorly managed transformation involves the risk of contributing to unemployment or pay cuts in these sectors, and thus exacerbates income inequality. Second, an energy transformation entails, at least initially, considerable investment costs: Even if from a macroeconomic standpoint no additional costs arise through a doubling of the share of renewable energy – because external costs for damage to the environment and to health can be reduced (IRENA 2014) – costs for technologies and infrastructure nevertheless accrue. Third, it must be considered that renewable energies could lead to social problems and environmental damage: Industrially produced biofuels and biomass or mega-dams for hydroelectric power sometimes have destructive consequences for humans and the environment, and a careful assessment of all of the risks as well as provisions for human rights and ecological criteria must be carried out. Fourth, there is a danger that the current fossil growth path will simply be replaced by a renewable growth path. Although increases in efficiency and the conversion to renewable energy can achieve short-term emission reductions, from an ecological perspective, this change does not necessarily lead to a sufficient reduction in absolute energy consumption. It even frequently happens that efficiency gains and CO_2 savings are eaten up again by increased consumption in other areas (rebound effects). And fifth, the limits of growth also threaten renewable energy, because the construction of motors and generators that use or generate renewable energy is also dependent upon rare earths and thus finite resources.

Thus, an energy transformation can only act to promote development when it is organized according to the principles of a *Just Transition* (Rosemberg 2010)[3] – i.e., socially just and democratic. This includes, first of all, that workers in the relevant sectors are offered early on broad-based, public and private retraining and continuing education opportunities. Only thus can job losses in traditional sectors be cushioned and the transition be made socially acceptable. Second, socially acceptable solutions must be found so that the costs of an energy transformation are not only borne by private consumers, but also shouldered by governments and corporations. Third, the risks of renewable technologies also have to be carefully considered by taking human rights and environmental criteria into consideration. And fourth, an energy transformation must be complemented by efficiency and sufficiency strategies and embedded in a radically new development paradigm. If this can be achieved, it offers a way to promote environmental sustainability and social justice, to democratize energy systems, and to produce positive effects for the economy and labour markets.

Is a Global Energy Transformation Possible?

Too land-intensive, too unreliable, too expensive – these are the three most common criticisms in reference to renewable energies.

As the first argument, it is often mentioned that power generation from renewable energy sources would lead to huge tracts of land being covered with wind farms, solar plants, and additional power grids. In fact, the infrastructure for renewable energy requires much less space than the existing space for oil, coal, gas, and nuclear energy – even if one does not count landfills or poisoned land. A 2012 published study by WWF shows that in 2050, less than 1 per cent of the land area in each region of the world would be sufficient to cover 100 per cent of the projected energy needs of the region with solar power systems (WWF 2012).

The second most frequently used counter-argument is that energy from renewable sources is too unreliable, because wind and sunlight are difficult to predict. From this, critics draw the conclusion that we need fossil or nuclear-powered power plants to ensure supply at all times. However, this is not the only solution: The problem of fluctuating availability can be countered by intentionally compiling the power supply from various renewable sources. Wind and solar complement each other well: In general, the wind blows when the sun does not shine – and vice versa. Wind turbines primarily generate electricity in winter; solar plants, on the other hand, in summer. The sun shines most at midday, while the wind occurs throughout the day – it often blows

3. The concept of a just transition was developed in the 1990s in the trade union environment and means the attempt to combine decent work and environmental protection by creating jobs in green sectors. In contrast to other approaches on green economy, the concept places a strong focus on the social dimension.

Table 2: Area Required for Renewable Energy Technologies in order to provide the World with Energy (Authors' own compilation based on Jacobson and Delucchi 2011.)

Energy technology	Estimated power generation of a plant in MW	Potential share of electricity demand in per cent	Number of plants required worldwide	Share of required footprint area as per centage of the global land area	Share of the required space area as per centage of the global land surface
Wind turbine	5	50	3.8 Mio.	0.000033	1.17
Wave power plant	0.75	1	720,000	0.00026	0.013
Geothermal plant	100	4	5,350	0.0013	0
Hydroelectric plant	1,300	4	900*	0.407*	0
Tidal power	1	1	490,000	0.000098	0.0013
Photovoltaic roof systems	0.003	6	1.7 Mrd.	0.042**	0
Solar plants	300	14	40,000	0.097	0
Concentrated solar power (CSP)	300	20	49,000	0.192	0
Total		**100**		**0.74**	**1.18**
Total new land required				**0.41*****	**0.59*****

* Approximately 70 per cent of the required water power plants are already installed.
** The area for photovoltaic roof systems do not have any additional land requirements because the required roofs are already available and not used otherwise.
*** An estimated 50 per cent of the wind, wave, and tidal systems are on the water; 70 per cent of the water power plants are already installed; and photovoltaic roof systems require no additional land.

least at the time of the highest sunlight (Agora *Energiewende* 2012); power from geothermal energy is very predictable because geothermal sources are continuously available. Instead of fossil and nuclear dual structures, long-term investments should therefore be made in storage technologies and decentralized networks for renewable electricity. If one wants to save money and resources and leave as many untouched landscapes as possible, a dual energy infrastructure makes little sense, especially not if a significant portion of the »shadow power plants« serves only as stopgaps and most of the time is not taken advantage of.

The third and often most weighty argument is the alleged cost of renewable energy. Especially proponents of nuclear energy frequently argue that this would be the cheapest form of power supply.

That this can hardly be correct is illustrated by both the cost explosions on the current construction sites in Finland and France (taz 2012, Focus 2012),[4] and the plans for the reactor Hinkley Point C in the UK, which can only be built with government subsidies in the form of a guaranteed power purchase price and would otherwise not be commercially viable (Manager Magazin 2013). This shows that nuclear power is only cheap if the facilities already exist or are already written off, and if they receive – through government start-up funding for large-scale nuclear projects – direct subsidies to uphold safety standards and subsidized tax exemptions. In addition, costs are incurred in the decommissioning of old plants or in the storage and disposal of radioactive waste, as well as the economic costs and burdens of public health systems caused by nuclear accidents. In the German Atomic Energy Act, for example, nuclear pow-

4. In the Finnish Olkiluoto 3 reactor, the initial cost was estimated at the start of construction in 2005 to be about 3 billion euro, now the cost is 8.5 billion euros. The cost of the French Flamanville 3 was estimated at the start of construction in 2007 to be 3.3 billion euro and is now also at 8.5 billion euro.

er plant operators have to assume liability insurances only up to a loss of 2.5 billion euro. Their liability is only unlimited if severe natural disasters, armed conflicts, or the like are not involved. With a maximum credible accident (MCA), however, this amount would certainly not be enough and the state would have to step in. If nuclear power plant operators insured themselve fully, the insurance costs would be exorbitant: The price of a kilowatt-hour (KWh) would rise up to 2,36 euro depending on the insurance model (Günther et al. 2011). These costs are not be passed on to consumers in the energy prices, but borne by the general public today and in the future (Netzer 2011). This is also true of fossil fuel corporations that receive direct grants and tax breaks, and cause environmental and health damages that do not appear in any settlement.

Furthermore, the costs of renewable energy sources have dropped more and more in recent years. In its report »Deploying Renewables«, the IEA showed as early as 2011 that some renewable energy technologies are cost competitive in an increasingly larger range of circumstances: In Australia, the world's largest exporter of coal, the cost of generating electricity from new wind turbines is meanwhile cheaper than power from new coal or gas power plants, and the costs of solar, hydro, geothermal, and bioenergy also continue to fall (Bloomberg New Energy Finance 2013).

But not only for cost reasons is renewable energy an increasingly interesting alternative. Many studies have shown that it is sufficient to cover the total world energy demand: In August 2011, *Science Magazine* reported that each year 101,000 terawatts of solar energy strikes the ground. Other scientists, like Mark Z. Jacobson and Mark A. Delucchi, refer to 6,500 terawatts of solar energy, of which 340 terawatts could be harnessed (Jacobson and Delucchi 2011). Since the entire global energy consumption is annually about 15 terawatts, just a little more than 1/10,000 of solar radiation would have to be captured in order to meet the needs of humanity. For comparison: A terawatt is a million megawatts (MW), which corresponds to the power of about 1,200 nuclear power plants. The same is true for wind energy: Worldwide 1,700 terawatts of wind energy above land and water areas at an altitude of 100 metres are available, if wind at all speeds would be used to drive wind turbines. From the wind power on land and near the coast, which has a speed of seven metres per second (the necessary speed to offer wind energy at competitive prices), 72 to 170 terawatts could be used to run wind turbines. About half of this energy is located in areas that could be practically used.

In summary, this means that wind could meet the world's energy needs by three- to fivefold in developable areas, and solar energy even 15- to 20-fold. Furthermore, the Intergovernmental Panel on Climate Change (IPCC) estimated in 2011 that 80 per cent of the world's electricity needs could be covered by renewable energy in 2050. This shows: An energy revolution is technologically possible, »the tricky part is society and politics« (Williams 2011).

Resistance of the Powerful – Who Profits from the Current Energy System?

The current energy system produces winners and losers: While a small minority benefits, the vast majority are affected by the negative consequences of fossil energy production. The losers include primarily poor people in resource-rich developing countries in Africa, Asia, and Latin America who are suffering from the health and social consequences of energy production and are excluded in large numbers from access to energy. This particularly applies to indigenous peoples, who are often driven out of their territories due to energy mega-projects. Equally affected are workers in the fossil energy industry, whose jobs in most countries are poorly paid, unsafe and life threatening, and who are forced to live for long periods away from their communities and families. Particularly affected are women in developing countries, who often have the primary responsibility for the arduous and time-consuming energy procurement. Their situation will not improve as long as the profiteers of the system want to impede change at all costs.

But who are the profiteers? Above all, the energy industry benefits from the current system, and this means primarily large energy corporations that own oil, gas, and nuclear companies as well as coal mines, operate plantations for industrial biomass and biofuels, or finance mega-dams and waste incinerators. In the second row are the building contractors that provide the infrastructure for these energy mega-projects, as well as energy-intensive companies of the industries that profit from cheap fossil energy, such as chemical, paper, ceramics, cement, iron, steel, and aluminium. These industries create or accept poor, sometimes inhuman working conditions, cause environmental damage from which the local population suffers, and contribute significantly to global warming: A recent study has shown that 90 major corporations are responsible for 63 per cent of global emissions (see Table 3). The companies come almost exclusively from the fossil energy industry and produce oil, coal and gas, and the remaining seven are cement manufacturers. Fifty of them are private companies, including well-known oil companies such as Chevron, ExxonMobil, BP, and Royal Dutch Shell, and coal producers such as British Coal, Peabody Energy, and BHP Billiton. A further 31 companies are owned by the state, such as the Saudi Arabian company Saudi Aramco, the Russian company Gazprom, or the Norwegian company Statoil. Nine more are state-run companies, and mainly include coal producers in China, the countries of the former Soviet Union, North Korea, and Poland. And: It is mostly the same firms that own a large part of the world's existing fossil resources – and these will transform into emissions in the future through mining, processing, and use.

These results show very clearly that the fossil industry plays a central role in the current emission-intensive energy system. This is startling for two reasons: Firstly, this fact could bring new life into the blocked climate negotiations, in which it has until now primarily been a matter of the historical emissions debt of countries and governments. The ability to hold individual emitters accountable, directs the focus on new actors: It is no longer exclusively about rich versus poor countries, but also about producers and consumers, as well as about resource abundance or scarcity. This could lead to the respective companies and their exploitation behaviour being examined more closely. On the other hand, the results make abundantly clear the consequences of the increasing privatization and liberalization of energy markets. Investments in the energy sector and the provision of energy are not guided by the goal to provide clean and affordable energy for all, but are made in order to maximize profits. In consequence, the energy industry has become a difficult-to-control power player widely patronized by government elites.

This is particularly pronounced in the nuclear industry: The global energy industry recognized early on that nuclear power plants are expensive and cannot compete in a market economy with other power generators – and let the state pay the bills. In fact, there is hardly a power plant that is not configured and planned by state agencies, massively supported with state funds, and operated by state, parastatal corporations or corporations associated with the government. The world's largest producer of nuclear power, EDF of France, is 85 per cent owned by the state. The city of Tokyo has a 40 per cent stake in Tepco Group. The Enel Group, in which the Italian government is the majority shareholder, controls through its acquisition of the Spanish utility Endesa, the Spanish nuclear power plants. In addition, they planned together with EDF to build nuclear power plants in Italy, where none previously operated. The para-governmental nuclear industry is thus the opposite of a smart economy, and basically a remnant of an outdated industrial policy approach to the expensive mega-projects of the 1960s and 1970s (Netzer and Steinhilber 2011).

And also in the fossil industry, governments and political elites – especially in resource-rich countries – profit from the business with resources: Through taxation, production and profit-sharing contracts or intergovernmental agreements, they secure access to raw materials and maximum profits. Frequently, multinational gas or coal companies even enter into legally binding partnerships with the governments of resource-rich countries, which grant the governments a share of production and the companies involved special financial incentives (Friends of the Earth International 2013). Thereby, the cost/benefits works in both directions: Frequently, the energy industry supplies politics with donations, or politicians with posts after their career. In turn, political decisions are made in the interests of the energy companies, and energy company lobbyists are generously granted access to political decision-making circles. An absurd example in recent times was the UN climate negotiations in November 2013 in Warsaw, where the main sponsors included, in addition to the airline Emirates, the energy company Alstom, the steel group ArcelorMittal, and the oil company Lotos. The Polish government took advantage of its role as host to generously allow their business partners from the oil and coal industry access to the negotiations, and in addition jointly organized the parallel »International Coal & Climate Summit« with the World Coal Association. Government support of fossil fuels even goes so far as national development banks, such as the German Bank for Reconstruction (KfW), or international institutions, like the World Bank, for decades awarding large-scale export credit guarantees for nuclear power plants or investing in coal efficiency technologies, and thus further encouraging carbon lock-in. In some places, there are signs of a rethink: The World Bank, the European Investment Bank (EIB), as well as the USA and the UK have now renounced

Table 3: Top 20 Private Companies and State-owned Companies according to CO_2- und CH_4 Emissions (Authors' own compilation based on Heede 2013.)

	Companies	Emissions 2010 in megatonnes CO_2 equivalents	Accumulated emissions from 1854 to 2010 in megatonnes CO_2 equivalents	Share of global emissions from 1751 to 2010 as per centage
1.	Chevron, USA	423	51,096	3.52 %
2.	ExxonMobil, USA	655	46,672	3.22 %
3.	Saudi Aramco, Saudi Arabia	1,550	46,033	3.17 %
4.	BP, UK	554	35,837	2.47 %
5.	Gazprom, Russia	1,371	32,136	2.22 %
6.	Royal Dutch Shell, Netherlands	478	30,751	2.12 %
7.	National Iranian Oil	867	29,084	2.01 %
8.	Pemex, Mexico	602	20,025	1.38 %
9.	ConocoPhilipps, USA	359	16,866	1.16 %
10.	Petroleos de Venezuela	485	16,157	1.11 %
11.	Coal India	830	15,493	1.07 %
12.	Peabody Energy, USA	519	12,432	0.86 %
13.	Total, France	398	11,911	0.82 %
14.	PetroChina, China	614	10,564	0.73 %
15.	Kuwait Petroleum, Kuwait	323	10,503	0.73 %
16.	Abu Dhabi NOC, UAE	387	9,672	0.67 %
17.	Sonatrach, Algeria	386	9,263	0.64 %
18.	Consol Energy, USA	160	9,096	0.63 %
19.	BHP-Billiton, Australia	320	7,606	0.52%
20.	Anglo American, UK	242	7,242	0.50 %
	Top 20 Private companies and state-owned companies	11,523	428,439	29.54 %
	Top 40 Private companies and state-owned companies		546,767	37.70 %
	All 81 private companies and state-owned companies	18,524	602,491	41.54 %
	90 major emitters total	27,946	914,251	63.04 %
	Total global emissions	36,026	1,450,332	100.00 %

the financing of coal technologies, and the European Bank for Reconstruction and Development (EBRD) announced in December 2013 that they will henceforth only support coal power plants in rare and exceptional cases.

But the energy companies and their government and private supporters are not the only ones who belong to the guardians of the current energy system. Wealthy consumers from the Global North and, increasingly, a growing upper and middle class in the Global South – whose consumerist lifestyle is made possible by always existing and affordable energy – also help to keep the system alive. And last but not least, workers and trade unions in the fossil energy industry, in the nuclear industry, and in emission-intensive sectors are to a large extent prisoners of the current system. Frequently, resistance to change also comes from them, because an energy transformation will cost – at least in the medium term – jobs and prosperity in their industries. Amongst the most memorable examples in recent years is the case of the workers from the damaged nuclear power plant Fukushima Daiichi, who despite all of the risks still campaign for a preservation of nuclear power and their jobs. In a letter from the Japanese Union of Metalworkers IMF-JC in December 2011, some six months after the nuclear disaster in Japan, they wrote:

»Adding to the above, as trade union, we are also expressing our intention to fully cooperate to recover and restoration of the devastated area and urging the Japanese Government to make countermeasures to the adversely effects on employment.«

There is no doubt as to who the main beneficiaries of this system are and why the energy companies do everything possible so that they can continue to take raw materials from the ground at the expense of the climate. The preservation strategies also include – in addition to the influence on political elites – the financial support of climate-sceptical research institutes: A report by Greenpeace published in September 2013 shows that in the last ten years, energy companies have financed campaigns against climate change with several hundred million US dollars. These donations were either concealed by specially established foundations, such as The Donors Trust and its associated Donors Capital Fund, or made openly as in the case of the oil barons Charles and David Koch of Koch Industries or the energy giant ExxonMobil (Greenpeace 2013).

If one looks at the winners and losers in the current system, it is clear that the road to a global energy transformation involves a shift of market share and ownership structures: In a centralized energy structure focused on fossil fuels, a few owners control the market. A decentralized energy structure based on renewable energy sources, however, brings with it a large number of private owners. In Germany, for example, only 4.9 per cent of renewable energy capacity in 2012 was in the hands of the four big power companies, the rest was distributed among private owners.[5] Thus, an energy transformation also means a reversal of power structures – without a doubt a contentious and long-term task. The line of conflict in this case runs between two apparently contradictory goals: the preservation of fossil fuel capitalism and the preservation of our planet, behind which a much less powerful lobby is united than behind the energy companies. Nevertheless, the climate protection movement is growing and more boldly addressing the profiteers of the system. Examples are groups like the climate grassroots movement 350.org, whose founder Bill McKibben says:

»We need to view the fossil-fuel industry in a new light. It has become a rogue industry, reckless like no other force on Earth. It is Public Enemy Number One to the survival of our planetary civilization.« (Weinrub 2012)

A Global Energy Transformation – How Do We Approach It?

Given the immense resistance of powerful stakeholders, but also the involvement of politicians and large segments of society, the question arises as to whether we have enough energy for the revolution. An energy revolution is therefore also an enormous task because two parallel challenges have to be addressed: The first is the opposition to the current energy system, as well as to new and extreme forms of energy production such as deep-sea drilling, drilling in the Arctic, tar sands extraction, and hydraulic fracturing. In addition, subsidies for fossil fuels must be combated, and emissions regulated and limited – for example, by the introduction of CO_2 taxes. While this opposition must be strengthened and expanded, at the same time the question must be answered: What could the alternative to the fossil, export-oriented, and growth-fixated economic system look like? The transition to a complete supply with renewable energy is an important part of the solution, because the energy sector is responsible for the largest share of global greenhouse gas emissions and all of the other sectors of the economy depend on the energy supply. Nevertheless, the climate crisis can only be solved if other economic sectors – such as industrial production, the building and transport sectors, and agriculture – are also organized with significantly less CO_2 emissions. And a truly sustainable transformation can only succeed if it is connected to a paradigm shift to a new economic model.

5. Individuals 34.9 per cent; commercial 14.4 per cent; project planners 13.8 per cent; funds/banks 12.5 per cent; farmers 11.2 per cent; other energy supply companies (utilities) 3.5 per cent; international utilities 2.2 per cent; regional producers 1.3 per cent; other 1 per cent; contracting companies 0.2 per cent (trend research 2013).

When discussing alternatives, there are two basic strategies on how to deal with the global energy, economic, and climate crises. They are indeed ideal-typical, but they lead the way quite differently also in reality:

The first can be described as a decarbonized growth strategy, which backs increasingly decoupling the current economic system from the use of carbon-based fuels. This means that although fossil fuels are replaced by renewable energy sources, at the same time the current growth course is maintained or even accelerated. This strategy aims to reduce CO_2 emissions in response to the climate crisis, but not to change the political and economic structures. Therefore, the advocates of this strategy support also maintaining the principle of centralized supply for renewable energy. Accordingly, they advocate centralized renewable energy structures, such as remote solar plants in the desert or outsourced wind farms. Although these are indeed renewable, they do not limit energy consumption to locally required capacities, but extend it to long transport routes. Renewable or not: A centralized energy supply remains an instrument of power retention, and supports – through the centralization of control and wealth creation – the continuation of a global economic system that destroys our environment and thus threatens our survival.

The second strategy places the principle of energy, economic, and climate justice at the centre and aims to build new economically and environmentally compatible structures. The focus is on the model of a decentralized supply with renewable energies. Furthermore, this strategy is based on a triad of decentralized power generation, demand reduction, and balancing of supply and demand. Important fundamentals of this approach are first, that the electricity is produced close to the point where it is also used, so that the distribution over power lines is not necessary. Second, efficiency technologies and reduced demand should ensure savings. And third, storage and load management technologies should be further developed to balance supply and demand. Thereby, the decentralized energy supply is independently managed by the respective communities and is under the democratic control of local initiatives.

