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Accelerators of Global Energy Transition: Horizontal and Vertical Reinforcement in Multi-Level Climate Governance

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Introduction

The increase of greenhouse gases and the scientific consensus on the consequences of man-made changes to the atmosphere of the earth, is a dramatic challenge to the governance of necessary climate mitigation. What is needed is a high speed of technological change towards a low-carbon economy, comparable to the industrial revolutions of past centuries, and it can be asked what strategic options exist that can accelerate mitigation efforts. Evidence shows that indeed, there have been cases of accelerated change in the last decade. The international diffusion of renewable energy technologies is a prominent example. This paper is dealing with mechanisms that can accelerate the diffusion of climate-friendly technologies.

Three types of interactive processes seem to be interesting in this regard:

1) *Mutually reinforcing cycles: the interactive reinforcement of policy, (domestic) market growth and innovation initiated by political action;*

2) the *reinforced (international) diffusion of innovations from pioneer countries*, which can be both:

- a diffusion of low-carbon *technologies* from lead-markets and

- a diffusion of the *supporting policy*, resulting from "lesson-drawing" by other countries;

3) the *reinforced diffusion by multi-level governance* at the sub-national level.

These mechanisms are characterised by a multi-factorial interactive reinforcement of innovation and diffusion processes. A reinforced diffusion of climate-friendly technology can be observed at different levels of the multi-level system of global governance. The following analysis will refer to selected cases of best practice (a pragmatic methodological decision, which excludes the discussion of failures).

Content

1. Economic and political Mechanisms of Acceleration and Reinforcement

Mechanisms of acceleration and self-reinforcement are not unknown in economics and political science. Brian Arthur presented a theoretical discussion on "dynamical systems of the self-reinforcing or autocatalytic type" both in the natural sciences and economics. According to him, self-reinforcing mechanisms in economics are related to four 'generic sources':

- *large set-up or fixed costs*, giving advantage to increasing economies of scale;
- *learning effects*, which act to improve products or lower their costs;
- *coordination effects*, which confer advantages to 'going along' with other economic agents;
- *adaptive expectations*, where increased prevalence in the market enhances beliefs of further prevalence (Arthur 1988).

Arthur mentions "virtuous cycles," and the option of "strategic action" and the possible role of policy "to 'tilt' the market" toward a certain dynamic (Arthur 1988). Arthur also mentions an important condition for a new equilibrium: "self-reinforcement (that) is not offset by countervailing forces" but supported by "local positive feedbacks" (Arthur 1988). Although this is not extended and lacks discussion or empirical analysis, Arthur gives a remarkable early theoretical view on a phenomenon that has become highly important, particularly in environment and climate policy research. We will present empirical cases, which are compatible with the typology of his "generic sources", but the picture is different if *policy-feedback* is included.

Modern *innovation research*, particularly on eco-innovation, has brought new theoretical and empirical insights into the phenomenon of accelerated technical change (Watanabe 2000, Hekkert et al. 2007, Bergek et al. 2008, IPCC 2011). Political science has added the dimension of *policy feedbacks* to the interpretation of interactive dynamics in modern policy making (Pearson 1993, Patashnik 2008): Policies generate resources, incentives and information for political actors, which can reinforce the policy.

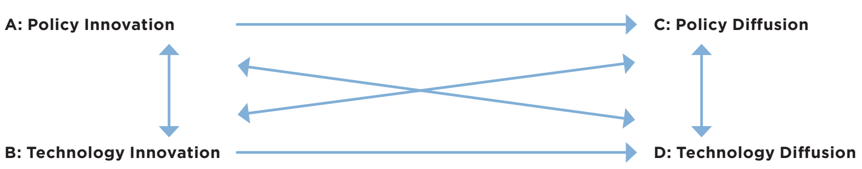
The present author has contributed to this research by adding the policy cycle to the reinforcing cycles of market growth and innovation in an analytical model for the diffusion of clean energy technology (Jänicke 2012). The policy cycle (agenda setting – policy formulation – decision – implementation – policy outcome – evaluation – new agenda setting, etc.) is a mechanism of policy learning and change. It is particularly open to policy feedback, for instance if there are unexpected co-benefits of the policy.

"Lesson-drawing" (Rose 1993) is another political mechanism of potential reinforcement. It can support the diffusion of policy innovations, for instance if there is a certain "group dynamic" between countries: a collective learning leading to the broad adoption of a certain "trendy solution" (Chandler 2009).