Alone for practical reasons, it is not useful to promote both models simultaneously: On the one hand, the expansion of the current unilateral infrastructure for power transmission is not suitable for supporting a decentralized model and its required reciprocal energy and information flow. And on the other hand, further investments in the centralized power structure hinder the development of decentralized energy resources (Weinrub 2012).

In recent years, the conflict between these two strategies has manifested itself in a veritable proliferation of new concepts. Above all, various Green New Deal approaches, which are clearly unique to the first strategy, increasingly threaten replacing the much more comprehensive vision of sustainable development. With this approach, however, the underlying problem of an outdated economic system is not solved. We need an energy transformation that follows the second strategy and places economic and climate justice at the centre. At the same time, no approach will be completely viable in reality. It is therefore important to choose a clever combination of both approaches, which also depends on the local context.

Broad Alliances for a Global Energy Transformation

Implementing a global energy transformation requires stakeholders that initialize and support it, even against resistances. Reforming the current energy system represents one of the most difficult challenges facing the world. There are already many social movements fighting for a just and sustainable energy system. For them to be successful, there has to be a continuous debate between activists, science, and politics about what the world in which we want to live should look like. It is also vital to oppose the interests of profiteers and regain democratic control over decisions regarding our energy systems. If this fails, the existing movements are left with only small exceptions. Therefore, we must continuously build on a shared vision and strategy for an energy transformation, and include everyone who has an interest in abolishing the current unjust and exploitative energy system. This includes affected local communities, indigenous groups without access to energy, energy consumers, workers from the energy industry, environmental activists, scientists, politicians, and experts. Together, we can create an energy system that is equitable and sustainable, respects the rights and different life styles of different communities around the world, and secures the fundamental right to energy for all.

2. The Status of the Energy Transformation – Examples of Transformative Processes

Jan Burck, Boris Schinke, Franziska Marten, Lukas Hermwille and Christiane Beuermann

In many countries, cities, regions, and households, the beginnings of a transformation of energy systems can be seen. However, transformation projects that involve all areas of the state, society, and economy are rare. A comprehensive energy transformation means that the development of renewable energy sources is simultaneously accompanied by a shift away from fossil fuels and nuclear energy, as well as the promotion of increased efficiency and a reduction in absolute energy consumption. An extensive energy transformation also means a social paradigm shift that goes much deeper than simply switching to alternative energy sources. The premise is that societies worldwide adapt to a new model of global development – with the result that the political and social leaders actively orient themselves on this model and thereby legitimize it.

In this chapter, three examples of countries that have set the process of energy transformation in motion are presented in the form of short case studies. The selection and evaluation of country processes was based on a number of criteria, which are discussed in the following introduction.

2.1 Criteria for an Energy Transformation

The selection of example countries was initially guided by the question of whether transformative processes were, in fact, set in motion in the respective countries. However, what does »transformation« mean?

»*A transition is radical, structural change of a societal (sub) system that is the result of a co-evolution of economic, cultural, technological, ecological and institutional developments at different scale-levels.*« (Grin, Rotmans, and Schot 2010: 108, quoted from Rotmans 2001)

»*We define a transition as a fundamental change in structure, culture and practices. (...) Our notion of structure should be understood broadly, including physical infrastructure (physical stocks and flows), economic infrastructure (market, consumption, production), and institutions (rules, regulations collective actors such as organizations, and individual actors). Structure is recursive: it is both the result and means of acting.*« (Grin, Rotmans and Schot 2010: 109)

All transformative processes are based on a paradigm shift, which includes a fundamentally new orientation of the economy and society on a new model and requires a departure from previously dominant patterns of behaviour. With regard to the energy transformation, this means, for example, the long-term shift away from fossil or nuclear fuels or a primarily central energy supply, and the establishment of decentralized structures with participatory processes that lead to a change in user behaviour. It should be noted that not all renewable energies correspond to a comprehensive understanding of sustainability, such as industrially produced biofuels and hydroelectric mega-dams.

In the rarest of cases, a transformation will happen on its own. It is designed change – not a product of coincidence, but an undertaking of society as a whole.

Whether transformative processes are involved in this sense is evaluated according to the criteria proposed in the following.

The Vision

A (successful) energy transformation can theoretically take very different forms, because any long-term, fundamental reorientation of the energy system is understood as a transformation. Central, however, is the question: transformation to what? If it is approached as a challenge for society as a whole, this must take place on the basis of a common vision. To first enable designed change in this sense, a common goal is essential. Therefore, one criterion for the selection of countries was the extent to which a vision for the goal of energy transformation exists.

This does not mean that this goal is supported by a comprehensive social consensus, or that the stakeholders have to be in agreement on the optimal route to this goal. In addition, there will hardly be any country where a shared vision is clearly described and differentiated. It is necessary, however, that a critical mass of stakeholders agrees on the direction in which they want to promote the energy transformation of their country.

The vision can manifest itself, for example, in the form of official policy documents or laws, civil society demands, or voter preferences. But this is not necessarily the case. Where appropriate, this vision exists only in the form of a diffuse common idea.

Energy Transformation on the Political Agenda

As described above, transformation processes are not self-perpetuating. Thus, it may be that they limit – particularly in an early phase – to sections of the society and economy of a country. However, the aim of this chapter is to introduce processes that are established as broadly as possible. For the selection of countries, therefore, the leading question was whether and at what point the theme of »energy transformation« arrived on the political agenda. A country in which the issues of energy transformation are discussed at the level of heads of state or government and this significantly influences the direction of development is, as a rule, already further immersed in the transformation process than a country in which these topics are only handled in a sub-division of the energy or environment ministry.

Social Dialogue

Closely related to the question of a comprehensive transformation process is the criterion of social dialogue. Is the subject publicly discussed? Central to this is civil society, with all its stakeholders from arts, media, science, NGOs, trade unions, and churches, but also economic stakeholders. A country in which the issues of energy transformation are only discussed by small elites and in tight circles, is still far from confronting the problem as a societal challenge. Although this aspect seems particularly important to us, it could only be considered very rudimentarily in the case studies, because too little information is available.

Redirecting Investment

An energy transformation that is driven purely verbally, does not meet the criteria. Implementing investments in energy infrastructure is a particularly lengthy process – many years usually elapse from the first plans to the completion of a power plant. On the other hand, such investments are also extremely durable, and create or strengthen possible path dependencies that complicate an energy transformation. It is therefore necessary that investment be diverted – or realigned – in the direction of renewable energy as quickly and comprehensively as possible.

This criterion has to be applied in consideration of the respective national contexts. In countries where there was previously hardly any energy infrastructure, where most people are still excluded from the public power supply, different standards are certainly to be applied than in industrialized countries. In the former case, it is useful to first develop strategies for sustainable electrification; in industrialized countries, it is primarily important that investment in fossil fuels is not forthcoming. If the freed resources are then invested in renewable energy, a next step in the transformation process has been accomplished.

2.2 Case Studies

The consequences of climate change and widespread energy poverty are pressing problems in many countries. At the same time, it can be observed – particularly in relation to climate change – that many countries are promoting climate protection measures on the national level on a much larger scale than they are committing to at the international level. Thus, alliances between leading states in which transformative processes have already begun will play an increasingly important role in the long term. In many states, these processes focus primarily on the energy sector, and in particular on electricity. In the long term, countries benefit from a switch to renewable energy, and they can also distinguish themselves as pioneers. A switch to clean energy sources is very effective for fighting climate protection, since CO_2 emissions from the power sector cause a large part of the total greenhouse gas emissions.

With three examples, it will be made clear in what follows that a transformation of the energy sector is possible and advantageous in all socio-economic development stages of a country, and the expansion of renewable energy is compatible with national development goals.

Among others, the Climate Change Performance Index (CCPI), which was developed by Germanwatch and the Climate Action Network Europe and annually rates leading states in climate protection, served as the basis for the selection of countries discussed below (Burck et al. 2013). Crucial calculation bases of the index are emissions in the electricity sector, as well as the development of the share of renewable energies and energy efficiency in the countries. In order to show that an environmentally and climate-friendly energy supply is possible at all times, the choice fell on three countries in very different stages of development: Ethiopia, Morocco, and Germany.

As a less developed African country with a comparatively young energy sector, Ethiopia is at the beginning of its economic development. The example shows that the establishment of a clean energy sector from the beginning represents a major opportunity for developing countries. Although larger investment amounts are needed for this, there are still no fixed structures that have to be rebuilt. In addition, the positive social side effects contribute to poverty reduction.

Morocco, however, is at a crossroads. Through energy imports, the country's energy mix thus far consists primarily of coal and oil. At the same time, the country is investing heavily in the expansion of renewable energy and has ambitious goals. For several years, Morocco has done well in the climate index rankings, and in 2014 received for the first time the title »Good Climate Protection«, mainly because the current energy policy has been rated positive, which after a few years is also reflected in the emissions data. Thus, Morocco is about to become a model in the Arab region. A consideration of this country can illustrate how beneficial it is to introduce transformation processes early on.

Germany is considered an example for all industrialized countries: It shows that even with historically grown and thus socially deep-rooted energy systems, transformation processes can be set in motion if the political will and the support of the population exist. Due to the double objective – nuclear phaseout and an ambitious expansion of renewable energies – the plans for the agreed »energy revolution« are unique worldwide. This is why the country's conversion is under global observation. The switch of a highly developed, and currently heavily industrialized country, to energy from renewable sources is a lengthy process in which existing structures would have to be broken up and changed, which in principle would meet with strong resistance. Therefore, convincing alternatives must be created; environmental compatibility, security of supply, and profitability should not be disregarded in the transformation of the energy system. These difficulties are illustrated very clearly in the current political debate in Germany. Through the faltering implementation of the »*Energiewende*« and the resulting poorer policy evaluation, Germany lost ground in the CCPI 2014 and fell out of the Top Ten in the rankings for the first time in nine years. Key performance indicators of the case study countries are summarized in Table 4.

2.2.1 Ethiopia

Ethiopia has been selected as the first pioneering country in terms of transformative processes in the energy sector, although the term »transformative« at this point is rather misleading, since it is one of the least-developed energy sectors worldwide. The underdeveloped energy supply, especially in rural areas, is an indicator of the country's poverty. Nevertheless, Ethiopia is a noteworthy example of an energy transformation, because the country has decided to build its economic growth from the beginning on sustainable energy. In the sense of the leapfrogging approach, the developing country wants to forgo the traditional fossil development path and rely – at least in the electricity sector – solely on renewable energies in the future. With the help of these inexhaustible resources, Ethiopia wants to achieve an economic upswing. Thus, the country is a model for other developing countries on their way to sustainable development, and for international climate protection.

Socio-economic Background

Ethiopia's 84 million people live in about 18 million households. They are represented by a democratically elected, broad coalition of different political parties, which have their origin mainly in the country's socialist revolution. Apart from the government representatives, there are only two more oppositional representatives in parliament. The country's president has no executive function, which is why the Prime Minister is of great importance (Foreign Office 2013). The population, already two-thirds of which is not older than 25 years old, is growing steadily by an average of 2.6 per cent. Over 80 per cent live in rural areas, 66 per cent in the high plains of the country. Some of the cities have a

Table 4: Ethiopia, Morocco, and Germany in comparison (adapted from UNDP 2013 and IEA 2013a[6])

	Ethiopia	**Morocco**	**Germany**
Area [km^2]	1,104,300	446,550	357,022
Population	91,195,675	32,309,239	81,305,856
Population growth [%]	2.9	1.05	-0.2
GDP [USD]	103,100,000,000	171,000,000,000	3,123,000,000,000
GDP per capita [USD]	1,100	5,100	38,100
Growth [%]	7.5	4.9	3.1
Human Development Index (HDI) Ranking (of 187)	173	130	5
Energy Mix 2011 [GWh]:			
Coal and peat	0	11,679	271,865
Oil	33	6,578	6,608
Gas	0	4,051	83,630
Nuclear energy	0	0	107,971
Hydropower	5,109	2,005	23,514
Wind energy	0	692	48,883
Solar PV	0	0	19,340
Solar thermal energy	0	0[7]	0
Other RE	0	0	32,868
Other	0	0	13,986
Total	**5,161**	**25,005**	**608,665**
Electricity consumption per capita [kWh/year]	60	826.4[8]	
CO2 Emissions per capita [tCO_2eq]	0.07	1.55	9.14
Solar energy potential [$kWh/m^2/year$]	1,920	2,300	1,055
Wind energy potential [MW]	10,000	6,000	

relatively well-developed infrastructure and are interconnected; outside of the cities, however, some areas are difficult to access. Ethiopia generates around 41 per cent of its gross domestic product through agriculture. Climatically, the country consists of a wide variety of zones: in addition to the rather cool and humid plateaus, where the bulk of the population lives, are the lowlands, which make up about two-thirds of Ethiopia and are characterized by a very warm, sometimes damp, sometimes dry climate (ERG 2012). Ethiopia is particularly affected by climate change through the increasing dangers of extreme weather events, such as droughts and floods (Grebmer et al. 2013).

The early preference for renewable energy and the exclusion of conventional industrialization could help provide Ethiopia with decisive advantages in the future. Providing the population access to electricity, as well as the development and climate protection goals should thus be achieved together.

6. For the sake of comparability, the data used in this table for the energy mix, as well as CO_2 emissions per capita and electricity consumption per capita of the countries are taken from the databases of the United Nations Development Programme (UNDP) and the IEA, and are thus from 2011. However, in the texts of the individual countries, in some cases more recent data from different sources are used.

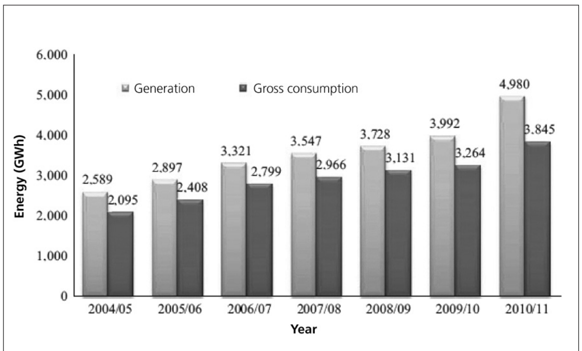
7. Some major projects in the field of solar thermal power generation are currently in the planning and construction process. Existing pilot projects are not listed in the IEA statistics (see the case study of Morocco).

8. Trading Economics (2013).

The Energy and Power Sector

Corresponding to the level of economic development in the country, Ethiopia's energy sector is still largely underdeveloped; the country consumed a total of only 361.4 TWh of energy in 2010 (ERG 2012). 92 per cent was obtained from biomass and 7 per cent from fossil fuels. The annualized per capita consumption of these resources was 960 kg biomass and 25 kg Petroleum (ERG 2012).

Figure 1: Energy Production and Gross Energy Consumption 2004 to 2011 (based on Asress et al. 2013)

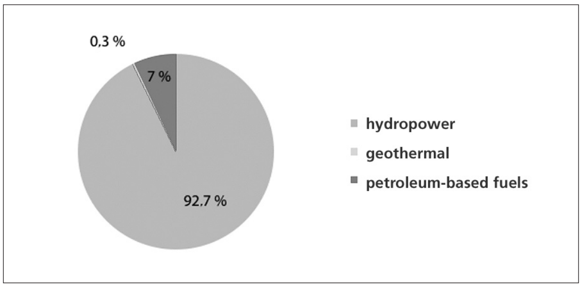


In 2010, electricity accounted for only 1 per cent of the total energy used. Since the country has no large manufacturing industry, building and service sector are the main consumers of the electricity produced. The country's poverty is embodied in a glaring shortage of electrical energy. The per capita consumption of electricity in 2010 was only 40 kWh/year, the German per capita average was 6,648 kWh/year in 2011 (ERG 2012). Although this rose a year later to 60 kWh in Ethiopia, this figure is also clearly in the area of energy poverty, which is defined as an annual per capita consumption of less than 500 to 1,000 kWh (Asress et al. 2013).[9]

The electricity fed into the grid is produced almost exclusively by large hydropower plants; in 2011, the share of electricity produced in eleven hydropower plants accounted for 92.7 per cent (ERG 2012); a geothermal power plant generates a fraction of the produced electrical energy (0.3 per cent). Only 7 per cent of the electricity in 2011 came from non-renewable resources; they were produced by diesel power stations and generators.

9. Such an energy poverty line describes an average value, and therefore does not make any statements about the distribution of energy consumption within the country.

Figure 2: Share of Different Energy Sources in the Energy Mix in Ethiopia 2011 (based on ERG 2012)



Ethiopian Electric Power Corporation (EEPCo), which was founded in 1997, is responsible for both the production and distribution of electricity, and their total installed capacity in 2012 was about 2,000 MW (see Table 5). Since the end of 2012, installed wind power plants have fed an additional 52 MW of electricity into the Ethiopian grid (Asress et al. 2013). The company sold 4,980 GWh of electricity in 2013, mostly to private customers (Asress et al. 2013).

Table 5: EEPCo capacity 2012 (based on Asress et al. 2013)

Capacities	[Unit]	Amount
Installed capacity of power plants	[MW]	2,000
Annual Energy Production	[GWh]	4980.08
Gross Consumption	[GWh]	3844.87
Length of Distribution Network	[km]	138,838
Number of Customers	[Million]	1.9
Electricity Access Rate	[%]	46

Despite pervasive energy poverty and other development issues, the current edition of the Global Hunger Index certifies a positive trend in the country, because some progress could be registered in the area of poverty reduction (Grebmer et al. 2013). The country's gradual development is illustrated, among others, by an increasing demand for electrical energy. This has increased in the past five years an average of 25 per cent per year (ERG 2012 according to EEPCo). Growth over the next five years is estimated to rise to 32 per cent annually. Thus, an installed capacity of 10,000 MW would be needed to meet demand in 2015. This would correspond to a fivefold increase in installed capacity in just three years, and accordingly there are more and more large-scale power generation projects in the realization phase. In 2013, there were 15 hydroelectric power plants in operation, and other major projects are in the planning stage (EEPCo 2014a). The Government reserves the right to implement large-scale projects for energy itself, whereas private investors are only permitted the construction of small power plants up to a capacity of 25 MW. Dams and hydroelectric power plants are the only exceptions here (Asress et al. 2013).

Despite the increasing demand and the positive developments, severe poverty continues to prevail, the extent of which can be found in conflicting statistics. Asress et al. (2013) assume that meanwhile, almost half[10] of the Ethiopian population has electricity, other authors give lower rates. Electrical connection is not affordable for many households in the population, even if in theory access to the network exists. With government subsidies, the price of 1 kWh of electricity is 0.042 US dollars (Asress et al. 2013). Thus, the majority of the Ethiopian population still relies on biomass or fossil fuels in the form of fuel-powered generators for lighting (ERG 2012). Nevertheless, the figure for CO_2 emissions per capita of the average Ethiopian is negligible; the figure in 2011 was 0.07 tCO_2. For comparison, a German emitted about 9.14 tCO_2 per year.

Since the 1980s, alongside the development of the network structure in individual regions, off-grid systems with electricity produced by using photovoltaic (PV) or smaller diesel power have also been installed. These micro-systems primarily produced light in residential and public buildings, such as schools. This includes, for example, a power supply network established in 1985, which served approximately 300 households, and the water pump and mill of a village that initially supplied 10.5 kW and has now expanded to 30 kW (ERG 2012). According to estimates, there are about 5.3 MW in the form of PV systems currently installed in Ethiopia (ERG 2012). Today, the off-grid electricity used accounts for about 1.8 per cent of the total amount (Asress et al. 2013). 87 per cent of this power is used as an off-grid power source for mobile and telecommunications systems, which makes this industry a major player in the Ethiopian electricity market (ERG 2012). According to government plans, it should continue to receive full access to the electricity market in the future (ERG 2012). Furthermore, 30,000 households owe their electrification to PV systems; public facilities such as hospitals, schools, and water pumps also benefit from this technology (ERG 2012). The financing of PV systems has traditionally been accomplished mainly through project funds provided by NGOs and the government; in the future, however, these are intended to be combined with market-based approaches and a further focus placed on training local experts to ensure that the technology can establish itself on the market in the long term (ERG 2012). However, the government's plans to ensure that all Ethiopians have universal access to the electricity grid by 2015 are paralyzing private stakeholders' willingness to invest in the off-grid system, which will then no longer be necessary (Asress et al. 2013)

10.On the degree of the Ethiopian population's level of electricity, there is very different information in current sources, ranging from around 20 to 83 per cent.

Ethiopia's Vision

The Ethiopian government's most important development objective is economic growth; the most rapidly emerging country in sub-Sahara is targeting 11 per cent growth per year by 2015. Industry is even predicted to grow 20 per cent annually. Since industrialization inevitably impacts on energy consumption, the development of a secure energy infrastructure is a high priority, and so 40 per cent of all government investment flows into projects such as the network expansion. Transmission and distribution networks should thereby be doubled in their scope. The government's electrification plans are ambitious: By 2015, the number of actual electricity consumers is expected to double, and by 2020 even quadruple (ERG 2012).

The potential of renewable energy in Ethiopia is large (Table 6). According to estimates, in the already quite extensively developed hydropower sector, it accounts for an additional 45 GW, and in geothermal energy estimates are 5 GW. The wind energy potential has long been unclear, which paralyzed the development of wind power, but according to the latest results of a wind mapping, the potential electricity from wind power is about 10 GW. The Ethiopian sun provides enormous options: Approximately 1,920 kWh/m^2/year yield possibly 10^6 GW of power in the solar energy sector; in Morocco, it is even a bit more; in Germany, on the other hand, it is about half of Ethiopia's potential in the annual average (Asress et al. 2013, Mazengia 2010).

Table 6: Potential of Energy Resources in Ethiopia

Resource	[Unit]	Exploitable Potential
Biomass	[Million metric ton/year]	75
Hydropower	[MW]	45,000
Solar	[kWh/m²/day]	5–6
Wind	[MW]	10,000
Geothermal	[MW]	5000
Natural Gas	[billion m³]	113
Coal	[million toe]	400

Based on the indicated needs, the government decided in 2010 on a five-year plan for the future energy generation (Table 7). Thus, the total installed capacity (from then 2,000 MW) should be expanded to 8,000 MW (ERG 2012). In addition supplying their own population, Ethiopia is also planning – through the development of renewable energy – the export of electricity to neighboring countries (Asress et al. 2013).

Table 7: Objectives of the Ethiopian Government's Five-year Plan

	[Unit]	Base – 2010	Target – 2015
Installed Power	[MW]	2,000	8,000
Distribution Lines	[km]	126,038	258,038
Transmission Lines	[km]	11,537	17,053
Customers	[million]	2.0	4.0

In addition, the energy mix should be diversified. The government's five-year plan envisages supplementing the electricity mostly produced from hydropower until now, with 1,116 MW of electricity from eight new wind farms. Wind energy, hitherto used more in the water supply sector, thus becomes the second most important source of power for Ethiopia (Asress et al. 2013). Above all, solar energy represents an important source for off-grid solutions. The Five-Year Plan (Table 8) aims to install at least three million »solar home systems« in rural areas (ERG 2012). Despite the immense potential of energy generation through solar power, the necessary technology is still too expensive for the country to promote them in extensive large-scale projects.

Table 8: Objectives of the Five-Year Plan regarding Solar Energy Systems (based on Asress et al. 2013)

	[Unit]	Base – 2010	Target – 2015
Off-grid Power:			
Solar home and institutional systems	No. [million]	< 0.02	0.15
Solar lanterns	No. [million]	< 0.02	3.0
Other Energy programs:			
Solar thermal systems (cookers, heaters)	No.	NA	13,500
Liquid biofuel production	Liters [million]	7.0	1,630
Clean cook stoves	No. [million]	7.0	16.0

In the area of energy efficiency, the EEPCo plans by 2015 to reduce the serious losses that occur in the distribution of electricity to households, from the current 20 per cent to an international average of 13.5 per cent (Asress et al. 2013).

Developments and Prospects

Implementation

To implement their own development, renewable energy, and climate goals, concrete plans have been adopted since 2010, such as the above-mentioned five-year plan, the »Growth and Transformation Plan« (GTP). A detailed supplement to the GTP is the »Energy Sector Strategic Plan«, which also refers to the years 2011 to 2015. It contains, among other things, the objectives for the expansion plans of grid and off-grid electricity. In addition, the Ethiopian parliament adopted the »Strategic Plan of the Ministry of Water and Energy« and the »Climate Resilient Green Economy Strategy«, both from 2011 (ERG 2012).

The development of renewable energy was, as well as in Morocco, initiated by the state and is a top-down process. The main actors in the electricity market, in addition to customers, are state agencies and the projects accordingly large. Smaller projects are supported in some regions, primarily in the context of off-grid solutions.

The record in recent years is mixed. The necessary requirements for the increase in installed capacity were quickly realised, and the number of electricity consumers rose rapidly between 2004 and 2010; since the commencement of the five-year plan, however, progress has only been gradual (ERG 2012). Reasons for this include challenges in connecting the rural population to the power grid. In addition, the number of households is increasing faster than the electrification progress, which poses further difficulties for the government (ERG 2012).

Current Projects

Ethiopia is also banking on hydroelectric power in the future, and the EEPCo is thus currently planning three large hydropower plants. The Grand Ethiopian Renaissance Dam Project (GERDP) on the Blue Nile River is the largest of the projects with 6,000 MW. The annual production is expected to amount to 15,692 GWh. The second largest, the Gibe III Hydroelectric power plant with its 1,870 MW annually, should contribute around 6,500 GWh to the country's electricity mix (EEPCo 2014b). At the same time, the major projects are an economic engine for the corresponding regions. Alone in the construction of the Genalle Dawa III power plant, one of the medium-scale projects, 2,400 Ethiopian workers should find employment. Four of the eight planned wind farms are currently under construction. In addition to water and wind power, Ethiopia continues to push geothermal electricity production and has released two test fields for its expansion, both made with a planned 70 MW, for which already extensive studies have been made. However, apart from the positive effects – such as economic growth and employment – precisely the mega-hydropower projects must be seen critically. First, the resulting jobs – primarily in the construction sector – are not necessarily those with a long-term impact on employment and good working conditions. Second, projects such as the Gibe III power plant change the natural life cycle of the Omo River and threaten the livelihoods of the people living along and from the river, who are not sufficiently involved in the planning of such large projects.

Prospects

According to EEPCo, in addition to the five-year plan, it is Ethiopia's stated aim to make the entire power production CO_2 free by 2025. The government is making billions in investments to develop their land into Africa's largest electricity exporter; contracts already exist with Djibouti, Sudan, and Kenya. So far, Ethiopia has received financial support from the World Bank; in the long term, however, the country increasingly hopes for involvement from the private sector. For that reason, the Ethiopian Electric Agency (EEA) submitted an application for feed-in tariff scheme to the Ministry of Water and Energy (MoWE) to be submitted to the Council of Ministers. Critics complain, however, that the rates prescribed therein were too low and took no investment costs into consideration. Neighbouring countries would have attractive conditions for investors (Asress et al. 2013). Also grants from those earmarked in the Kyoto Protocol's Clean Development Mechanism (CDM) for the reduction of greenhouse gas emissions could be interesting for investors. But because the CDM emission reductions are calculated on the basis of the electricity sector, which in Ethiopia has a low emissions factor on the whole – because the majority of energy comes from hydropower – the CO_2 reduction potential is relatively low. However, to win investors and consolidate Ethiopia's full potential, MoWE is currently working on a national energy mapping (ibid.).

2.2.2 Morocco

As a country that stands at the crossroads of its development, Morocco offers a particularly exciting example to illustrate the benefits of an early transformation of the energy sector.

In the Climate Change Performance Index 2014, Morocco is ranked 15 and leads the group of moderately performing countries. In the area of renewable energy, Morocco still has some catching up to do; the share of renewable energy in the Moroccan energy mix is currently low, however, the country is steadily gaining ground in its development. In the current issue of the Arab Future Energy Index (AFEX), which is published annually by the Regional Center for Renewable Energy and Energy Efficiency (RCREEE), Morocco occupied first place (Samborsky et al. 2013).

Socio-economic Background

Although not to the same extent as in Ethiopia, development and poverty reduction are still high on the political agenda in Morocco. With a gross domestic product

(GDP) of 171 billion US dollars overall and 5,100 US dollars per capita as well as an annual growth rate of 4.9 per cent, the emerging country occupies position 130 (of 187) in the Human Development Index (HDI). The unemployment rate is 8.9 per cent and displays, like the distribution of wealth, a wide gap between urban and rural populations. Increasingly larger proportions of the rural population are seeking a better future in the cities. Moroccan rural areas, in particular, already suffer from water scarcity, progressing desertification, and climatic fluctuations; the effects of climate change could significantly intensify these difficulties.

Their vulnerability with regard to the consequences of climate change and the positive social effects of a low-emission development are the driving forces behind Morocco's ambitious goals in the area of renewable energy. Some of the projects are declared to be Nationally Appropriate Mitigation Actions (NAMAs) under the UN Framework Convention on Climate Change (UNFCCC) and are financially supported. In the country's constitutional monarchy, the royal family is highly regarded, and the decisions of King Mohammed VI are generally accepted. Thus, he is primarily driving the Moroccan energy transformation.

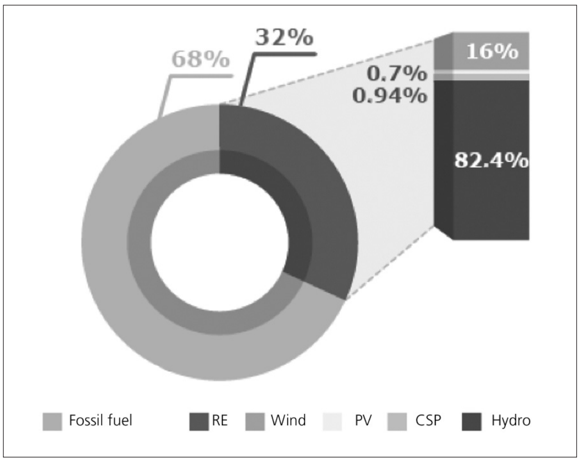
The Energy and Electricity Sector

Morocco derives nearly 97 per cent of its energy needs from abroad, making the country the largest energy importer in northern Africa. Energy consumption is increasing steadily; in the decade between 2002 and 2011, with an annual growth rate of 5.7 per cent, the growth in power consumption was 7 per cent (Cîrlig 2013). The per capita consumption in 2011, however, was less than one-third of the global average. Through the implementation of a plan for the electrification of rural areas (*Programme d'Electrification Rurale Global*, PERG), 97.4 per cent of the regions meanwhile have access to an electricity network; in 1995, it was still about 18 per cent (Cîrlig 2013). The Moroccan network is connected to its neighbors Algeria and thereby also with Tunisia. Morocco is also the only African country with a connection to the European electricity grid, across the Strait of Gibraltar. Within the country, the network is being expanded in the north; in the south, however, there are still adjustment requirements, primarily to the new challenges posed by the fluctuating feed-in of electricity from renewable sources (de Visser et al. 2013).

While petroleum-based raw materials make up the majority (62.9 per cent) of the Moroccan energy mix, only 4 per cent comes from renewable energy sources and 3 per cent from hydropower (IEA 2013A). The partially intensive use of biomass for energy, particularly in rural areas of Morocco, is not included in the calculation of the energy mix of the International Energy Agency. The main energy-related CO_2 emissions in the country amounted to 50.16 megatonnes in 2011.

The country consumed 31,056 GWh of electrical energy in 2012. The country's energy mix is based mainly on the raw materials coal and peat. Oil ranks second, while renewable energy makes up a share of 10 per cent (IEA 2013A, BMCE 2013). If one considers the installed total output of the kingdom, the share of renewable energy increases (Figure 3): it was 32 per cent in 2012, of which 82.4 per cent was still covered by electricity from hydropower, 16 per cent from wind power, and 1.64 per cent from solar energy (Samborsky et al. 2013).

Figure 3: Morocco's Renewable Energy Mix 2012 (RCREEE 2013)



A national utility, the *Office National de l'Electricité et de l'Eau Potable* (ONEE), is responsible for production and distribution. The utility is the main actor in rural areas. In some of the larger cities, electricity is distributed by private companies. However, the sole network operator remains ONEE (BMCE 2013). Moreover, Morocco's energy transformation is regulated top-down. It was decided by the government, and relevant institutions have been set up to implement it.

To further promote renewable energy, the Moroccan government guarantees private producers access to the grid by law (Bryden et al. 2013). The conditions, however, are negotiated on a project basis with the *Office National de l'Electricité et de l'Eau Potable* (ONEE). As a result, there is great uncertainty in the preliminary stages about the accruing connection fees, and the utility is so far the only buyer (de Visser 2013).

In addition to the connection to the general grid, the programme also provides for the establishment of individual island solutions based on renewable energy, such as photovoltaics. By 2008, 44,719 houses in 3,163 villages were equipped with their own PV modules (FEMISE undated). In 2010, PV accounted for a 2.6 per cent share of domestic electricity consumption; in villages, even 10 per cent (Bryden et al. 2013). To date, approximately 15 MW capacity has been installed in the area of photovoltaics (FEMISE undated).

In the heat generation sector, Morocco launched the PROMASOL programme, with whose assistance, 240,000 m² of small solar thermal systems had been installed by 2008. The goal for 2020 is to increase this figure to 1.7 million m², whereby the country is progressing well (Bryden et al. 2013); the installed capacity of solar thermal systems amounts to 0.24 GWth on 340,000 m² (Bryden et al. 2013).

Morocco's Vision

»Morocco has decided to take a long-term view and support the development of a clean energy industry. (…) For Morocco, the switch from being North Africa's largest energy importer to the region's first exporter of green energy is well under way.« (Altmann 2012)

To live up to its role as a leader of the Arab states, Morocco has initiated – with the expansion of clean power generation – long-term development steps, which should lead the country, according to the vision, towards sustainable prosperity by 2020. The dependence on energy imports from neighbouring states is the most important driving force behind the country's ambitious renewable energy targets. Morocco's great potential in this area is intended to be used and their industry capacity built up. Thus, the state wants to become an exporter itself in the long run.

By 2020, 42 per cent (6,000 MW) of the country's total installed capacity should come from renewable sources. This increase is to be fed by 14 per cent each (2,000 MW) from hydro, wind, and solar energy. This 6 GW installed capacity will produce about 18 TWh of electricity per year, which would cover 20 per cent of energy consumption.

Table 9: Objectives of the National Energy Strategy [per cent of total installed capacity].
(Cîrlig 2013 based on MOEWE)

	2009	2015	2020
Coal	29 %	35 %	27 %
Oil	27 %	19 %	10 %
Gas	11 %	8 %	21 %
Hydropower	29 %	21 %	14 %
Solar	0 %	5 %	14 %
Wind power	4 %	12 %	14 %

The country's potential, both in the field of wind energy as well as solar energy, is large. Morocco could produce 1,500 times more power than it needs for its own use (Altmann 2012). According to the European Parliament, the production of 2,300 kWh/m² would be a realistic parameter under Moroccan conditions (Cîrlig 2013). In the field of wind energy, the installation of up to 6,000 MW would be conceivable, and also offshore projects in the 1835-km-long coastline would represent an opportunity (FEMISE undated).

Developments and Prospects

Especially in the energy sector, Morocco maintains close relations with the EU. The country is a member of the »Renewables Club« founded by former German Environment Minister Peter Altmaier, and finalized already in 2007 a declaration with the European Commission for more cooperation in the energy sector. The country's connection to the European electricity network promotes plans for electricity exports to the EU, which would entirely be in the interests of the EU. The EU is under pressure to find new sources of renewable energy, and thus Morocco's export interests are set out in Article 9 of the European Renewable Energy Directive.

Also in cooperation with Europe, a plan emerged for the expansion of solar energy in the Mediterranean region (MENA). The main objective of the MENA solar plan is to install 20 GW of power from renewable energy sources in the region. Moreover, the plan focuses on the expansion and construction of transcontinental network systems (FEMISE undated). Of the 20 GW, five are designated for export to the EU. Morocco has already begun to implement the first large solar thermal projects (Bryden et al. 2013). In 2009, Morocco put the projects into national law and adopted its own solar plan. According to the vision for the development of renewable energy, it provides for the installation of a total of 2,000 MW in five central thermal solar farms on five already designated areas; the last is scheduled to go online in 2019. The solar plan is the pivotal point of Moroccan ambitions in the field of renewable energy; the country has earmarked billions for its realization (FEMISE undated; Cîrlig 2013). It is being implemented by the Moroccan Agency for Solar Energy (MASEN). The expected annual yield of the installed capacity is 4,500 GWh, whereby the CO_2 emissions would be reduced by 7.8 per cent (de Visser et al. 2013).

In addition to this important instrument of Morocco's energy policy, the government decided on further national plans that flank the Moroccan solar plan: The National Strategy for Environmental Protection and Sustainable Development (SNPEDD), the National Action Plan for the Environment (PANE), the 2020 Strategy for Rural Development, the National Initiative for Human Development (NIHD), the National Action Plan against Global Warming, and the Green Morocco Plan, which has an eye on the country's agriculture. For the implementation of these plans, the government created a number of agencies and research institutions to carry forward the development of renewable energies. This includes, for example, the *Société d'Investissement Enérgetiques* (SIE), which manages two investment funds for the development of renewable energy and an increase in energy efficiency. One fund is dedicated to the promotion of wind and solar power projects for which SIE wants to generate money from Moroccan investors and international funding bodies.

Concrete Implementation

The first of the five major projects (Table 10) in the expansion of solar energy is the power plant in Ouarzazate in the south of the country; a 500-MW plant, which will combine PV and solar thermal energy, and after its completion is expected to produce 1.2 TWh per year of electrical energy. In 2016, the first phase of the power plant is expected to be completed, then 160 MW parabolic trough power plants should feed their electrical energy into the Moroccan network (FEMISE undated; Cîrlig 2013). The costs for the completion of this first phase of the power plant alone are estimated to be 1.16 billion US dollars (Bryden et al. 2013). The order/contract for the construction of Ouarzazate went to the Saudi International Group of Water and Power (ACWA), which now holds 95 per cent of property rights. The solar farms are financed mainly by loans from various development banks – such as the World Bank, the European Investment Bank, the African Development Bank, and the EU (FEMISE undated). The German Federal Ministry for Economic Cooperation and Development (BMZ) and the Reconstruction Loan Corporation (KfW) are also participating in the projects' financing (Altmann 2012).

Table 10: Overview of the five major projects in the framework of the Moroccan solar plan (FEMISE undated)

Site location	Capacity (MW)	DNI (kWh/m²/year)	Area (ha)	To be commissioned in
Ouarzazate	500	2,635	2,500	2015
Ain Ben Mathar	400	2,290	2,000	2017
Boujdour	100	2,628	500	2020
Sebkhat Tah/Tarfaya	500	2,140	2,500	2019
Foum Al Ouad/Laayoune	500	2,628	2,500	2019

The 2,000 MW of wind energy provided for in the aims for 2020 are also to be generated by the realization of the five major projects. The capacity to be installed corresponds to 6,600 GWh per year, which equals 26 per cent of the existing electricity production. The first of these wind farms is scheduled to go online in 2014 (FEMISE undated; Cîrlig 2013). Wind energy has already reached grid parity in Morocco and is therefore competitive (Hafner and Tagliapietra 2013).

Despite the currently already relatively high share of hydropower in renewable energies in the Moroccan energy mix, the government also seems to see further potential in this area. Existing facilities will be supplemented in 2020 by two more major projects. Furthermore, about 200 areas were identified for micro-hydro projects (Cîrlig 2013).

Prospects

While some studies criticize Morocco that its targets for 2020 have thus far hardly been concretized through policy measures (see, for example, de Visser et al. 2013), others highlight the many positive developments in precisely this area (Altmann 2012; Samborsky et al. 2013). In particular, Morocco has created a solid institutional framework for the implementation of its goals, such as the establishment of the national energy agency MASEN and other mentioned actors, as well as the adoption of the Renewable Energy Sources Act in 2010 (Altmann 2012). In the CCPI, Morocco's national experts also rated the country's policy as good. In this category, Morocco even climbed in 2014 from 18th to ninth place.

The policy focuses primarily on publicly tendering large projects in the solar and wind energy sector, rather than relying on financial incentives for projects in the field of renewable energy on a smaller scale. There are no tax regulations that would encourage smaller investments in renewable energies (de Visser et al. 2013). De Visser et al. further criticize that on the contrary, fossil fuels are still massively subsidized.

Among the tasks that lie ahead for Morocco is the revision of its electricity market design. De Visser et al. call for incentives to promote renewable energy, for example in industry. In addition, a socially responsible way should be found to reduce subsidies for fossil fuels so that renewable energy can survive on the market.

»Reducing energy subsidies is politically challenging and requires a pragmatic approach, which could include increasing spending on education, health, and social welfare as compensation for potentially higher energy prices.« (Bryden et al. 2013)

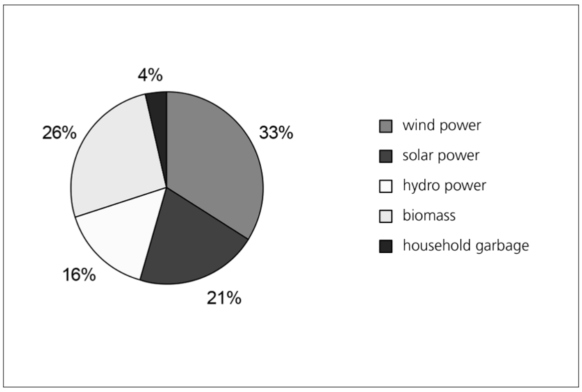
In order to accelerate the transformative processes in Morocco's energy and electricity sector in the long term, the country would also have to develop a vision beyond 2020, and, where appropriate, initiate policy measures for its support (de Visser 2013).

2.2.3 Germany

In contrast to the two previous examples, Germany is a country that meets its power requirements to a large extent from coal, and is in seventh place on the list of the largest emitters of greenhouse gases, ahead of Canada and the United Kingdom. However, the per capita output is slightly lower than this placement suggests. The most populous country in Europe has now adopted an »*Energiewende*«, according to which, the total energy should come from renewable sources in the future. The success of this transition in the strongest European economy would be a strong signal – above all for other coal nations – and would make it clear that not only is the power supply from 100 per cent renewable energy possible, but also the transformation of an established energy system.