There may be more types of acceleration. Economic but also regulatory competition (Héritier et al. 1994) can reinforce the diffusion of goods or policies. Both economists and political scientists are familiar with the purposeful use of a *window of opportunity* (Kingdon 1995). Here we find an incidental convergence of "multiple streams" providing a situational opportunity for decision makers (Zahariadis 1999). However, not necessarily produce a stable result and a new equilibrium. On the contrary, windows of opportunity (such as the situation after the Chernobyl or the Fukushima catastrophe) often close after a while. Therefore this type of acceleration without a new equilibrium is excluded from consideration here. This article deals with forms of accelerated *transformation, i.e.* change with stable long-term effects (Patashnik 2008).

2. The Diffusion of Eco-Innovation and the Interaction of Policy and Technology

The diffusion of innovative low-carbon technologies and of innovative supporting policies are interlinked. There is, however, no clear causal relationship but a pattern of multiple interactions between technology and policy (Jänicke/Jacob 2007) (Figure 1). Policy can support the innovators of a low-carbon technology, and the innovators may provide new technology-based policy options for climate policy. Policy may act as a first mover, and its diffusion by lesson-drawing may support the diffusion of the technology. Often the technological innovation comes first (as in the case of wind power) and governmental support can reinforce its success in national and global markets. In any case, the interaction between policy and technology can contribute to a reinforced diffusion of both the low-carbon technology and the supporting policy. This is a "coordination effect" in terms of Arthur's classification (Arthur 1988).



Policy-induced Diffusion

Technology Forcing A → B → C → D
- e.g. Vehicle Emission Standards & Technologies

Political Initiative A → B → D → C
- e.g. Cadmium substitutes

Political Dominance A → C → B → D
- no example yet?

Technology-induced Diffusion

Technology Initiative B → A → C → D
- e.g. desulphurization technologies

Technological Dominance B → A → D → C
- e.g. CHP Technologies

Autonomous Diffusion B → D
- e.g. Energy efficient technologies

Fig 1: *Patterns of interaction of policy and technology in the diffusion of eco-innovation (Jänicke/Jacob 2007).*

In recent times there has been a rejuvenation of industrial policy (Stiglitz/Lin 2013, Hallegatte et al. 2013). Prominent examples include green growth strategies and the design of environmental and climate protection measures. (UN 2007, UNEP 2011, OECD 2011, World Bank 2012). The translation of environmental and climate policy goals into the language of a technology-based economic strategy has become a success story in several countries. Many governments regard themselves as actors in a highly competitive global market for clean technologies, in which innovation is regarded as the core of competitiveness (Jänicke 2012). As such, climate policy has been able to mobilise economic interests. The following analysis will show that this ability can be observed at all levels of the multi-level system of global governance.

3. Interactive Cycles of Climate-Friendly Innovation

It is a basic economic truth that growing markets are inducing a demand for further innovation which reduces production costs and improves the quality of the end-product. This is the *learning effect* in Arthur's classification (Arthur 1988). Markets for climate-friendly technologies, however, are characterised by the specific fact that they are typically *policy-driven* (Ernst & Young 2006). Therefore, a *third* dynamic system is relevant: not only the market and the technical innovation system, but also the political system – as a learning system – influences the process (see also Dierkes et al. 2001).

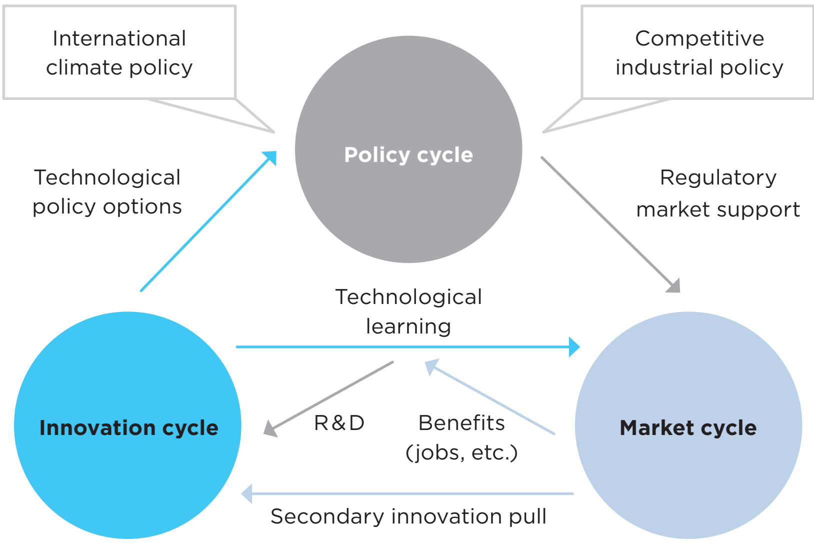


Fig 2: Interactive cycles of climate-friendly innovation (Jänicke 2012).