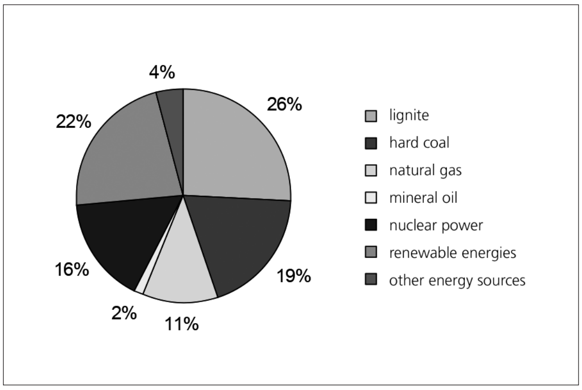
The Energy and Electricity Sector

Figure 4: Germany's Mix of Renewable Energies 2012



In 2012, Germany's primary energy consumption was 15,745 petajoules (AG Energy Balances 2014). In 2011, the electricity consumption was 545 billion kWh, and the average per capita consumption was 6,648 kWh/a (*Stromvergleich.de* 2014). In contrast to Ethiopia and Morocco, the German energy mix is extremely diverse, due to the enormous power consumption. In 2012, lignite constituted the majority of electrical energy, with a share of 25.7 per cent of the energy supply, followed by black coal (19.1 per cent), nuclear energy (16.1 per cent), natural gas (11.3 per cent), and petroleum, which supplies 1.5 per cent of Germany's electricity. Together, renewable energy had a share of 22.9 per cent of the electricity mix in 2012. The contributions of individual energy sources are relatively close. Wind power is already competitive on the German electricity market, and thus among renewable energies, wind energy has the largest share of electricity generation (7.4 per cent). At 5.8 per cent, 4.5 per cent and 3.4 per cent follow biomass, photovoltaics, and hydropower. Incineration provides 0.8 per cent (AGEB 2013).

Figure 5: Share of Different Energy Sources in Germany 2012.



The German electricity market design is dominated by the »Big Four«, a term commonly used in the country's energy industry; the term refers to the four market-dominating power companies Eon, RWE, Vattenfall, and EnBW. They are producers, operators, and suppliers at the same time, and thus also control the republic's power system.

With the introduction of the Renewable Energy Sources Act (EEG) in 2000 – by the then red-green coalition government – it was also possible for smaller producers and suppliers to survive in the market, because the law granted them some advantages. Hence, green electricity providers gradually became established on the market. Furthermore, an important instrument of the EEG – already introduced in 1991 – is the feed-in tariff that guarantees to buy over years the electricity generated by renewable energy to a fixed price. It ensures planning security for investors, and thus the share of renewable energy in the electricity mix rose from 3.2 per cent in 1991 to 22.9 per cent in 2012 (AGEB 2013).

The German »*Energiewende*«

The plan to phase out nuclear power and fossil fuels and convert all of the energy supply of the country to renewable energy has a long history in Germany and is rooted in a growing environmental awareness and the anti-nuclear movement of the late 1960s and 1970s.

Already then, the term »*Energiewende*« was used after the oil crisis of the 1970s had raised the awareness of the need for alternative energy sources. But not only have classical fossil fuels been the subject of public debate; after the nuclear disaster at Chernobyl in 1986, increasingly greater resistance formed against nuclear power, which had once been introduced as a saviour. The foundation for a transformation of the electricity sector was laid in the late 1980s with the introduction of the first prototypes of a feed-in tariff for photovoltaics, which were transferred to the Electricity Feed-in Act in 1991. This made it possible for the investment costs to be offset by compensation for the generation of clean electricity. From 1998 until then, the monopolized electricity market was by law gradually liberalized, which enabled small producers – and thus renewable energy – unlimited access to the electricity grid (Birke et al. 2000). Climate protection became more important, and thus the path to the »*Energiewende*« – also through the adoption of international, European, and German CO_2 reduction targets – was determined. In 2007, the federal government decided on an integrated energy and climate programme, which aimed through energy efficiency and renewable energy both to promote climate protection and ensure the security of supply (BMWi/BMU 2007).

Germany's Vision

The »*Energiewende*« is law since 2011. The goal is to meet energy consumption almost exclusively with renewable energy sources by 2050, so that CO_2 emissions in total will be reduced by 80 to 95 per cent. Thereby, the promotion of energy efficiency also has an important role (BMU 2012, CO2online 2014). The »*Energiewende*« plan provides for an annual growth of 2.1 per cent in energy productivity. A milestone is scheduled for 2020: By then, greenhouse gases are meant to be reduced by 40 per cent (compared with 1990). Due to efficiency-enhancing measures, primary energy consumption should be reduced by 20 per cent by 2020. To scale back emissions, as much as 50 per cent savings are planned by 2050. In the area of electricity, consumption should be reduced up to the first stage in 2020 by 10 per cent, and by 2050 by 25 per cent. The reference year for these savings is 2008. Renewable energies are to be expanded and by 2020 account for 18 per cent of total energy consumption. The renewable energy targets have determined further milestones; in 2030 their share will be 30 per cent, 60 per cent in 2050. It has been announced that by 2020, the share of renewable energy in the energy mix should be 35 per cent renewable energy, and 80 per cent by 2050 (BMU 2012).

The Targets of the German »*Energiewende*« at a Glance (CO2Online 2014)

Phaseout of Nuclear Energy
- by the end of 2022

Increase the Share of Renewable Energy in the Gross Final Consumption
- by 2020 to 18 per cent,
- by 2030 to 30 per cent,
- by 2040 to 45 per cent and
- by 2050 to 60 per cent.

Increase the Share of Renewable Energy in Gross Electricity Consumption based on the Renewable Energies Act (EEG) from 2012.
- by 2020 to 35 per cent,
- by 2030 to 50 per cent,
- by 2040 to 65 per cent and
- by 2050 to 80 per cent.

Reduce Greenhouse Gas Emissions (base year 1990)
- by 2020 by 40 per cent,
- by 2030 by 55 per cent,
- by 2040 by 70 per cent and
- by 2050 by 80 bis 95 per cent.

Reduce Primary Energy Consumption
- by 2020 by 20 per cent and
- by 2050 by 50 per cent.

Increase Energy Productivity to 2.1 per cent in relation to final energy consumption

Reduce Electricity Consumption (compared with 2008)
- by 2020 by 10 per cent and
- by 2050 by 25 per cent.

Reduce Heat Demand in Buildings
- by 2020 by 20 per cent.

Reduce Primary Energy Demand
- by 2050 by 80 per cent.

Double the Building Renovation Rate from 1 to 2 per cent.

Developments and Perspectives

For Germany, a multitude of technical, planning, and social challenges are associated with renewable energy and efficiency targets and the simultaneous phasing out of nuclear energy. With a share of renewable energy in the electricity mix currently over 20 per cent, it is estimated that the 2020 target of 35 per cent is very likely to be exceeded in the current development pace. For the intended transformation, with its long-term targets, the entire energy system must be further rapidly transformed. The results will be a much more complex supply structure.

Striking in the German example is that a strong civil society commitment for the change of central structures was crucial. For instance, a variety of local energy cooperatives (approximately 900) have been founded that target the construction of solar and wind power plants or renewable heating systems. This development is also due to the fixed compensation rates for electricity from renewable sources, which provide investment security. At the local level, particularly in rural areas, a large number of participatory processes in the context of renewable energy also occur. For this, two motives in particular are mentioned: First, on the civil side, it can be assumed that there is diminishing trust in political processes and decisions, also in the infrastructure sector. Participation in processes is therefore demanded. And second, on the policy side the acceptance for strategic projects is meant to be strengthened through political participation (Dunker and Mono: 2013).

There are also a number of challenges on the technical level: In addition to the construction of systems and their intelligent networking, in order to be able to integrate them more effectively in decentralized structures, the development of networks for low-loss electricity transmission over long distances, as well as the development of storage technologies is also central. Yet it is not the technical challenges, but the political discussion and decision-making processes of all technical issues connected with the energy turnaround (onshore/offshore wind farms, sites for storage technologies, transportation routes) that are currently in the public eye and controversially discussed in various forums. Thus it appears that despite widespread approval, in the concrete implementation in planning and participation processes, massive concerns are frequently expressed by those affected on site (»Not in my backyard« [NIMB] arguments).

On the political level, these challenges also mean the review, adaptation, or redesign of all the instruments for the promotion of energy security and supply. This is therefore openly formulated, because the subsidization of all energy sources – from coal to remaining nuclear power to renewable energy – are currently on trial politically. Through the design of incentives, such as the EEG, apart from the intended steering effect, the utility structure and price development in the electricity market, as well as the distribution of debits and credits are influenced as in the past; for example, an attenuation of electricity prices on the electricity market has led to increased exports to neighbouring countries. At the same time, prices for consumers are increasing, which is conditioned on the political design of the EEG instrument – in particular the exemptions – and the passing of costs (CO2 Online 2014).

2.3 Conclusion

The three examples of countries in highly different stages of development and with different political and socio-economic backgrounds show that a shift to renewable energy or an expansion of renewable energy is possible at any time and, moreover, quite advantageous. Ethiopia and Morocco demonstrate that economic development is also possible without classical industrialization or with an early rejection of it. As suppliers of clean energy, they can gain an advantage as pioneer countries in their own region, and serve as a model for their neighbours. Here, supply security and the fight against energy poverty are the focus of a »top-down« approach, in which social participation processes still do not play a significant role though. Social acceptance is instead created through the narrative »reduction of energy poverty«. Germany's plans for the »*Energiewende*« are ambitious and show other industrialized countries that the transformation of established systems can be initiated and promoted. Here, environmental and safety objectives are the focus. This example makes it clear that in the context of an energy transformation – over and above the shaping of policies and instruments – decentralized civil society engagement can also be sustainably deployed, which can contribute significantly to a widespread dissemination of renewable energy. Nevertheless, the difficult initial phase of transformation in Germany also makes clear that transformation is a process that does not only progress in a linear fashion. Important for all projects of this type is the social and political backing within the countries. In the long run, it will be essential that forerunners such as Ethiopia, Morocco, and Germany join together in pioneer alliances, which are able to convince other countries about their objectives. This could pave the way to a climate-friendly future.

3. Energy Transformation in the Multilevel System

Christiane Beuermann

The transformation in the electricity sector towards renewable energy is shaped on various political and government levels. The processes and policies in various fields of activity can be both complete (synergies) as well as contradict each other (trade-offs).

International energy policy is thus far an underdeveloped field of policy: on the one hand, the different, in the context of energy supply, action areas and levels – such as climate protection, security of supply, and reducing energy poverty – are seemingly unconnected (Fischedick et al. 2011). On the other hand, the prescribed framework conditions for a transformation, first and foremost the institutional landscape, are mostly highly fragmented. The various levels at which energy policy is developed (international, intergovernmental, national, and sub-national to local) influence each other, even if the national and sub-national spheres of influence vary from country to country. Also, in the chronological sequence of a transformation process, the different levels may each at different times be varyingly strong drivers. Thus, Verbong and Geels conclude in 2007 for the example of Europe, in particular the Netherlands, that the energy transformation would be driven towards renewable energy sources above all by the liberalization and Europeanization of energy markets, and less by environmental considerations. With the nuclear accident in Fukushima, this has changed – at least in Germany and Japan.

In this chapter, some starting points for an energy transformation and their interactions between the different levels are illuminated and documented with examples. The illustrated models for influencing factors and framework conditions can have different effects on an energy transformation depending on their configuration. An integrated approach across all policy tiers would be useful also to develop a successful energy transformation. Furthermore, it is strategically important that the orientation on the long-term goals of an energy transformation is maintained and conflicts of interest are resolved beyond election or government periods or Government also maintained (see also the chapter »Energy Transformation Between Conflicting Interests«).

3.1 International Level

Fossil fuels still account for more than 80 per cent of the global energy supply (IEA 2013C: 9). At the same time, about three billion people have no access to a basic supply of modern energy services (WBGU 2011). Thus, climate protection has become worldwide the »defining factor« for the development of future energy systems (IEA 2014), and the transformation of energy systems – in addition to urbanization and land-use changes – one of three key global transformation fields to perceive future responsibilities with regard to climate protection and sustainability (WBGU 2011).

An internationally coordinated energy policy does not exist. The problem areas associated with the global energy supply and use are dealt with in different forums and processes with different commitment (Fischedick et al. 2011). Correspondingly, there emerge in various international processes and negotiations fragmented approaches that influence each other. At the same time, there is a correlation between the international negotiating positions, targets, and instruments, and national transformation processes that reflect the national interests. Central international processes are the negotiations in the context of the climate regime, the discussions about sustainable development goals (SDGs), as well as the relatively new Sustainable Energy for All Initiative (SE4All). These negotiations and processes give mandatory or orienting frameworks for national policies and measures.

Thereby, the role and relevance of these processes in the context of a global energy transformation are assessed by us as follows:

- Discussion and commitment to internationally agreed emissions reduction targets and derived policies and measures with national effect

- Discussion and agreement on a global vision as an action-determining guideline

- Catalyst and impetus effect on national transformation processes

- Continuity and security of topic presence on the international and national political agenda

3.1.1 The Negotiations under the UNFCCC

The aim of the negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) is to prevent dangerous disruption of the climate system by humans, or to mitigate their consequences as much as possible (Art. 2 UNFCCC). The energy sector worldwide contributes to about two-thirds of greenhouse gas emissions, making it a central field of activity (IEA 2013C: 9). The negotiations are directly relevant for the development of energy systems worldwide. With the Kyoto Protocol, commitments for 37 industrialized countries and the EU were resolved in 1997, which had the goal to reduce the emissions of the six regulated greenhouse gases – carbon dioxide, methane, nitrous oxide, as well as the synthetic gases HCFC, PFC, and SF6 – by a total of 5,2 per cent based on 1990 emissions levels. This should have been achieved in the first commitment period 2008–2012. A supplement of the Kyoto Protocol was adopted in Doha in 2012. In it, new (theoretical and not yet operationalized) commitments for industrialized countries were resolved, which approved reducing greenhouse gas emissions by at least 18 per cent compared to 1990 in a second commitment period (2013–2020). In a further process, a successor agreement should be negotiated by December 2015.

Ambition Gap

The gap between the vision (necessary, recognized need for action) and the willingness to implement measures is referred to as the »ambition gap«. In the wake of the Cancún Agreements, all developed countries and more than 40 developing countries named official reduction targets, which however revealed the full extent of the so-called ambition gap. Only about 60 per cent of the emission reductions that would be needed to prevent dangerous climate change were also announced by the countries (UNEP 2013). It is estimated that with the current reduction pledges, rather a global warming between 3.0 and 4.6°C has to be reckoned with (Carbon Action Tracker 2014).

An important milestone in the wake of very differentiated negotiations in 2010 in Cancún, Mexico, was the agreement on a global target for a not-to-be-exceeded upper limit of human-induced climate change. The parties were able to agree to this so-called 2°C target not until 18 years after the signing of the UNFCCC. It was recognized that this goal can only be achieved with deep cuts in emissions and that a paradigm shift towards building a low-carbon society is necessary (Cancún Agreement).

Consequently, this corresponds to the acknowledgement that the systems of energy production, delivery, and use have to be converted worldwide to a non-fossil basis and this means accepting the task of advancing a global transformation of energy systems. With the 2°C target, a central global vision has been recognized as a guideline for future development paths. Moreover, in a review process, it has been decided that a tightening to a 1.5°C target should be tested, which only increases the urgency of energy transformation.

In addition to the discussion on concrete targets and derived emission reduction commitments, instruments were introduced in the climate negotiations that are relevant for the development of global and national energy systems: On top of the targeted climate financing and incentive instruments, activities for the reduction of greenhouse gases have been initiated at the national level. The Clean Development Mechanism (CDM) and Nationally Appropriate Mitigation Actions (NAMAs) have been installed to finance adaptation and CO_2 reduction measures. Thus, measures that promote a transformation in the energy sector could be concretely implemented in the country. Even national programmes – such as Germany's International Climate Initiative (IKI) – count among them, because through them international financial commitments made by the German government are realized.

How is the role of the UN climate negotiation process for energy transformation to be assessed? In our view, it is a catalyst and impetus for national debates, policies, and measures. Often, the actual goals of the Conferences of the Parties cannot be reached at the targeted time points – i.e., the annual UNFCCC Conferences of the Parties – as the failure to stick to the roadmap for a new agreement in Copenhagen showed in 2009. Subsequently, however, national dynamics are often set in motion that would probably not have arisen without the negotiation process (Sterk et al. 2013). The international process can also be understood as a legitimation for national action, in which it is necessary to make fundamental course corrections – for example, in the strategic development of energy supply systems.

Also relevant is the continuity of the process; it is important that the negotiations are continued gradually, the objectives discussed further, the negotiating parties remain at the table, and hence the subject is secured a high priority on political agendas. This is central to the long-term dynamics of the transformation processes. The repeated reference to the negotiations, the 2°C target and its ambition, as well as the necessary reversals in the energy sector strengthen the relevance of the national discussions on the change in energy systems.

Traditionally, the climate negotiations were always marked by block building and shifting coalitions depending on the positioning for the subsequent negotiations, including the Warsaw negotiations in 2013. The argumentation patterns presented there reflect the prevailing narratives (see the chapter »Energy Transformation between Conflicting Interests«). Many decision-makers doubt the practical feasibility of low-carbon development paths (de Boer 2010). There is a direct relationship or correlation between national discourses on the feasibility of these development paths, the demonstration by pioneers, and progress in the international negotiations.

The tactical results of the climate negotiations, determined by constellations of power and self-interests, document the international minimum consensus. This becomes clear when negotiating positions and trend developments are considered together. Thus, Japan announced in Warsaw that it would amend its national emission reduction target from -25 per cent to +3 per cent compared to 1990 levels. The Japanese government justified this step with the shutdown of the nuclear reactors after Fukushima. Independent analysis (de Visser et al. 2013), however, show that even a complete replacement of nuclear reactors with coal power plants should only lead to a halving of the original target. At the same time, it is projected that Japan will be the world's largest photovoltaics market in 2013, head to head with the People's Republic of China (Watanabe 2013). Along with the massive expansion of other forms of renewable energy, it would be likely that the actual development path is much more climate friendly than the official target. The same argument can be made for the People's Republic of China, which behaved as a hardliner in the Warsaw negotiations, but at the same time invests heavily in renewable energy. The country has already launched several regional emission trading schemes on a pilot basis (Song 2014), to test different options for a national emission trading system to be set up in the medium term.

3.1.2 The Discussion on the Sustainable Development Goals (SDGs)

In the context of the fight against energy poverty, international development policy processes are also driving the transformation of energy systems.

Essentially, this is the UN's Post-2015 Process with regard to sustainable development goals (SDGs), which connects to the development process of the Millennium Development Goals (MDGs). The outcome of the MDG Summit in September 2010 was to take steps to continue the MDG process with increased focus on sustainability issues, and to develop a post-2015 agenda. The Rio+20 conference in Rio de Janeiro in June 2012 specified the central steps for this in its final report »The Future We Want«. Thus, an open working group on SDGs, an intergovernmental committee of experts on sustainability financing, and a high-level political forum was set up. In September 2013, a high-level summit was decided for 2015, at which new targets are meant to be agreed upon (UN 2014a).

Millennium Development Goals (MDGs)

The MDGs were formulated in 2001. They are based on the Millennium Declaration of the 55th United Nations General Assembly from the previous year. They were elaborated by a working group with representatives from the United Nations, the World Bank, the IMF, and the Development Assistance Committee of the OECD. The overall objective is to halve global poverty by 2015 compared to 1990. For this, eight development goals with 20 sub-items and 60 sub-indicators were identified. However, environmental issues, climate change, and energy issues such as energy poverty were not thematized.

In February 2014, 19 focus areas were presented, which relate to the SDGs, including the focus area 7 on energy and focus area 15 on the climate. The goals proposed were, among others, low to zero energy emission technologies, renewable energy, and the cutback of subsidies for fossil fuels (UN 2014b).

A discussion strand of the open working group on the SDGs deals with potential financing opportunities. This discussion, however, is not complete. In a policy brief from December 2013, possible instruments for implementation were indeed described, but in general potential sources of funding still remain vague.

3.1.3 The Sustainable Energy for All Initiative (SE4ALL)

The UN General Assembly has declared the decade 2014–2024 as the Decade of Sustainable Energy for All (UNGA 2012). This is intended to supplement the MDGs and the Post-2015 Process on the action area of energy, and targets concrete activities.

Apart from the fact that the commitment and legitimation of the processes are different, the argumentation pattern of the Sustainable Energy for All Initiative (SE4ALL) also differs significantly, for example, from that of climate negotiations. In the SE4ALL, common interests have organized, which pursue common objectives and focus on the expected benefits instead of costs. Emphasized, in particular, are the interactions of different policies and measures, as well as the potential to simultaneously achieve development progress in different areas and thus to switch to a low-carbon development path.

UN Secretary-General Ban Ki-moon launched the SE4ALL in 2010. The initiative is intended as a partnership between governments, the private sector, and civil society, and represents a multistakeholder approach. It is represented and supported by various personalities, such as the UN Secretary General, the President of the World Bank, and 35 supervisory board members from politics, business, and civil society. Its foundation is the enhanced new form of partnership between the World Bank and the United Nations.

The initiative wants to achieve the following three aims by 2030:

- universal access to modern energy services
- doubling of the global rate for improving energy efficiency
- doubling of the share of renewable energy in the global energy mix

The initiative refers to the correlation and mutual reinforcement of the three objectives. Thus, for example, affordable renewable energy technologies enable modern energy services in rural areas, when the expansion of the existing conventional power grid is too expensive or cannot be carried out. Supplemented by an energy-efficiency strategy, the benefits of a transformation for the development of a country can be maximized, while at the same time, the climate can be stabilized in the long term.

This new, ongoing process is also a driver for the global transformation of energy systems. Its effect depends on which resources can be mobilized and how the public and private sector, as well as civil society, interact.

3.2 Intergovernmental or Regional Level

At the interstate level, a cross-border or transnational cooperation in the introduction and implementation of renewable policies is considered on the one hand, and the »special case« of the European Union, on the other.

3.2.1 Intergovernmental Cooperation on Renewable Energy Projects

Joint cross-border projects for regional cooperation can advance a global energy transformation as well. There have been projects between countries in the electricity sector for a long time in places where the power supply at the respective aggregate national level meets the demand, but capacity asymmetries exist regionally – for example, through supply shortages (Weintraub 2007). Therefore the objectives are, among others, regional energy security and access to energy services. Regional cooperation and integration in the electricity sector is a long-term process and involves various aspects of national energy policies (see chapter on national level), which must be harmonized (Burgos 2007):

- joint energy policy dialogue, definition of goals, and development of a joint strategy
- establishment or adaptation of regulatory institutions
- joint planning processes and criteria
- linking and harmonized management of the infrastructure
- joint operation of power generation plants
- joint funding and creation of a secure investment climate

Experience in the production of electricity from renewable energy sources exists, for instance, in South America as part of binational hydroelectric projects. This showed that the success – to achieve environmental or especially climate objectives with such projects – depends on many factors, such as the strategic direction of cooperation and the political will for enforcement. Despite the potential of the joint use of hydropower, the previous experiences in the region were ambivalent (Weintraub 2007). Historically evolved conflicts and lack of willingness to implement them are principally cited as barriers.

Cross-border projects for the joint development of the electricity sector also exist in other regions. In southern Africa, collaborations have been strategically developed in a longer process since the 1980s. For example, the Southern African Power Pool (SAPP) was established, which is a cooperation platform of energy producers from twelve countries of southern Africa (SAPP 2014). The SAPP has the primary objective to ensure a reliable and economic power supply, especially in rural areas, which uses the appropriate natural resources and considers environmental effects. The principles of cooperation are set out in various documents. There is an active information policy, which is featured on the SAPP website and various media such as the »SAPP Sustainability Bulletin«, in which the latest developments are reported – for example, the establishment of a grid emission factor for the SAPP region, which is a tool for identifying emissions from an electricity system (SAPP Bulletin 2013).

Results of the SPLAT Model

Renewable technologies in the networked model

- can play a an increasingly important role in the supply of dependable, affordable, low-cost electricity
- reduce the consumption of fossil fuels. Decentralized options reduce investment in domestic transmission and distribution networks.

Within the model horizon, the costs of the introduction of renewable energies into the future electricity generation system are higher than for fossil and nuclear fuels. But the cost savings from the avoided fuel costs and reduced investment in transmission and distribution networks outweigh the additional investment costs by far.

The SPLAT model also shows that the development and export of hydroelectric power from the Inga Hydropower Project, the planned world's largest hydropower project in the Democratic Republic of the Congo, significantly sink the average electricity production costs significantly.

In comparison to the benefits of international electricity trading, the financial expenditure for investment in electricity interconnections is minimal.

The SAPP works closely with other international institutions: For example, the International Renewable Energy Agency (IRENA) developed a planning tool (System Planning Test Model, SPLAT-model), with which a power supply system should be designed that estimates the future role and the investment opportunities for renewable energy in four scenarios. This system simultaneously takes into account specific guidelines, such as reliability or economically optimal configurations. Based on this model, a funding scenario for renewable energy in eleven countries of the Southern African Development Community (SADC) has been developed (Miketa and Merven 2013).

3.2.2 The EU's Climate and Energy Package

With respect to interstate relations, the European Union represents a unique entity (Strohmeier 2007: 24): It is a voluntary association of sovereign states that have transferred their sovereignty or their sovereign rights in part to the EU. The EU exerts state power, without itself being a state. In terms of the energy transformation, this means that there is an additional level of correlations: On the EU level, framework conditions are created that affect the national processes of energy transformation, and the national processes simultaneously influence the EU framework.

With the diversity of national interests and narratives, a similar situation has thus existed – as in the negotiations in international climate policy. In the past, the EU was seen on the international level as the engine of an ambitious climate policy (EurActiv 2014a, 2014b). With the decision to specify a target path by 2050 and until then to reduce greenhouse gas emissions by 80 to 95 per cent compared to 1990 (European Commission 2011), the EU has created a long-term vision and adopted an action guideline. The current policy, however, is rated more as regressive and less ambitious (EurActiv 2014a, 2014b).

With the energy and climate package, the European Union created in 2008 an important initial building block towards a European energy transformation. By 2020, CO_2 emissions are meant to be reduced by 20 per cent (relative to 1990), the share of renewable energy in total energy consumption increased to 20 per cent, and an improvement in energy efficiency of also 20 per cent (20-20-20 target) achieved. The reduction target for CO_2 emissions has been divided and differentiated for the member states. The actual development has already shown for some time, that both the CO_2 emissions target and the renewable energy target are likely to be overfulfilled or fulfilled (EurObserv'ER 2012).

In January 2014, the European Commission submitted proposals on how these objectives could be adapted for 2030. Accordingly, the share of renewable energy should reach 27 per cent and CO_2 emissions reduced by 40 per cent by 2030, while a target for energy efficiency has not been formulated (EU Commission 2014). Central criticisms from environmental and development organizations (Bread for the World et al. 2014) are that the CO_2 reduction target for the EU is definitely too low (55 per cent required), an efficiency target is not shown in concrete terms (reduction of energy consumption by 40 per cent required), the expansion target for renewable energy is too low (45 per cent required) and as EU average is no longer apportioned for member states. Also, the focus is placed only on CO_2 reduction, but it is left open how it could be achieved (renewable energy, efficiency, fossil technologies, or nuclear power). A weak framework is particularly problematic, because the energy infrastructure in the EU is facing a fundamental renewal and a wave of investment is to be expected.

3.3 National Level

- In the targeted transformation of the energy system of a country, stakeholders face six key questions:

- Has a vision of the development of energy systems been developed in the country and is it robustly anchored in the consciousness of the state and society?

- Has the vision been lifted to the political agenda and concretized in terms of goals, commitments, policies, and actions?

- Have processes, institutions, and concrete legal framework conditions for the implementation of the transformation and the achievement of the objectives been created?

- Is there a success examination?

- Has an understanding of the correlations with other policies and levels of government, and about the positive effects of low-carbon paths on other social goals been developed?

- Are risks reflected?

3.3.1 Development and Robustness of the Vision of an Energy Transformation

The Danish and German example of energy transformation is typical of the durability of developments of a political field of action: Favoured by windows of opportunity (triggers such as the reactor accidents at Chernobyl and Fukushima, as well as a number of other events in the intervening time), an environmental vision has developed over a long period of time into a broadly supported social project (Strunz 2013). However, the formation of the vision can also result from other contexts: the dilemma of the massive increase in energy demand and pollution, as in China; an energy supply shortage, as in Cuba; or the perspective of challenging the quasi 100 per cent electricity supply from renewable energy sources, as in Uruguay.

How can the vision of an energy transformation be anchored to the political agenda and the development and implementation of measures be controlled? The World Bank looks at this issue as a fundamental country- and market-independent success factor, a process-oriented, consistent design of different policies and instruments (Azuela and Barroso 2012: 54). Thereby, an effective policy need not necessarily be cost effective. Required framework conditions are:

- Adaptation of policies to each country's starting situation and context.

- The nature, complexity, and expected impact of the renewable energy policy are crucial for the design of a renewable electricity market. An example is the introduction of indeed expensive, feed-in tariffs that offer incentives and create investment security, and help to reduce direction uncertainty in investment decisions.

- Legal and regulatory framework conditions for resource and land use must be created before renewable energies are promoted politically (e.g., through targets or incentive instruments).

- The policy impact is continuously reviewed and adjusted, and if necessary, supplementary measures adopted.

- The consideration and inclusion of stakeholders is documented.

- There is a broad social consensus on the energy transformation.

The robustness of the transformation process will depend on whether the vision can be anchored in the political administrative system and society, their implementation is confirmed by success, and the vision thus remains a guideline for action beyond election and government periods. The acceptance and anchoring is more probable, the more clearly the added value in areas such as environmental pollution, health costs, import dependency, new markets, and jobs can be made visible (Schreurs 2014). However, this added value is different from country to country.

Special challenges for setting the framework for an energy transformation at the national level are the following aspects (Bartosch et al., 2014: 27ff and 35ff, Agora Energiewende 2012):

- Technological challenge: How can renewable energy be integrated into customized systems solutions and, for example, energy efficiency technologies be bundled?

- Compatibility challenge: How can the future increasingly stronger integration of renewable energies – especially the fluctuating wind and solar energy feed-in – be organized in the existing systems with conventional technologies (intelligent energy market design)? In order to ensure security of supply and system stability, investment in conventional power plant capacity and/or new storage options and load management measures will be required in many countries in the future. What could solutions for the supply from 100 per cent renewable energy look like in certain constellations?

- Investment challenge: The expansion of renewable energy is associated with relatively high initial investment and relatively low variable costs (exceptions are biogas and biomass plants).

- Infrastructure challenge: If no stand-alone solutions are implemented, the extension of electricity transmission infrastructure (new high-voltage lines, which in the rising expansion of renewable energy sources, power sources and sinks are connected) is generally required. Affected stakeholders should be directly involved in the planning. Further alternative options are, for example, the strengthening of the existing network, load and use management, the use of storage systems, and the adaptation of the power distribution network.

3.3.2 Instruments for Promoting Renewable Energy

In the promotion of renewable energy, three systems are distinguished: price mechanisms (feed-in tariffs, FITs), quantity-based mechanisms (expansion requirements), and auctions. Various studies have investigated and analyzed the existing policies, and which approaches – in terms of sustainable least-cost development of markets for renewable energy – are more effective (see, for example, Azuela and Barroso 2012).

Thereby, price mechanisms are evaluated as more effective in limiting investment risks than quantity-based mechanisms. However, some studies point out that quantity-based mechanisms are cost-intensive because FITs constitute subsidies and promote competition between different technologies. Nevertheless, a general statement about the effectiveness of one or another instrument cannot be made and is to be considered in each country context. Factors that influence the effectiveness of the instruments are the degree of political ambition (e.g., about targets), an elaborate system of incentives, and the ability of a system to overcome non-economic barriers.

At the same time, it has been established in the studies that the legal and regulatory framework conditions for renewable energy constantly change and evolve (see, for example, Azuela and Barroso 2012: 5). Thus, the switch from price- to quantity-based systems, or vice versa, took place in the USA, Italy, and the UK. Through adaptations in the use of regulatory instruments in cases of unexpected price effects, introduction difficulties, or lack of service fulfillment, combined systems have evolved in many countries. Also, many emerging countries have introduced price- or quantity-based promotion instruments, and to some extent redeveloped them in the light of their experiences, such as Brazil, China, India, the Philippines and South Africa.

In principle, classical pricing instruments, such as energy and CO_2 taxes, are also to be mentioned among funding instruments, which exist in a number of countries. As with the cutback in subsidies for fossil fuels, these instruments are indirect incentives and thereby raise the profitability of renewable energy.

Emissions trading systems were introduced (ETS) as a classic quantity-based instrument in many countries in and outside the EU (but here as a national instrument). The EU ETS was the first system installed almost ten years ago. By 2015, a total of 16 ETS will operate, nine of which were first introduced in 2013, seven in large cities or provinces in China. Thus, the share of global greenhouse gas emissions, which are covered by an ETS, increases compared to 2005 by over 70 per cent (ICAP 2014: 21). The scope and subject of the ETS vary from country to country.

3.4 Sub national Level

The sub-national level plays a dual role for the transformation of energy systems: On the one hand, it is the place for demand creation and implementation of renewable energy projects. On the other hand, the energy transformation can be co-created there, whereby the creative leeway on the sub-national level differs from country to country.

3.4.1 Decentralized Power Generation

Globally, energy poverty is one of the most pressing challenges, and improved access to electricity has basic development priority in order to create income sources, to achieve health objectives, and to enable education. About three billion people use solid fuels to heat and cook; 1.4 billion people have no access to electricity at all, and another billion only intermittent access (IEA 2010: 237, Legros et al. 2009). The decentralized, non-grid-connected electricity supply from renewable energy is an option to reduce energy poverty. In Nepal, for example, the significant benefits of decentralized micro-hydropower systems could be shown in rural mountain areas, and a double dividend in terms of the implementation of the MDGs and the fight against climate change could be reached (Legros et al. 2011). Thereby, the special importance of capacity building was highlighted in all stages of planning, funding, and implementation. It became clear that with appropriate training, the local population could implement and manage the decentralized plants themselves. Positive effects were also attained in the area of regional economic activity.

3.4.2 Cities and Communities as Sites of Energy Transformation

Currently, 80 per cent of global anthropogenic greenhouse gases originate in urban areas. In the medium term, it is expected that the proportion of the global population living in cities is growing from 50 to 60 per cent. This is connected with a further increase in global greenhouse gas emissions. Therefore, cities in particular are significant actors of an effective climate change policy as well as sites of transformation of energy production and use (Martinot 2011). In cities, the transition can be concretely promoted. Decision-makers, local businesses, and other stakeholders, as well as households and individuals can directly interact as on the national or even international level. In addition, a competition of local activities or regions can be created or promoted.

Martinot (2011) groups possible policies and activities to the local promotion of renewable energies in five categories (see Table 11). The relevance depends on the local context.

Many cities in industrialized countries have developed plans to feed their power supply from 100 per cent renewable energy. These are, for example, European cities in Denmark, Spain, Austria, Italy, Sweden, but also in Japan and the United Arab Emirates. In Germany, smaller communities like Feldheim near Berlin, Effelter in northern Bavaria, and Kronprinzenkoog on the North Sea coast were already able to achieve this goal. An increasing number of municipalities are striving for self-sufficiency and energy production under their own control. The initiatives and the fact that about half of renewable energy plants are privately owned, document a wide anchoring of the vision of an electricity supply from renewable energy sources in the society and at the sub-national level. Nevertheless, there are many obstacles, especially at the local level. Many groups are not against renewable energy per se, but against major infrastructure projects in their neighbourhood. This ranges from wind turbines, to the increase of storage, up to new power lines. Here participation processes are particularly important.

Conclusion

The observed developments in the various levels of governance show that a change of course is possible today, despite the many different policy processes with different priorities and tempos. At all levels of governance, there are examples of ways to promote the transformation. These ways should be used in parallel, because the different levels could inspire and encourage each other.

But it is also clear that the energy transformation takes place in a highly complex system. The exclusive consideration of the political-administrative system and the political power to shape a new global energy transformation is necessarily a narrow perspective, as is the focus on renewable energy and the electricity markets. Politics interacts with other influential actors in different arenas. In this network of relationships between government, business, and civil society, the creation of framework conditions for the energy transformation has repercussions on existing and newly developing influence or power constellations at all levels, and vice versa. This frequently results in negotiation processes in the different arenas.

Influence and power constellations are also revealed, for example, in the prevailing patterns of argumentation: how the energy policy objectives of *security of supply*, *environmental compatibility,* and *energy justice* should be met; and what role renewable energy plays in the process. In the following chapter, these *narratives* are discussed.

Table 11: Policies and Activities for Local Promotion of Renewable Energy (Source: Martinot (2011))

Policy / Activity Category	Key	Descriptions of Policies / Activities by Sub-Category
1. Target setting	Target setting	(a) CO_2 reduction targets
		(b) Future shares / amounts of renewable electricity or energy for all consumers in city
		(c) Future shares / amounts of renewable electricity or energy for government operations and / or buildings
		(d) Future shares or absolute numbers of buildings or homes with renewable energy installations
		(e) Future shares / amounts of biofuels for the government vehicle fleet and / or for public transport
		(f) Other types of targets, for example to become fossil-fuel free or »carbon neutral«
2. Regulation based on legal responsibilities and jurisdiction	Urban	(a) Urban planning and zoning that encourages and integrates the local generation, distribution and use of renewable sources of power in the local jurisdiction – including planning and zoning for public transportation and electric vehicle infrastructure.
	Building	(b) Building codes and / or permitting that applies to, or incorporates renewable energy in some manner. Examples: mandates for solar hot water and solar PV installations, zero-net-energy homes, shading legislation, and mandated design review / scoping of opportunities and potentials for renewable energy.
	Taxes	(c) Tax credits and exemptions within tax systems: for example, sales, property and fuel taxes, permitting fees, and carbon taxes.
	Other	(d) Other regulation, including municipal departments mandated to promote or plan for renewable energy, mandates for biofuels use in vehicles or biofuels blending, and mandatory carbon cap-and-trade.
3. Operation of municipal infrastructure	Purchase	(a) Local government purchasing (and joint purchasing with other municipalities or with private sector) to integrate renewable energy into government operations. Includes renewable electricity, biofuels, and bulk purchasing for market transformation programs.
	Invest	(b) Local government investment in renewable energy for government buildings, schools, vehicle fleets, and public transport.
	Utility	(c) Public utility regulation, including tariff regulation, renewable energy targets, feed-in tariffs, interconnection standards, net metering, and portfolio standards; also designates private utility policies of these types.
4. Voluntary actions and government serving as a role model	Demo	(a) Demonstration projects, including participation in national pilot and demonstration projects. Often done with private sector.
	Grants	(b) Grants, subsidies, and loans for investments in renewable energy by homeowners or businesses
	Land	(c) Using local government land / property for renewable energy installations (leasing / selling / permitting). Can also include deals that require developer promises for renewables and efficiency.
	Other	(d) Examples: joint ownership of private projects, city-financed investment funds, bond issues, and green certificates and trading.
5. Information promotion, and raising awareness	Info / promo	(a) Includes public media campaigns and programs; recognition activities and awards; organization of stakeholders; forums and working groups; training programs; enabling access to finance by local stakeholders; enabling stakeholder-owned projects; removing barriers to community participation; energy audits and GIS databases; analysis of renewable energy potentials; information centers; and initiation and support for demonstration projects.

4. Energy Transformation between Conflicting Interests

Lukas Hermwille

The energy system plays a central role in the global economic and social system. Energy in general and electricity in particular are essential for human coexistence and every modern form of economic activity. In regions where no adequate supply can be ensured, modern life and business are not possible.

Thus, a radical transformation – here radical does not means the speed of change, but its completeness – involves enormous risks, but also opportunities for our societies. The transformation of the energy system from a few central and large fossil- or nuclear-fueled power plants, to a variety of mostly smaller, decentralized renewable power plants presents both the stakeholders of the special power supply system as well as the entire economic and social system with great challenges. These challenges differ around the world. They result from the different prerequisites of the countries, such as the existing (energy) infrastructure, the level of economic development and economic structure, the topography, the potential for renewable energy, fossil fuel reserves, and cultural preferences.

If the energy transformation is to come off successfully and completely, these challenges have to be addressed. However, it is often not even the challenges that impede or even prevent a fundamental transformation of the energy sector. Rather, it is social actors who either problematize the challenges or formulate them as an opportunity in terms of energy transformation. We refer to the basic pattern of argument by these actors as narratives. These narratives characterize a paradigm that becomes the action guidelines for actors from the energy regime.[11] These narratives frame the political and social debate, and support certain dynamics and functions depending on the direction of action for or against an accelerated energy transformation (Byrne et al. 2011: 9).

11. We are not using the term »regime« here in the political science sense, but on the basis of the transition research: »A technological regime is the rule-set or grammar embedded in a complex of engineering practices, production process technologies, product characteristics, skills and procedures, ways of handling relevant artefacts and persons, ways of-defining problems; all of them embedded in institutions and infrastructure.« (Rip and Kemp 1998, quoted in Grin et al. 2010: 20).

This chapter presents some of the key challenges, which a successful energy transformation must face. We pay particular attention to the, in some cases, conflicting narratives that dominate the debate about similar topics in different countries. The following points are examined in detail:

- *Energy is the essential foundation for economic development.*

Worldwide, about 1.3 billion people still have no access to modern energy (IEA 2012: 532). Establishing this access has priority over the issue of environmental- and climate-friendly power.

On the other hand, the challenge for emerging economies with extremely high growth rates is that the energy infrastructure must keep pace with this growth.

- *Energy transformation requires international cooperation.*

The scope for national solo efforts is limited because the electricity networks of most countries are more or less closely linked with those of the neighbouring countries. Therefore, changes in electricity networks and markets as a result of a high proportion of renewable energy do not stop at the borders of a country. Nowhere is this more apparent than in the EU.

- *Nuclear power is in competition with renewable energy.*

Nuclear power is an established technology and is often perceived as a supposedly climate-friendly alternative to renewable energy. Hence, it competes with renewable energy for scarce investment resources. In addition, nuclear power and fluctuating renewable energy are relatively poor complements in a power system with high security of supply due to their technical properties.

- *Many countries are dependent on the income from the production of fossil raw materials.*

In countries where fossil fuels are available in large quantities and at low prices, renewable energies have a hard time. Nonetheless, some of these countries recognize that their fossil fuel resources are finite and are also beginning to tap into their renewable potential.

4.1 Introductory Remarks

4.1.1 Cost Degression and Competitiveness

The cost of renewable energy technologies have declined dramatically in recent years, and this cost decline seems likely to continue. Alone because of the private costs – without considering the external costs of fossil fuels through environmental damage and direct environmental and health burdens – renewable energies are now preferred over their fossil fuel competitors in some areas. In many regions of the world, private customers and small companies can cover their electricity consumption more cost-effectively with their own photovoltaic systems than obtaining it for retail prices from the electricity grid. This applies to a relatively low-sunlight country like Germany, and even more in southern regions where a higher number of hours of sunshine increases the productivity of each individual cell and thus reduces the electricity production costs. While photovoltaics can already somewhat keep up with retail prices, in terms of wholesale prices, wind turbines are in many places even competitive with new coal and gas power plants. In a number of major markets – such as Australia, the USA, and Brazil – electricity from wind power is already, or will be in the very near future, competitive with power from existing fossil fueled power plants (Parkinson 2013). With further decreasing prices for renewable energy and at the same time rising prices for fossil fuels, the regions where renewable energy can prevail in price competition against fossil-based electricity will expand further.