It has been shown that cases of accelerated diffusion of low-carbon technologies can be explained by the interaction of the three cycles (Figure 2). The author has studied 15 empirical cases in which these kinds of dynamic interactions can be observed (Jänicke 2012, 2012a). The example of green power in Germany after the introduction of attractive feed-in tariffs is shown in Figure 3. As in certain other cases – particularly in China – the policy starts with an ambitious target inducing an unexpected market growth, which again induces innovation and finally a positive policy feedback in the form of an increase in the policy's targets. The ambitious (and contested) German target in the year 2000 – 20% green power – was increased after nine years and again only one year. Later on, the Ministry for the Environment proposed doubling the original target.

Box 1. Reinforcement by Interactive Cycles of Climate-Friendly Innovation

1. *Ambitious targets* based on clean-energy innovation plus effective policy implementation
2. *Market growth* of the supported clean-energy technology
3. Induced *technological learning* (secondary innovation)
4. *More ambitious targets: policy feedback* from the new economic interests.

The Intergovernmental Panel on Climate Change, in its Special Report on Renewable Energy Resources and Climate Change Mitigation, has drawn the policy conclusion regarding the "virtuous cycles" of innovation: "that long-term objectives for renewable energies and flexibility to learn from experience would be critical to achieve cost-effective and high penetrations of renewable energies" (IPCC 2011).

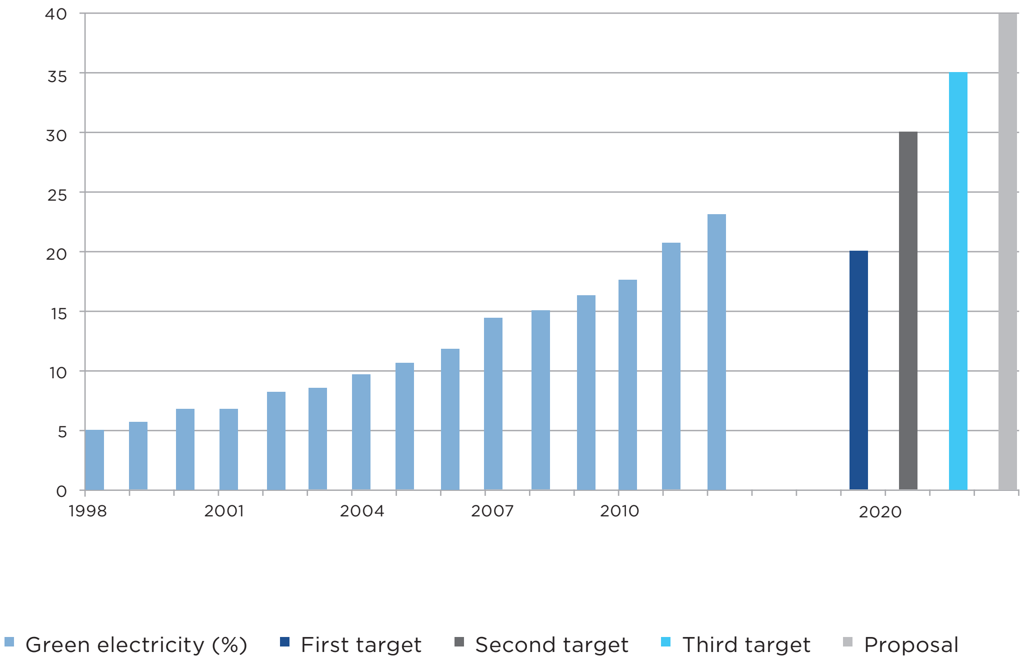


Fig 3: The share of "green" electricity 1990 – 2012 and targets for 2020 in Germany (Jänicke 2012).

4. Enforced Diffusion from Pioneer Countries: Lead Markets and political Lesson-Drawing

A second mechanism of enforced diffusion is provided by national pioneers and trend setters (Jänicke 2005). The *creation of a lead market* for low-carbon technologies in a pioneer country and the political *lesson-drawing* (Rose 1993) by other countries has been a prominent mechanism for the international diffusion of such technologies. Both mechanisms are independent, but they can reinforce each other.