4.1.2 Power Constellations: Losers and Winners in an Energy Transformation

Despite falling prices for electricity from renewable sources, the energy transformation cannot be taken for granted. Even if an energy transformation seems worthwhile from an economic perspective due to falling prices for renewable energy, there will also be losers, however, who want to hold on to the existing structures. They will try to use their market power to determine the political and social discourse, and thus secure their market share and ultimately their survival. The dominant stakeholders of the old, fossil regime are frequently the ones who stand to lose the most in the energy transformation. Either these actors realize the opportunities of an energy transformation and use their market power to become the drivers of energy transformation, or on the contrary, they employ their dominance to thwart the energy transformation. They are thereby in a conceivably favourable position, because they can build on existing path dependencies.

»*(...) [S]ystems of energy service tend to develop along path-dependent trajectories. (...) [E]nergy practices are the emergent outcome of complex, intimate and evolving relations between technologies, institutions, markets and people.*« (Byrne et al. 2011: 9)

The dominant actors in the old energy regime often try to exploit these path dependencies for their benefit, or to strengthen them through new investments in old structures. They emphasize the difficulties of the system change and try to shape the public debate about it in their favour.

»*(...)[T]here are many ways of ›framing‹ (i.e., bounding and understanding) any given energy system. (...) These framings inform generic narratives that guide both analysis and action. A framing will delimit the energy system boundaries, and privilege certain dynamics, functions and outcomes (...)*« (Byrne et al. 2011: 9).

The stakeholders of the old energy regime will try as long as possible – i.e., as long as they experience high profits with their existing business models – to determine these narratives and suppress alternative narratives to the best of their ability. Thereby, they can rely on their technological expertise and their influence on institutions and markets.

4.1.3 The Energy Trilemma

The global energy policy debate is based on a master plan, the energy trilemma that defines the energy sector's triangle of objectives (see Meyers et al. 2012: 29f). The three target dimensions of this scheme are:

- *Security of supply*, thus the securing of a functioning power system. This includes both the technical network stability within the country, as well as an international component when it comes to access to (fossil) resources and dependence on suppliers.

■ *Environmental compatibility* represents a major challenge in times of climate change. This includes the consequences of the nuclear disasters at Chernobyl and Fukushima, as well as the consequences of climate change, the consequences of the industrial extraction of raw materials, and the direct noise and pollution from power plants.

■ *Energy justice* includes not only the cost of energy supply – with its important aspects of the competitiveness of companies and the affordability of the costs for consumers – but also another component: access to modern energy. In view of more than 1.2 billion people without access to electricity worldwide, this aspect is currently central for developing countries.

The term »Energy Trilemma« implies that the three sides of the triangle involve three basic challenges, which together are difficult or even impossible to overcome simultaneously. Hence, energy policy, as the concept suggests, has to counterbalance the three dimensions in a compromise against each other.

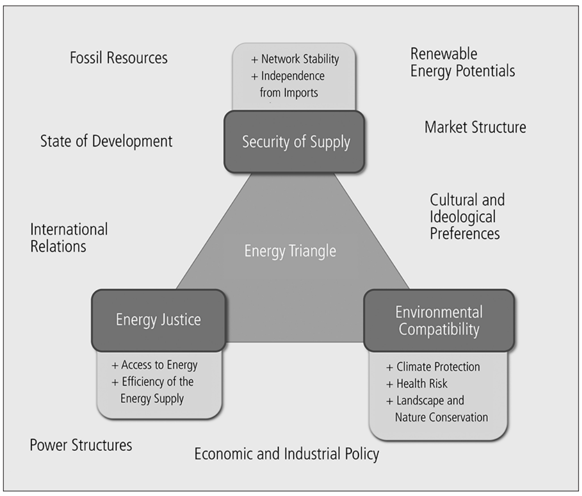
In view of climate change, it is becoming increasingly clear that the environmental compatibility dimension has thus far been too one-sided and as a result not sufficiently taken into account in this trade-off. The focus has been too much on short term effects, for example, in relation to the short-term effect of conventional air pollutants. The current global energy system is extremely unsustainable – i.e., on the way to breaching the planet's environmental boundaries. The planet's long-term resilience is not only exceeded in terms of climate change, but according to expert opinion, also in the areas of biodiversity and the nitrogen cycle. Only within these boundaries can the welfare of humanity be secured in the long-term. If the limits are exceeded, the danger exists of sudden and catastrophic environmental changes that also threaten the continued existence of human society, as we know it today (Rockström et al. 2009).

A possible explanation for this apparent failure is that the concept of the energy sector's triangle lacks a temporal dimension. A static, short-term optimization of the energy system designed on the basis of the energy trilemma can therefore easily lead to sub-optimal long-term results. For that reason, the long-term consequences of our energy production – in particular the consequences of climate change – were for the most part not adequately considered in the past. The same applies to the future costs of the energy system. Investments in energy infrastructure are highly durable in general, but also need a long preliminary phase. Precisely in these two aspects are renewable energy sources superior to conventional fossil fuels; they are more climate-friendly and play out their cost advantages only in the long run.

With the energy trilemma, it becomes clear how the analytic grid for the existing technological regime structurally discriminates against individual technologies. Yet, we cannot avoid drawing on the analytical grid for the energy triangle; it still provides an analytical framework that helps to embed many of the narratives described above. In addition, the energy trilemma itself still shapes the debate on energy policy. An analysis based on energy trilemma therefore makes it possible to consistently formulate our arguments for the debate within the existing energy regime.

Dominant energy policy narratives are often differentiated aspects of the individual components of the trilemma. Nonetheless, there are also formative narratives that feed on the closely related demands on the energy system, which are not directly associated with the energy trilemma. Figure 5 shows a graphical representation of the energy trilemma and some of the external factors that can have a significant influence on the development of the energy transformation.

Figure 5: The Energy Trilemma and External Factors (author's illustration)

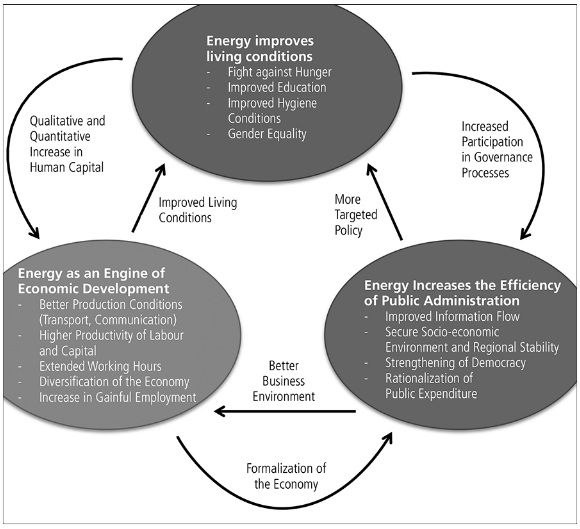


In this chapter, some of the most influential areas of conflict are classified and analyzed. We concur with both the aspects of the energy triangle, as well as some of the most influential external factors. When possible, we will draw on examples that illustrate that similar challenges are framed in very different narratives in different countries: those that create a fertile soil for the expansion of renewable energies and thus support a sustainable energy transformation, and those that have the opposite effect.

The narratives presented here are exemplary. They should contribute to a better understanding of the socio-political correlations on the often rocky road to energy transformation. Some aspects of these narratives are probably recognizable in almost every country, others probably do not play a role in many countries. It is also possible that in some countries, very specific narratives develop or have developed that are not listed here.

4.2 Renewable Energy as a Development Engine

Figure 6: Correlations between Energy and Human, Social, and Economic Development (Source: Kaygusuz 2012: 1119)



Secure access to energy is essential to modern economies and thus for social prosperity as we know it today. This is especially true for electric power. Empirical studies estimate, for example, income gains through electrification in rural Bangladesh rose from 9 to 30 per cent, depending on the security of supply. This income growth can be traced back to things as simple as the ability to use the evenings for economic activities. In addition to the income effects, the access to electricity considerably changes living conditions: Health care is improved because more favourable treatment conditions exist and drugs can be reliably cooled; and the education level rises, because the evenings can be used for studying (Khandker et al. 2009, IPCC 2012 : 721ff). The correlations between energy on the one hand, and the different dimensions of development – human development, social development, and economic development – are presented schematically in Figure 6.

Without access to electricity, development is limited. It seems hardly possible to overcome a certain development threshold without access to electricity. Therefore, in countries with a low level of development, energy policy is also always development policy and policy for poverty reduction. This relationship was an important argument that led the countries of the world to agree to promote a sustainable supply of modern energy worldwide in July 2012 at the Sustainable Development Summit RIO+20 in Rio de Janeiro. The promotion of sustainable modern energy was formulated as a separate target in the context of the development of the Sustainable Development Goals there (UN General assembly 2013: 24f).

Renewable energy can and must make an important contribution here. However, this is by no means a matter of course. If one succeeds in embedding the development of renewable energies in narratives that adequately address the most pressing development problems, an energy transformation as a part of economic development is possible and useful.

In the following we will investigate, as an example, the situation of the Least Developed Countries (LDCs) on the one hand, and take a look at the situation of emerging countries on the other. The fact that this separation in reality cannot always be clearly maintained, and sometimes in one and same country various narratives can exist next to each other – due to large development differences – will become clear in the example of India.

The Poorest Countries in the World

According to the report »World Energy Outlook« from the International Energy Agency, 1.265 billion people worldwide in developing countries have no access to electricity (IEA 2012: 532). Most of these people live in rural areas in Africa and South and Southeast Asia. Naturally, the challenge »energy transformation« is entirely different for these people than for people and companies in industrialized countries. An energy transformation here cannot mean a transformation of the existing energy infrastructure; rather it has to do with establishing an energy infrastructure in the first place.

In countries where a large proportion of the population still lives without electricity, the focus of the energy sector debate will be on energy justice. In these countries, a strategy change to renewal energy will only succeed, when it is embedded in a narrative oriented on energy justice.

Narrative: »Renewable energy can help to leapfrog unsustainable models of development.«

The expansion of decentralized and renewable structures, isolated systems, and mini-grids – especially in rural and sparsely populated areas – despite the higher costs for electricity generation, can on the whole be more cost effective, if as a consequence investments in the expansion of central power grids are renounced. The triumph of mobile technology in developing countries makes it clear that development does not necessarily have to follow the prescribed development paths of industrialized countries. Communication technology could only spread so quickly there, because new opportunities made the costly expansion of a wired network unnecessary (Deichmann et al. 2011). Various economic analyses suggest that there is also high potential for renewable operated decentralized energy supply systems (Thiam 2010; Szabó et al. 2011; Deichmann et al. 2011).

Basically, the conditions for renewable energy in almost all developing countries are extremely good. Africa, for example, as a continent with the largest proportion of the population without access to electricity offers excellent physical conditions for the use of renewable energy. Even the most unfavourable locations in Africa still reach a potential for electricity from solar plants of over 3,000 Wh/m^2 per day (Chineke and Ezike 2010). There is large wind energy potential, for example, in northern West Africa and the Horn of Africa. The Great African Rift Valley offers good opportunities for the use of geothermal energy. For the exploitation of hydropower, including small hydroelectric power plants, there are also suitable conditions in many parts of Africa, including in Ethiopia, Kenya, and Uganda (IPCC 2012: 96; Arens et al. 2011).

Even where there is already a connection to the power grid, (decentralized) renewable energy can still provide an added value. The central power supply in many developing countries is very unreliable. The power supply frequently collapses for hours or even days. This often leads to high economic losses and makes it impossible for companies to optimize their business activities. While in industrialized countries the irregular availability of renewable energy is cited as an argument against an energy transformation, the decentralized renewable supply systems in many developing countries could even increase the security of supply; because the supply of wind and solar power is indeed irregular, but in contrast to power outages, to some extent predictable, enabling businesses to plan their production better.

Renewable energy also has a very good reputation in developing countries. Polls show that a large majority of the Nigerian population rates it positively when the expansion of renewable energy is given priority. From a representative sample of 650 respondents from the Niger Delta, 87 per cent stated this desire, and the authors suggest that these results can be transferred to other regions in Africa (Chineke and Ezike 2010).

Narrative: »The expansion of renewable energy is too expensive.«

However, there are also unresolved issues that stand in the way of the nationwide expansion of renewable energies in developing countries. The financing problem must be emphasized. Even where renewable energy is in the long-term more cost-effective than fossil fuels, it is questionable whether a financing of the renewable infrastructure is possible. The reason is that the cost structure of renewable energy in part differs greatly from that of fossil fuels. While the total costs incurred in renewable energy – such as wind, solar, hydro and geothermal energy – are almost entirely in the form of investment costs at the beginning of a plant's operating life, the initial investment costs in many conventional power generators, such as diesel generators or gas turbines, is relatively low; instead, high fuel costs accrue over the plant's operating life. If the available investment funds are limited, it may thus be useful from the perspective of political stakeholders, despite the higher total cost, to invest in fossil fuels to close short-term gaps in coverage. In the case of an acute supply crisis, political stakeholders could thus achieve the greatest effect in the short term and capture political capital. The negative consequences – higher overall costs over the life of the plant – probably do not carry much political weight.

To escape this dilemma, it has to be recognized in the financing of infrastructure projects. Donor countries could shift the interests through guarantees and thus reduce the capital costs for renewable energy projects in developing countries, and in this manner shift the cost structure in favour of renewable energy.

The cost structure of renewable energy also leads to the (perceived) risk of investors increasing. In contrast to fossil fuels, investors – if they opt for renewable energy – generally expose their capital to a greater extent and for a longer risk period. There are also risks, such as the previously limited experience of many project developers and owners in dealing with renewable energy – not only with its technology, but also with administrative hurdles such as licenses, network access, and the like (IPCC 2012: 882).

Another problem is the financing structure of the financial sector. It corresponds only to a limited extent to the structure of decentralized supply systems based on renewable energy. Traditionally, most banks, including dedicated development banks, are set up to finance individual, large infrastructure projects. Renewable energy projects, however, generally have a much smaller scope than investments in coal, gas, or even nuclear power plants. In comparison, smaller projects usually have disproportionately higher transaction costs, because the expenditure for feasibility studies is not significantly different from that for large infrastructure projects. Moreover, investors – even if the net return of renewable energy is competitive – favour investment in fossil plants due to a higher gross return (IPCC 2012: 882). For the financing of small, decentralized photovoltaic systems, or run-of-the-river power plants, it may be necessary to mobilize private investors with the assistance of appropriate financing instruments, like small and micro loans. Such tools already exist, but they are far from widely disseminated (Mainali and Silveira 2011; Brew-Hammond 2010; Rao et al. 2009).

Narrative: »Industrialized countries just want to develop new markets for their renewable energy technologies.«

Again and again, the argument is put forward by actors from developing countries that the pressure on behalf of industrialized countries for the development of renewable energy is less motivated by a concern for the environment, but more by market-based interests. The industrialized countries are accused of only being interested in the development of new markets.

However, the market for renewable energy technologies is by no means one in which the classical division between developed and developing countries predominates. Meanwhile, emerging markets such as India and particularly China are strongly represented here and have supplanted industrial countries – for example, in photovoltaics – in terms of market share (for more information, also see the subsection »Emerging Markets« in this chapter). Nevertheless, it has to be taken into consideration that the least developed countries have thus far not ranked among the main investors and profiteers in the renewable energy sector.

Ultimately, this does not contradict the other (positive) narratives that we present in this section – not even when market economic interests on the part of industrialized countries in the promotion of renewable energies play a role. Even if the renewable energy technologies are fully imported, direct and indirect jobs develop in the country – for example, in the establishment and maintenance of the systems. In Bangladesh, small solar systems for domestic use have been booming for several years. In the last ten years, the number of such systems has increased from around 25,000 to more than 2.8 million and it is expected that this trend will continue. In particular, the assembly of such systems, but also the joining of the individual system components and the maintenance of the installed systems have led to the creation of more than 100,000 jobs in the country (IRENA 2014).

South Africa takes this much further. The declared aim of the South African Renewables Initiative (SARi) is to promote the development of renewable energy systems and at the same time to build a renewable energy industry in the country. In the initiative, South Africa is working with international partners. These are the governments of Denmark, Germany, Norway, the United Kingdom, and the European Investment Bank (SARi 2014). South Africa has announced tenders for a total of 10 GW capacity through the so-called Renewable Energy Independent Power Producer Procurement Programme.

Currently, the bidding for the programme is in its third round. Particularly worth mentioning is that in the tenders, a minimum of 40 per cent local South African contributions in the value chain is demanded as a condition. For the current round, it is understood that the following shares are achieved: wind turbines, a local share of 46.9 per cent; photovoltaic systems, a local share of 53.8 per cent; and for solar thermal power plants a share of 44.3 per cent (Rycroft 2013: 9).

With the appropriate strategic formation, the renewable energy business can be one in which developing countries also benefit strongly.

Narrative: »Renewable energy runs contrary to long-established power elites and contributes to democratization.«

Similar to many industrialized countries, the resistance of long-established companies and elites in developing countries is a major constraint on the expansion of renewable energy. Frequently, these stakeholders dominate the debate on energy policy and maintain their interpretative authority. However, the population at large, but also many entering actors, are not sufficiently informed about the skills in dealing with renewable alternatives. The development of appropriate competencies takes time and is in competition with the existing (fossil) energy regime, which supports itself through the education and training of workers (IPCC 2012: 881f). It has been shown time and again that central supply systems and power structures strengthen each other. Elites can exert their power on the basis of centralized structures, including energy supply structures, and vice versa, elites secure the continued existence of centralized structures. This seems to inhibit the interests of the power elites for a decentralized energy transformation. Where corruption plays a role in the energy sector, this effect is even stronger. For example, the energy sector remains dominated by a small elite in Tanzania, which they could consolidate – despite or possibly because of the failed privatization plans in the 1990s (van der Straeten 2013: 28f, 34).

A focal point of the dispute between established companies and civil society was also the construction of the massive Medupi coal power plant in South Africa. The South African power company Eskom was able to prevail against the resistance of a broad civil society alliance of trade unions, environmental organizations, academia, and local groups to secure the financial support of the African Development Bank as well as – this was particularly controversial – the World Bank, and implement the project (Rafey and Sovacool 2011). Although South Africa and the dispute over the Medupi project are certainly not typical of conflicts in the rest of Africa, the example nevertheless shows the strategies with which the old-established companies successfully assert themselves and their power.

The Dispute over the Medupi Coal Power Plant in South Africa

The South African state-owned power utility Eskom is currently building on the border with Botswana, the largest coal power plant in the country. The first of six power plant units, each with 800 MW, should go online in 2014. The plant, with a total of 4,800 MW is expected to cost nearly 18 billion US dollars and cover 10 per cent of South Africa's electricity consumption. The power plant is also of great importance beyond the country's borders, because South Africa powers a large part of southern Africa through a collective electricity grid.[12]

Eskom could not carry the huge investments alone. The construction is supported by loans from the African Development Bank and the World Bank. The support of the World Bank, in particular, has provoked strong criticism in South Africa and worldwide. The dispute over the construction of the power plant is in some ways typical of the debate between defenders of fossil fuels and advocates of renewable energy in developing countries. The intensity of the debate, its concentration around the World Bank's vote to grant loans, and its general publicity enabled a thorough work-up of the discourse shaped by proponents and opponents (Rafey and Sovacool, 2011). The main results of this analysis are summarized in the following comparison.

→

12. This includes a total of nine countries: South Africa, Botswana, Democratic Republic of the Congo, Lesotho, Mozambique, Namibia, Swaziland, Zambia, and Zimbabwe.

←

Proponents	Opponents
▪ *Economic Development:* Abundant and cheap energy is essential for economic development. The power plant creates a basis for secure and predictable economic growth. ▪ *Sustainability:* The facility is highly efficient and a great improvement over existing facilities. Moreover, the power plant is embedded in an integrated climate protection strategy. ▪ *Energy Security* The power plant relies on South African coal and makes the country independent from imported raw materials from other countries. ▪ *Lack of Alternative:* There are no real alternatives. Thus, it is inconceivable and unacceptable not to build Medupi.	▪ *Misguided Development:* Only bureaucrats, large corporations, and the World Bank profit from Medupi, at the expense of the (impoverished) South African population. ▪ *Environmental Destruction:* The plant not only has a devastating impact on the climate, but through other emissions and coal mining, also on the direct vicinity of the power plant. ▪ *Energy Poverty:* The enormous investments will have to be refinanced through higher electricity prices. This additionally burdens the poor population. Furthermore, alternative, especially decentralized concepts for universal access to electricity are crowded out. ▪ *Democracy:* The opponents see themselves as part of a global movement, supported by general population and democratically legitimized, while the proponents only represent the interests of a small elite.

Emerging Countries

In many emerging countries, the situation is more differentiated. While for countries with a very low level of development the debate on energy policy is strongly oriented towards the target energy justice, energy security and environmental sustainability as well as external factors also play an increasingly stronger role in emerging countries, as the examples of India and China show.

The partially rapid development of many countries in the past ten to 20 years has meant that there are many highly developed regions in these countries, which only marginally differ from those in developed countries. At the same time, other regions lag behind in development. Nowhere is this more apparent than in India. India remains, despite strong economic development in recent years, the country where absolutely the most people live without access to electricity – almost 300 million people are still undersupplied (IEA 2012: 532). Of course, the narratives described above remain for these people as valid as in LDCs. In India, renewable energy can also make an important contribution to electrification, especially in rural areas (Nouni et al. 2009).

Narrative: »Industrial Policy: Renewable energy is the market of the future.«

At the same time, India is now also active as a technology provider in the market. For example, the Indian company Suzlon is the world's fifth largest manufacturer of wind turbines with a global market share of 7.4 per cent. In wind power, India was in 2012 – after the USA, China, and Germany – the country with the highest investment; and also in absolute installed capacity, India is among the top five worldwide (REN21 2013: 17, 50). The expansion of renewable energy here also has an industrial policy aspect.

It is similar in China. The country is driving the expansion of renewable energy so strongly, among other reasons, because it wants to secure a strategic position as a technology leader in the field of renewable energy and thus strengthen its geopolitical role. The renowned Chinese economist and government adviser Hu Angang describes the relationship between technology leadership in renewable energy and geopolitical position as follows:

»Different waves of industrialisation and modernisation have been tied to the emergence of important new energy technologies. Historically, the countries that have been able to effectively exploit these new energy technologies before anyone else have succeeded in increasing their influence and changing the balance of power in the international system.« (Quoted in Boyd 2012: 12)

At least as far as the first part of this statement, China is extremely successful. In 2012, China was the country with the largest investments in renewable power plant capacity. In hydropower, China was the world number one. In the field of wind turbines, it was surpassed only by the United States. In photovoltaics, China was in third place behind Germany and Italy (REN21 2013: 17). Forecasts for 2013 even see China in first place, closely followed by Japan (Bloomberg New Energy Finance 2013). China is also far ahead in the development of solar thermal systems. In the first half of 2013, more renewable than conventional power generation capacity was added to the Chinese power grid for the first time (Reklev 2013). Moreover, not only in expanding, but also in the absolute installed performance, China is the world leader – both with and without consideration of large hydropower plants (REN21 2013: 17).

This expansion has meant that China is also among the leading technology providers in the field of renewable energy. Chinese companies dominate in the solar industry. The largest manufacturer of PV modules is Yingli Green Energy (6.7 per cent market share). All Chinese module manufacturers together cover more than 30 per cent of the total photovoltaics market (REN21 2013: 41). Even in the wind industry, Chinese companies are competitive. The four largest Chinese companies – Goldwind, United Power, Sinovel, and Mingyang – had a combined market share of 16.6 per cent in 2012 (REN21 2013: 50).

Narrativ: »Clean renewable energy is an important contribution to solving acute environmental problems.«

However, the industrial policy aspect is by far not the only motive for the Chinese commitment to renewable energy. Equally important are the aspects of environmental impact. Thereby, the consequences of climate change are a secondary theme, although the Chinese government also recognizes the dangers of climate change for the country: damage caused by extreme weather events, heavy loss of biodiversity, melting permafrost and glaciers in Tibet and the resulting massive effects on the Chinese river systems, the rise of sea level with threats to the densely populated and highly developed coastal region, as well as the impact on the social structure and development prospects of the poorer social strata (Boyd 2012: 8). However, much more urgent – because they are more acute – are the effects of air and water pollutants. For 2011, the immediate environmental damage is estimated to be 5 to 6 per cent of gross domestic product (Watts 2012). In 2013, China's economic metropolises suffered under smog so heavy that in some places public life collapsed entirely for days, as in the city of Harbin in October.

The Chinese government is responding to these environmental problems first and foremost with sharp energy-efficiency measures. These stretch so far that it was even ordered in 2010 to take inefficient factories, which did not meet environmental standards, out of service so that the objectives of the eleventh Five-Year Plan could still be achieved (Branigan 2010). In September 2013, it was announced that the Chinese government had decided that no new coal power plants were to be allowed in three of the most important economic regions – Beijing, Shanghai, and Guangzhou (Watt 2013). Furthermore, four of eleven pilot emissions trading systems in China are now meanwhile underway.[13] Similar to European emissions trading, industry and power plants are obliged to

13. The emissions trading systems began in December 2013 in Shenzhen, Shanghai, and Peking, as well as the region Guangdong.

account for each tonne of greenhouse gases they emit and match them with a emission allowance certificate. With this a carbon price forms, which increases the price of the climate-damaging plants and thus shifts the cost structure in favour of renewable energy (ICAP 2013). If renewable energy in China is not at the core of this narrative, it can still benefit from it.

Narrativ: »We need renewable energy to meet the rapid increase in demand.«

Another major reason for the expansion of renewable energy in China is energy security. Chinese economic growth and the growing hunger for energy is so great that the energy supply is barely able to keep pace. For example, China has one of the largest coal reserves in the world. Yet, China has to import large amounts of coal, because the country's infrastructure simply does not allow the transportation of the coal needed from the north and west of the country to the economic centres. Because of this gap between power demand and supply, there have been repeated widespread power failures in the past (Boyd 2012: 4). With energy efficiency measures, the Chinese authorities are trying to master the problem on the demand side. At the same time, the issue for the government on the supply side is less a question of which additional types of power plants can be prioritized. Instead, several options are developed in parallel, and these also include – besides coal, gas, and nuclear power – renewable energy. In addition to efficiency measures, the expansion of renewable energy is therefore one of the pillars of the Chinese government's energy security policies.

The examples of India and China make it clear, how multidimensional energy narratives can be in emerging markets: Renewable energy is an engine of growth and development, it is a climate protection instrument, and the object of a strategic economic and industrial policy. An energy transformation to a sustainable power supply will only be successful where it is possible to integrate different renewable energies in supporting narratives, to reconcile them with each other, and thus to achieve synergies. Scenario analyses show that such holistic approaches to energy policy are better able to mobilize the huge investment needed in renewable energies (van Vliet et al. 2012, Jiang et al. 2013).

4.3 Cooperation or Conflict? Energy Transformation as International Project

Very few countries operate their power grid completely independently of their neighbours. The linking of national transmission systems is sensible. It increases the network stability because of the failure of individual power plants may be better absorbed into a larger network. Costs can also be saved through international trade, as the case may be. And the integration of neighbouring power grids becomes more advantageous, if high amounts of renewable energy feed the networks: The larger the surface on which renewable energy power plants are distributed, the greater their secure contribution to the power supply, because the farther the plants are away from each other, the better weather fluctuations can be compensated for. Moreover, not all countries have the same potential for renewable energy. When different types of renewable energy sources are connected with each other via a large integrated power supply, they can complement each other.

However, the connection of different national electricity systems also leads to the fact that changes in the power system of one country affects the electricity networks and markets of neighbouring countries. Nowhere is this more apparent than in the European Union. The German »*Energiewende*« is often perceived in Europe as a national solo effort. So far it has for the most part only concerned the German energy sector. But the further the energy transformation in Germany advances, the stronger the consequences will appear also in Germany's neighbouring countries and the rest of Europe. If the energy transformation is to be successfully implemented, electricity from renewable energy sources has to change from a niche product to the dominant source of the total electricity market.

An energy transformation is an enormous challenge for the established structures, market design, and the most technologically institutional infrastructure, particularly because electricity from fluctuating renewable energy sources has fundamentally different economic characteristics than, for example, electricity from gas or coal power plants. The production of electricity from wind, solar, and hydropower generates no short-term marginal costs: Electricity is produced when the wind blows, when the sun shines, or when sufficient water is available in the reservoirs. Therefore, the production does not obey the rules of the previously existing markets. Unlike conventional thermal power plants, the lion's share of the charges is attributable to the investment costs. The costs of plant operation and fuel hardly accrue, or not at all. In Germany, the first consequences of this altered cost structure are already appearing. The rapid development of wind and solar power in recent years has meant that wholesale electricity prices have dropped sharply. According to the Federal Statistical Office, the average monthly purchase prices for electricity traders in the last five years have fallen by almost 40 per cent.[14] Given this development, it is unclear whether investments in new facilities – which are perhaps not funded by the German Renewable Energies Act (EEG) – will be refinanced in the future under the existing market structures.

Many experts assume that the current energy-only markets cannot set sufficient investment incentives to guarantee security of supply in the long term. In Germany, therefore, a debate on the revision of the EEG and structural reform of the electricity market is beginning, driven by the »*Energiewende*«. Among other things, capacity markets are being discussed: In these markets, power plant operators would be paid a premium for the provision of (flexible) generation capacity, in addition to compensation for the electricity generated (see, for example, *Bundesverband der Energie- und Wasserwirtschaft* 2013). Such a market design would be fundamentally different from the current structures, and present the politically desired integration of the European electricity markets with a major challenge.

In the UK, the government has recognized that the traditional market system is not compatible with the challenges of a sustainable power supply. Consequently, it already carried out a reform of the electricity market in 2012, in which it introduced a capacity mechanism as well as a so-called feed-in tariff with contract for difference, which should make electricity from climate-friendly sources economically viable (HM Government 2012).

Narrative: »The costs of the German ›Energiewende‹ will be passed on to neighbouring countries.«

However, not all European countries are constructively dealing with the technical and economic challenges of the energy transformation. Until now, the Polish government thinks very little of an energy transformation to renewable energy. Poland is heavily dependent on its coal reserves, and the government wants to adhere to the extraction of fossil fuels. The Polish government fears that a more ambitious climate policy could lead to a so-called carbon leakage, which means that particularly energy- and emission-intensive industries could shift to Belarus or Ukraine, and thus the Polish industry would be weakened. Empirical studies show, however, that this risk hardly exists (Sartor and Spencer 2013).

The Polish attitude was also clear during the United Nations Framework Convention on Climate Change (UNFCCC) held in Warsaw in November 2013. The Polish government set up, parallel to the UN climate change conference, the high-level International Climate & Coal Summit of the World Coal Association on the premises of the Ministry of Economic Affairs (see also introductory chapter).

In this light, the announcement by the Polish transmission system operator (PSE Operator) and its northeast German counterpart (50 Hertz) to build so-called virtual phase shifters on the coupling point of the Polish-German border (50 Hertz Transmission 2012), seems like the attempt to detach itself from Germany. With these systems, it is possible to regulate the electricity flows between the two networks and, if necessary, to break the connection. Indeed, there are such generators on the borders with Germany's western neighbours and in an emergency, they can also help with grid stability when extreme situations occur. Nevertheless, the media in Germany interpreted the announcement in this specific case as »revenge for Germany's solo effort« in the energy transformation (Wetzel 2012).

To turn this narrative around, it would be necessary for proactive countries within the EU, including Germany, to enter into a dialogue with Poland, which is much stronger and on a broader level, in order to begin a constructive process for the design of a European energy transformation.

Narrative: »As a joint project, the energy transformation can advance European integration and help to overcome the European economic crisis.«

14. Responsible for this is the so-called Merit Order effect of the renewable energy feed-in: Renewable energies are increasingly replacing power plants that have relatively high marginal costs and determine the price on the electricity exchanges. The high cost of gas power plants, especially at lunchtime when the demand was particularly high, was particularly noticeable in the past. With the increasing feed-in, particularly from solar power, these power plants are rarely price setting. As a result, the average electricity price falls (Sensfuß et al. 2008).

The European Union has developed historically from an association to the joint regulation of energy and heavy industries. The European Coal and Steel Community (ECSC) enabled one of the first free trade zones, and was the forerunner of the European Community and the subsequent European Union. A European energy transformation offers enormous opportunities. The idea of the energy transformation meets with great approval in European civil society. Even in Poland, the government's negative attitude is in sharp contrast to the wishes and expectations of the Polish population. A representative survey of 1,066 participants commissioned by Greenpeace in the run-up to the climate summit came to the conclusion that an overwhelming majority of Poles support renewable energy (87 per cent). 70 per cent of respondents even said that the Polish energy policy should prioritize the development of renewable energy (Greenpeace 2013). If it is possible to embed the energy transformation in a narrative as a joint European project, the energy transformation – as an identity-establishing moment – could point to a way out of the European crisis, by perhaps drawing up a European investment programme for renewable energy on a large scale. Thus, the countries of the European Union could together pursue a positive path to a sustainable future and overcome the ongoing economic crisis.

For this to succeed, it would be necessary to link the current political debates on energy transformation in the member states more closely together, and to enter into direct dialogue. This is already happening, for example, in the context of cooperation between the countries of the region Central Western Europe (CWE), within the European Network of Transmission System Operators for Electricity (ENTSOE). These were originally France, Luxembourg, Belgium, the Netherlands, and Germany; meanwhile, it also includes Austria and Switzerland. In this region, the electricity markets are coupled to each other with the aim of a far-reaching harmonization of prices. Already in 2007, the relevant regulatory authorities signed a corresponding Memorandum of Understanding (MoU). These seven countries are also the ones that decided on a work programme in June 2013 to further promote market integration and jointly tackle the challenges described above (Pentalateral Energy Forum 2013: 6f).

Beyond that, an extensive consultation process was started in France – *Débat national sur la transition énergétique* (national debate on energy transformation). Between January and July 2013, stakeholders from civil society, business, and politics were invited in different rounds to discussion forums. The stakeholders summarized the results of these consultations in a synthesis paper, which serves as the basis of a draft law to be developed and resolved in 2014. Although the European perspective of the energy transformation was not the focus, it was repeatedly introduced into the debate by some stakeholders – such as the *Réseau Action Climat France* (RAC-F), a network of 18 environmental, transport, and development organizations in France – so that the synthesis paper also embraces this perspective (*Conseil national du débat de la France* 2013: 39).

The European dimension of the energy transformation is also perceived at the level of the French government. Thus, Delphine Batho, who was French Minister for Ecology, Sustainable Development and Energy at that time, participated at a conference of the European Economic and Social Committee (EESC) with the title »Energy Transitions and Public Dialogues: National and European Perspectives«. Together with her Danish counterpart, and a representative of the European Commission, she emphasized the necessity to modernize and expand the European electricity grid, to completely integrate the European electricity market, and, where appropriate, to harmonize the mechanisms to ensure sufficient power plant capacity (EESC & *Notre Europe – Jacques Delors Institute* 2013).

The further the energy transformation progresses, the more important it will be to strengthen the narrative of the energy transformation as a European project and to seek dialogue within the European Union. Thereby, Germany is due a special role, because the country forms the largest electricity market in Europe. If renewable energy squeezes wholesale power prices in Germany and forces conventional power plants to a more flexible plant schedule, this also indirectly applies to the electricity markets associated with Germany. It would not benefit the energy transformation either in Germany or Europe, if other European countries felt compelled to take on the German market model. If Germany, despite the increasing impact on neighbouring countries, further accelerates the energy transformation against their will and leaves the countries concerned alone with the consequences of their own policies, this conflict could have an impact on other areas of the EU. A German solo effort would fundamentally contradict the idea of European solidarity. Against the background of dealing with the European financial and economic crisis, in which the German federal government has often asserted its political ideas against opposition of the states concerned in an extremely dominant way, the reckless enforcing of the German »*Energiewende*« and the resulting energy or electricity hegemony within Europe could weaken the idea of Europe and further EU integration.

4.4 Nuclear Power and the Energy Transformation: Bridge Technology or Billion-dollar Grave

Nuclear power is playing a diminishing role in electricity generation worldwide. In 2012, the share of nuclear power in electricity production fell by as much as 7 per cent (Schneider et al. 2013). This is not only because other power plants are being expanded at a faster pace, but also the fact that for some years more nuclear reactors have been shut down than newly commissioned. This development is not just since the nuclear disaster at Fukushima in March 2011; even before that experts saw that the nuclear industry was already in decline (Schneider et al.: 6).

Nevertheless, nuclear power is proposed again and again as the (interim) solution in climate protection and to meet the growing energy demand in developing countries. Worldwide, there are currently 66 reactors under construction – most of them in China, India, and Russia. According to the International Atomic Energy Agency (IAEA), a total of 29 countries are currently conducting programmes in order to use nuclear power for energy production for the very first time (IAEA 2012: 18). Especially in many developing countries, politicians and other civil society actors hope for economic recovery and a solution to many problems from nuclear power. In addition, many connect a good reputation with the civilian use of high-tech nuclear power. A country that is able to control nuclear power proves its progressiveness and in the eyes of many, leaves the status of »developing country« a bit behind.

Globally, nuclear power or its lobby was – and is – a top dog in the energy sector debate. It is in strong competition with renewable energy, particularly for scarce investment resources. In addition, nuclear power and fluctuating renewable energies are only technically compatible with each other to a limited extent: While the fluctuating feed of renewable energy has to be supplemented with flexibly controllable power plants, nuclear power plants are very slow, and controllable at very high costs.

The role of nuclear power within a country's energy mix is often controversial. Narratives often form around this debate, which can have a strong impact on the success or failure of energy transformations. To understand the effective direction of these narratives, it helps to situate the nuclear debate within the energy triangle described above.

The dangers posed by nuclear power plants are obvious. The catastrophic consequences of the accidents at Chernobyl and Fukushima have made this all too clear. For many people, nuclear power is thus not (any longer) acceptable in the sense of an environmentally friendly energy supply. This aspect has dominated the debate in Germany. Compared with this, in the United Kingdom the focus – also in terms of environmental sustainability – is on the supposed environmental friendliness of nuclear power.

In the past, it was primarily these two aspects that shaped the nuclear debate. In the context of a transformation towards a sustainable energy supply, the conflict between nuclear power and renewable energy sources – but increasingly also from the point of view of security of supply and the profitability of the energy supply – is virulent.

Narrative: »The nuclear phaseout enabled the energy transformation in the first place.«

Especially outside of Germany, the disaster at Fukushima in March 2011 is often considered to be the starting point for the German »*Energiewende*« and the subsequent final phaseout of nuclear power (see, for example, Gerke 2012). The expansion of renewable energy had already been promoted with the EEG and its predecessors for over ten years. Even if this perspective is an incomplete reality, it is nontheless indisputable that the nuclear phaseout is an integral part of the »*Energiewende*« in Germany (Mez 2012). Only when it was clear to all stakeholders that nuclear energy would make no further significant contribution to the German power supply in the future could a broad political consensus to that effect form – to close the resulting gap, initally with the help of renewable energy and in the long term to rely entirely on renewable energy. Hence, the nuclear debate has made a positive contribution to the »*Energiewende*« in Germany, by having raised the issue from a niche into a wider public.

The situation in Japan is similar. In Japan, the concept of energy security has always been at the heart of the energy policy debate. The country consists of a densely populated, relatively isolated island group, and has no appreciable fossil resources of its own. Despite the traumatic experiences in World War II, the Japanese population has borne the civilian use of nuclear power for decades, and Japan has even become a leading provider of technology for nuclear power plants. With the devastating disaster in Fukushima, however, this attitude to nuclear power changed abruptly. Yet what has not changed is the great concern about energy security (Calder 2013).

Against this background, the Japanese government has massively reversed its energy policy: It now pursues a strategy, according to which the country is to survive in the medium to long term completely without nuclear power (McLellan et al. 2013). Their share is to be compensated by the use of coal and natural gas – which reaches Japan via liquified natural gas (LNG) freighters – as well as by renewable energy. For the first time, the development of renewable energy received attention at the highest political level. In 2010, the share of renewable energies in electricity production stood at about 5 per cent, 3.5 per cent of that from hydropower. Since then, however, a massive boom in renewable energy has begun. The feed-in tariff introduced in mid-2012 developed into a success story, especially for photovoltaics. In 2012, Japan was already in fourth place of the countries with the highest investment in renewable energy (REN21 2013: 17). For the expansion of photovoltaics in 2013, it is expected that Japan has taken second place, just behind China, in newly installed capacity, but due to the higher costs represents the market with the highest turnover in the world (Bloomberg New Energy Finance 2013).

Despite its status as a high-tech country, Japan lagged behind other countries in expanding renewable energy for a long time. The change in energy policy after the Fukushima disaster has brought about a transition. This is most evident in the province of Fukushima itself, which announced that they would meet their energy needs from 100 per cent renewable energy sources by 2040 (Phillips 2014).

Narrative: »Cheap nuclear power versus expensive renewable energy«

Only in recent years has this narrative, which has massively hampered the energy transformation, lost its influence. It is becoming increasingly clear that the signs of the cost equation have changed. The costs of new nuclear power plants have exploded. Increasing safety requirements are one reason for this. The experience with the construction of new reactors, such as in Finland and France, has shown that the construction work is often delayed for years. Despite the very low global interest rates, companies have to pay extremely high risk premiums for the construction of nuclear power plants, which lead to very high capital costs. In February 2013, the news service Bloomberg reported that the French electricity company EDF would bow out as the last bidder in the race for a new nuclear power plant in the UK if the British government would not ensure the profitability of the project (Patel 2013). Thus set under pressure, in October 2013 the British government agreed upon a minimum price with EDF of about 90 pounds per MWh of electricity, including compensation for inflation and guaranteed for 35 years (HM Government 2013). This price is significantly higher than the costs that are paid for most renewable energy sources, and about twice the current market price.

While the cost of building new nuclear power plants in recent years has increased sharply, the cost of renewable energy – particularly wind and solar power – has decreased. For the future, essential factors also indicate that the cost advantage will continue to shift in favour of renewable energy (see, for example, de La Tour et al. 2013, Lantz et al. 2012, and Schroeder et al. 2013). Nuclear power has been researched intensively for more than 60 years. There were rarely extensive technical breakthroughs in the past, and there are hardly any expected for the future. Nuclear power has only a conditional potential for cost degression through learning effects. For this, the quantities in which nuclear power plants are built are much too small (Grubler 2010, Hirschhausen et al. 2013). The exact opposite is the case for renewable energy. The market is growing rapidly, and thus in many cases significant learning effects can still be realized, not only in the production of the plants, but also in the installation and maintenance.

However, regardless of the overall economic cost advantages or disadvantages, new nuclear reactors are still in competition with the expansion of renewable energy. Both technologies have high initial investment costs. In a world of scarce resources, one must assume that a decision for the expansion of nuclear power at least partially deprives renewable energy these resources and thus reduces their promotion.

Narrative: »Nuclear power is a climate-friendly bridge technology.«

Frequently, nuclear power is highlighted as a promising bridge technology that can produce climate-friendly[15] electricity, as long as renewable energies are still prohibitively expensive and its availability is not guaranteed at all times.[16]

However, it is questionable to what extent nuclear power in a sustainable energy economy can make a contribution to grid stability within an energy mix dominated by renewable energy. Particularly where fluctuating renewable energies – such as wind and solar power – dominate, the rest of the power plant complex has to be extremely flexible in order to offset the fluctuations in the feed of renewable energies. Of all the thermal power plants, however, nuclear power plants are the most inflexible. They can only change between 1 and 5 per cent of their nominal capacity per minute. Gas turbines, in contrast, are able to increase or curb their performance by up to 8 per cent of the nominal capacity. The flexibility of nuclear power plants is even more limited when they need to be completely started up or shut down. In a heated state, a nuclear power plant requires two to three hours to be started. If the reactor is shut down cold, it needs at least 25 hours (Swider 2006). In Germany, this has led to the fact, which at first glance might seem absurd, that negative hourly prices were paid on the electricity exchange. This means that consumers received a renumeration if they took additional power. However, these negative prices are understandable if one bears in mind that operators of nuclear power plants and other inflexible systems are willing to pay a price for their plants to be allowed to run instead of possibly shutting down for several hours, and in consequence to forego profits until a later time.

In the long term, it is expected that the structure of the transmission and distribution will change over the course of a successful transformation process. So far, the networks in most industrialized countries are laid out so that the electricity is routed from a few large power plants to the demand centres and distributed from there. Thermal power plants are relatively free in the selection of location, which is why the plants are built as close to the demand centres as possible. The electricity grids are now facing the challenge that renewable energy systems – with the exception of large hydropower plants, offshore wind farms, and where applicable geothermal power plants – are much smaller and decentralized, adjusted to the potentials, and distributed. The networks will have to adapt to these challenges. The construction of new nuclear power plants, however, would consolidate the old, centralized network structure and could thus potentially inhibit or delay the necessary restructuring of the electricity networks.

Against this background, it is clear that nuclear energy is only suitable to a very limited extent as a complement to fluctuating renewable energies. Especially in countries where there is high potential for wind and solar energy, and it is intended to play a supporting role in a sustainable energy system, a renaissance of nuclear power seems to increase the transformation challenge further.

Narrative: »Nuclear power enhances national reputation.«

On the other hand, nuclear energy continues to be a high-tech product and is perceived as such. Especially for developing and emerging countries, the civilian use of nuclear energy in the past was also a symbol for being able to play in the »premier league of states« (cf. Adler 1988, Otway et al. 1978). This may still play a role today in the policy debates in some countries.

If one understands the energy transformation merely as a transformation to a low-carbon energy supply, large-scale technologies such as coal or gas power generation may also play a role in the capture and storage

15. Due to emissions that occur during the entire life cycle – from construction and operation through to scrapping of the equipment and the disposal of waste – nuclear power plants have significantly higher specific greenhouse gas emissions per MWh of electricity than renewable energy. A special share is accounted for in the extraction and processing of nuclear fuels (Lenzen 2008, Sovacool 2008).

16. Simulations and model experiments show that with a skillful combination of the different sources of renewable energy in so-called virtual power plants, the electricity demand can be met at all times (see, for example, Ernst et al. 2013).

of CO_2 and nuclear power, even if in terms of the total production chain – from construction to operation to disposal, and particularly uranium extraction and fuel processing – they certainly cause more greenhouse gas emissions than renewable energies (Lenzen 2008, Sovacool 2008). In this study, however, we go further. Energy transformation means a complete reorganization of energy infrastructure to 100 per cent renewable energy. In addition, the energy transformation is complete only when alongside the technical infrastructure, social structures adapt to the changed conditions. In this sense, one can evaluate a continuation of the power supply from nuclear power plants or even a renaissance with the construction of new nuclear reactors only as an obstacle to a successful energy transformation. In contrast, the examples in Germany and Japan show that a nuclear phase out, which is clearly communicated and broadly supported by society, creates the necessary leeway to accelerate the development of renewable energy.

4.5 Oil, Gas, and Coal – Resource-rich Countries and Renewable Energy

An energy transition to 100 per cent renewable energy presents a particular challenge in countries where large fossil resources and reserves dominate the energy industry. In resource-rich countries – such as the OPEC states, Canada, and Russia – the energy policy debate has been focused heavily on just these resources. Issues of energy security and justice are often only marginally relevant. Instead, the (fossil) energy sector is of societal and national interest, because it represents as a rule a key source of foreign currency, and often makes a major contribution to the financing of the public budget. Although many of these countries also have excellent potential for the use of renewable energy in addition to fossil fuels, they have barely been tapped yet. Only in recent years has a timid change been detected in some resource-rich countries. This change is supported by two major narratives: 1. The power consumption of many countries is rising sharply. What the countries consume themselves, they can no longer export, and because the supply for the domestic market is often heavily subsidized, they lose out on increased profits due to the high domestic consumption. 2. In addition, some countries are also trying to strategically position themselves beyond fossil fuels as a global energy service provider.

Narrative: »What we consume ourselves, we can no longer export.«

Together, the OPEC countries now consume almost as much oil as China, and around a quarter of its own production. Thereby, oil consumption has increased annually in recent years by about 5 per cent. In contrast, the average economic growth is only just over 3 per cent (Gately et al. 2013). The drivers of this consumption, in addition to rising wealth, are a relatively high population growth and an increase in freshwater consumption. The countries of the Middle East are increasingly dependent on water from desalination plants. These systems require large amounts of energy. At the same time, the power plants need large amounts of fresh water. Water and electricity production are thus to some extent mutually dependent.

The power supply in the Middle East is almost entirely based on oil or gas power plants. Consumer prices are extremely low in almost all countries. It can be assumed that the utilities pay only the short-term extraction costs. These are generally far below the world market price. The greater the difference between world market prices and the prices to be paid in the country, the greater the loss of profits.

As long as the self-consumption ratio was low and the export revenues were high, so that the cost of subsidizing the domestic market could easily be covered, it was not necessary for the governments in the Gulf region to change their energy policy. The energy policy was entirely focused on the extraction of raw materials and as profitable marketing as possible.

Towards the late 1990s, a first wave of reforms took place. The world market price of oil and thus the export earnings were relatively low during this period. It was increasingly difficult for countries to finance the subsidization of their domestic energy consumption. The reforms were intended to make electricity markets more competitive, to create incentives for more efficient power generation. After a delay of several years, the Gulf Region followed with a wave of liberalization of electricity markets, which starting from Chile and the United Kingdom had reached much of the Western world (Dyllick-Brenzinger and Finger 2013).

Even if the price of oil has now returned to a much higher level, which in the opinion of analysts will hold for the foreseeable future, the strong rise in personal consumption along with continued heavily subsidized retail prices ensures that governments in the region are no longer neglecting their domestic markets. The lost profits are now reaching levels that cannot be ignored. For Saudi Arabia, the amount of subsidies for 2007 is estimated at around 42 billion US dollars (Wittmann 2013: 960). The United Arab Emirates have meanwhile even become a net importer of natural gas. When the power consumption from air conditioning is particularly high in the summer months, expensive liquified natural gas has to be purchased in order to meet the demand (Mondal et al. 2013).

The obvious solution to the problem is to reduce the subsidies of the retail prices. The extremely low prices ensure that the electricity market is almost saturated. This means that the demand will be fully exploited in the short term and there are no incentives to save power. Regardless of the price, under the current conditions there is no demand for additional, potentially renewable, power plant capacity to speak of. The subsidization of oil, gas, and electricity prices displaces the renewable energy sector. Conversely, studies show that a reduction of subsidies could be enough to make renewable energy – especially photovoltaics and wind energy due to the excellent physical conditions – competitive (Wittmann 2013, Mondal et al. 2013). Thus, the reduction of subsidies for the consolidation of government spending and the possible increase in export surpluses also promotes the development of renewable energies. Particularly in the Middle East, a narrative that combines both aspects can strongly support the first steps to a sustainable energy transformation.

Narrative: »From raw material supplier to global energy service provider«

In the Gulf Region, this narrative has thus far shaped the policy of the United Arab Emirates most extensively. This is evident in the national prestige project »Masdar City«. Since 2008, the eco-city Masdar has been built in the emirate Abu Dhabi. The city is intended to fully supply itself with renewable energy and serve as an experimental space for new technological concepts. At the same time, the city is to be established as a science centre for sustainability and renewable energy. With the Masdar Institute of Science and Technology, one of the world's first universities was founded, which focuses exclusively on issues of environmental sustainability through renewable energy. Moreover, the government of the Emirates has succeeded in bringing the headquarters of the International Renewable Energy Agency (IRENA) to Masdar. The political importance of the project is also made clear in that the Interior Minister of the United Arab Emirates, Sultan Ahmed Al Jaber is also CEO of Masdar. The state-controlled, but commercially oriented company develops and invests in renewable energy technology across the entire supply chain. Moreover, it is responsible for the planning and implementation of the large-scale project »Masdar City«. Sultan Al Jaber sees investments in renewable energies as an »*opportunity to extend [...] (global energy) leadership well into the 21st century and beyond*« (Al Jaber 2013: 5).

Another example of a resource-rich country that wants to distinguish itself as a service provider in the energy transformation is Norway. Norway is somewhat unique in the world, because as an oil and natural gas producing country, it almost completely covers its own power supply from hydropower. In the country itself, there are therefore only very limited opportunities to reduce greenhouse gas emissions through the development of renewable energies (Gebremedhin and de Oliveira Granheim 2012). Nevertheless, the country can make a major contribution to the success of the energy transformation in Europe: The Norwegian hydropower potential, as a giant energy storage, could offset the fluctuations in wind and solar power in the rest of Europe. In June 2013, a broad alliance of non-governmental organizations, business associations, electricity network operators, trade unions, church and development organizations, as well as other civil society actors from Norway and Germany issued a joint statement in which the two governments are asked to work more closely to promote renewable energy (Joint Norwegian-German Declaration 2013).

The practical expression of the cooperation between Germany and Norway are two planned deep-sea high-voltage connections through the North Sea. The two connections »NorGer« and »NORD.LINK« would each provide a capacity of 1,400 MW, thus enable the use of Norwegian pumped-storage power plants through German renewable energy. However, these connections are not without controversy. In addition to the direct environmental impacts, it is primarily discussed in Norway whether the use of Norwegian storage actually promotes the use of renewable energy in Germany. Opponents fear that instead, only the negative consequences of the German energy transformation would be exported to Norway. Another aspect is that the fossil resource companies in Norway have no strong interest in the connection. Rather, they hope that the fluctuations in the feed are offset by the natural gas that they produce (Ohlhorst et al. 2012).

Narrative: »The promotion of renewable energy must not stand in the way of fossil raw material production.«

The example of Canada shows that the development of renewable energy, especially in resource-rich countries, cannot be taken for granted. In recent years, the production of unconventional oil from tar sands in Alberta has been massively expanded. It is expected that this trend will continue and the production will increase from about 1.8 million barrels per day currently, to over four million barrels by 2035 (IEA 2013B: 473). However, the promotion of these fossil reserves is incompatible with the international climate policy's 2°C limit. If global warming is to be limited to (significantly) below 2°C, unconventional fossil fuels such as the Canadian tar sands, must be left under the earth (Campanale et al. 2011).

It is therefore hardly surprising that the climate protection ambition – and with it the Canadian national government's ambition to expand its renewable energy – has decreased to the same extent as the promotion of unconventional oil has risen. Canada joined the Kyoto Protocol in 1997 and ratified it in 2002. At the Climate Conference in Bali in 2007, the government announced that Canada would not achieve the ambitious goals. At the climate negotiations in Copenhagen, Canada was only willing to accept less ambitious goals – which were also not legally binding – and was oriented itself towards the weak objectives of the United States. Then in 2011, Canada was the first country to formally resign from the Kyoto Protocol. While emissions in the United States have declined relatively sharply in recent years, they have increased in Canada, and thus it is clear that Canada will also not be able to fulfil its scarcely ambitious goals from Copenhagen. Hence, Canada has become one of the largest climate policy hindrances on the international stage. This is also reflected in the fact that the country ranks only 58th in Germanwatch's Climate Performance Index and is thus the lowest-ranked of all industrialized countries (Burck et al. 2013).

Canada is also hardly exemplary in the promotion of renewable energy. Although energy policy in Canada is in principle a matter for the provinces, there were nevertheless approaches at the national level. However, tax incentives to promote energy efficiency and renewable energy have recently expired and have not been renewed. Some provinces, such as the most populous province of Ontario, are quite active – Ontario announced in 2013 that it was shutting down the last coal power plant and in the future would forego electricity from coal – but the climate protection efforts of proactive provinces were overcompensated by the rapid increase of emissions from the tar sands provinces of Alberta and Saskatchewan.

Instead of looking for sustainable alternatives and developing the potential for renewable energy, which definitely exists (Islam et al. 2004), Canada's national energy policy essentially confines itself to promoting the futher expansion of fossil fuels and supporting international marketing opportunities – sometimes with aggressive means. Thus, the Canadian government has attacked the EU because in the framework of the planned Fuel Quality Directive, Canadian oil from tar sands is meant to be classified as a particularly dirty fuel (EurActiv 2013).

Overall, it can be said that the expansion of renewable energy in many resource-rich countries has so far progressed very little. Only traditional hydropower is used as a renewable energy source in some of these countries, and makes Norway in some way an exception. Just in the last three to five years has a slow change of thinking begun in some countries. In the Gulf Region, the UN Climate Summit 2012 in Doha, Qatar, was certainly a milestone that has raised the issue to the top of the political agenda in the region. Generally, however, the countries of the Gulf Region remain far below what would be possible and necessary in view of climate change. There where something moved, the narratives described above were key drivers.

5. Conclusions and Recommendations

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This study considered the preconditions for a global energy transformation in order to analyse

- what this energy transformation should look like, measured against the guiding principles sustainability and energy justice,
- which framework conditions and governance structures have an influence on the design and implementation of a global energy transformation, and
- how its design and implementation are influenced by social paradigms (narratives).

Thereby, a restriction to the area of renewable energy was made. It should be clearly pointed out that this is only one pillar of the global energy transformation, which is to be significantly complemented by changes on the demand side. The integration with energy-efficiency objectives and policies is a requirement for the solution of the energy trilemma – i.e., the simultaneous reduction of greenhouse gas emissions, security of energy supply, and the fight against energy poverty.

In our view, two essential conditions for effective energy transformation emerge from this analysis: Firstly, stakeholders should take into account the correlations between the different design levels and the respective instruments; Secondly, they have to be aware that a successful implementation also significantly depends on a long-term paradigm shift occurring in the argumentations for an energy transformation.

Correlations and Instruments

A fundamental transformation of the energy sector, thus the overcoming of conventional practices and structures, can only succeed if dynamics are generated in a similar direction at the various levels of governance (cf. Grin et al. 2010: 4). In addition to this, visions, guidelines, frameworks, and instruments have to be worked out and implemented, but also niches created, where new technical, economic, and social concepts can develop and establish.

The observed developments in the various levels of governance show that a change of course is possible today, despite the many different policy processes with different priorities and tempos. At all levels of governance, there are examples of ways to promote the transformation. These ways should be used in parallel, because the different levels could inspire and encourage each other. In this respect, the diversity of approaches at different levels expresses a mutually complementary experimental phase which is itself part of the transformation process. This phase can be understood as a search process which has to deal with opposed developments (Bartosch et al. 2014).

The legally binding, but slowly progressing climate negotiations are supplemented by the more development-focused SDG and energy policy processes. The longevity and continuity of the international processes such as the SE4All Initiative ensure that the issues on the national policy cycles also remain relevant. Thus, an alternative guideline (»transformative vision«) about the long-term objectives of energy policy at the international level has developed. This has the potential to increasingly act as a focus and catalyst for national energy policies, and thus also forms a unifying basis for both cross-border and intra-national policies. But as long as this is not yet internalized as a basis for national policies and is not reflected in the political agendas, experiments and stimuli from the different levels are important drivers for the transformative processes. This was apparent in the example of the regions that (want to) meet their power supply with 100 per cent renewable energy.

At the international level, additional stimuli may be created by, for example, the addition of supplementary obligation elements to the current design of a climate agreement after 2015 on emissions reduction commitments that relate specifically to policies or energy sources (Sterk et al. 2013). Such a multidimensionality of the international obligations would clarify the design scope for an energy transformation in the context of climate policy. Moreover, there are suggestions on how pioneering states could join together, as a complement to the UN process, in an »Renewables Club« to support transformative strategies in different regions of the world (Ott 2011; Messner et al. 2014).

The country examples and the consideration of the national levels have shown that the national leeways – even under the condition of protracted negotiations and international processes – can be taken advantage of more quickly. Moreover, it was clear that the positioning on the international level could differ greatly from national acts. It cannot otherwise be explained that some states reject stronger international commitments, but the trends in their respective national energy sector point towards pioneers. In our view, this reflects clearly that not only the forums of the energy policy are fragmented, but also the objectives of national energy policies and the landscapes of interests behind these policies.

Thus, we also see tangible approaches – such as the promotion of transformation of energy systems – in a greater coordination of climate and development policy objectives and instruments. It would therefore be conceivable to use the financial instruments from both processes to promote renewable energy in a targeted manner.

Paradigm Shift in the Patterns of Argumentation

A second condition for the success of a transformation of the energy sector is to increase the external pressure on the established energy regime (Grin et al. 2010: 4). For this to happen, ways must be found so that the deficiencies of fossil energy production in the regime can be communicated and clarified.

Narratives play a central role in this second aspect. The narratives, as we discussed in the chapter »Energy Transformation between Conflicting Interests«, legitimize the

Table 12: Overview of the analysed challenges and associated narratives as well as their direction of action with respect to the success of an energy transformation

Challenge / Narrative	Impact
Energy is the essential foundation for economic development.	
Renewable energy can help to leapfrog unsustainable models of developement.	+
The expansion of renewable energy is too expensive.	–
Industrialized countries just want to develop new markets for their renewable energy technologies.	+/–
Renewable energy runs contrary to long-established power elites and contributes to democracy.	+
Industrial policy: Renewable energy is the market of the future.	+
Clean renewable energy is an important contribution to solving acute environmental problems.	+
Energy transformation requires international cooperation.	
The costs of the German »*Energiewende*« will be passed on to neighbouring countries.	-
As a joint project, the energy transformation can advance European integration and help to overcome the European economic crisis.	+
Nuclear power is in competition with renewable energy.	
The nuclear phaseout enabled the energy transformation in the first place.	+
Cheap nuclear power versus expensive renewable energy.	(–)
Nuclear power is a climate-friendly bridge technology.	–
Nuclear power enhances national reputation.	–
Many countries are dependent on the income from the production of fossil raw materials.	
What we consume ourselves, we can no longer export.	+
From a raw material supplier to a global energy service provider.	+
The promotion of renewable energy must not stand in the way of fossil raw material production.	–

structure of the energy regime, thus the institutions as well as implicit and explicit rules of the system. At the same time, they act as guiding principles on the regime's actors and hence shape the practices repeated daily. An overview of systematized narratives in this study is found in Table 12.

We showed how for four important challenges that a successful energy transformation has to face, similar conditions in the socio-political discourse are communicated differently. Almost always, the challenges are either problematized and used against the energy transformation, or seized as an opportunity and thus prepare fertile soil for the energy transformation.

We have tried to cover as wide a range of different conditions as possible and to illustrate them with the help of short, anecdotal examples. Each of these case studies may seem trivial or not new. What is new, however, is the systematic presentation that helps to better understand the complex political relationships and thus to develop concepts that can break down social and political resistance and advance the energy transformation.

The wide range of examples also shows that even among the seemingly adverse conditions for the energy transformation, approaches can be found upon whose basis a promising strategy to promote energy transformation can be built. If the examples shown are chosen so that they are particularly easy to follow, and prominent because they rely primarily on clear and obvious cases, aspects from them can nevertheless be identified in almost every country.

Moreover, the presentation of the narratives in this study does not claim to be complete. In a more detailed analysis of each of the national contexts, further examples will very likely be found that shape the socio-political debate on the energy supply system to a variable degree.

Despite these limitations, we have shown that there are rarely immutable facts and technical conflicts that hinder or even prevent the development of renewable energy. Instead, it is mostly about structures and their interpretation of the »de facto« circumstances that prevent or inhibit a profound transformation. The traditional structures legitimize themselves through these narratives, and simultaneously support and strengthen the same narratives using their (market) power. Therefore, political and social conflicts are at least as important as technical aspects for the success of an energy transformation. Hence, a purely technocratic approach will fail.

Knowledge about the role of narratives as well as awareness of the dominant and, as the case may be, emerging narratives are the key to effectively designing and carrying through the energy transformation. An analysis of narratives can help to reveal barriers to the expansion of renewable energy and then to establish alternative narratives that support an energy transformation.

The energy transformation can then be particularly successful if it manages to bring as many narratives as possible together in resonance. A promising strategy is to first build on existing – in the sense of the energy transformation – positive narratives, to strengthen them, and to emphasize the social and political debates. Based on these narratives, alliances between innovative stakeholders on the edge of the regime and established, but open to transition regime stakeholders can possibly be established. From this position, alternatives to the negatively working narratives can be more easily developed and settled in the socio-political discourse.

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