Box 2. Enforced Diffusion of Clean-Energy Innovation by Lead Markets

1. Lead markets are the national "runway" where an innovative technology finds supportive conditions – such as price, demand, or market structure – to expand into international markets.
2. National lead markets for clean-energy innovations are specific because they are "policy-driven" providing a regulatory advantage by political support (Rennings/Schmidt 2010).
3. The international diffusion of the supporting policy ("lesson-drawing") can create an additional transfer advantage.

The *economic* mechanism is the enforced diffusion of climate-friendly technologies via *lead markets.* Lead markets are the national "runway" from which a new technology can expand to international markets. A national lead market is, according to Beise et al., "the core of the world market where local users are early adopters of an innovation on an international scale" (Beise et al. 2003). Well-known general cases are lead markets for mobile phones (Scandinavia) or the Internet (USA). They originated in markets with special market advantages, such as price, market structure, demand or export advantages.

Lead markets in pioneer countries have played a special role in the diffusion of low-carbon technologies: they financed the *costs for technological learning* until the product was sufficiently cheap and effective to diffuse into international markets; and also had a *demonstration effect,* demonstration effect, proving that (and by which means) a specific climate-related issue could be solved, often entailing an economic advantage. This mechanism has become an important pathway for translating climate policy objectives into the logic of global markets. Examples include the development of wind power in Denmark and Germany, photovoltaic installations in Japan and Germany, heat pumps in Sweden, hybrid motors in Japan and fuel-efficient diesel cars in Germany (Figure 4). Examples of lead markets in emerging economies include solar water-heating in China and bio-fuel technology in Brazil.

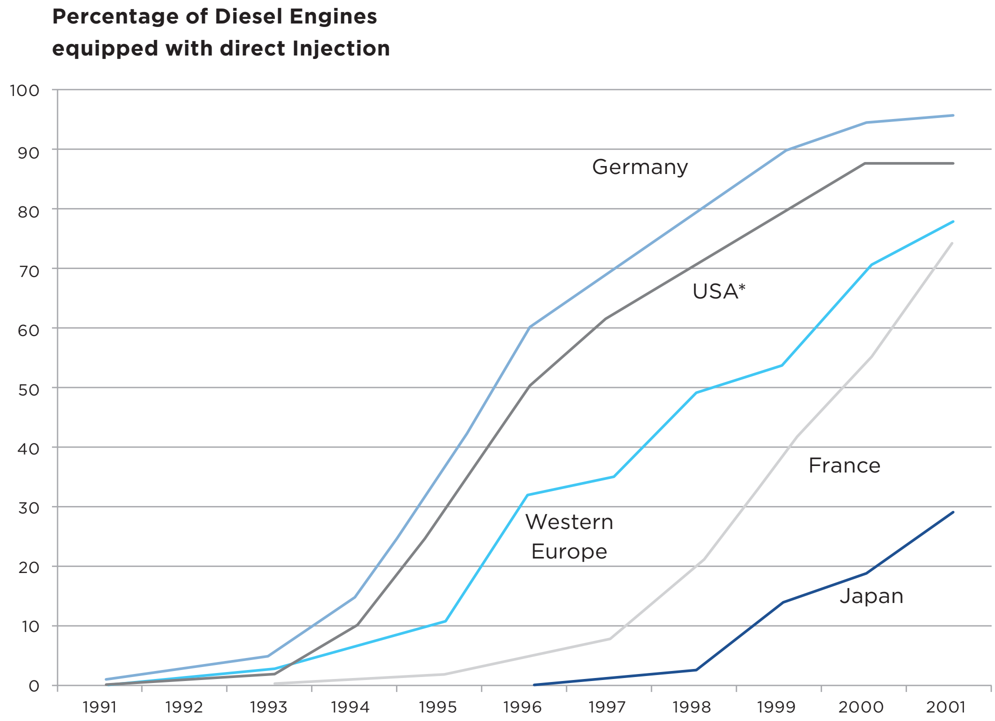


Fig 4: *Revise marked to market for fuel-efficient diesel engine (Beise et al. 2003).*

Source: *ZEW, Bosch*
** USA: predominantly light trucks*

Lead markets for climate-friendly technologies arise in countries with a "regulatory advantage" and a "transfer advantage" (Rennings/Schmidt 2010). That means that the technology is supported by policy. Their international diffusion is supported by "lesson-drawing" by other countries. This political "*lesson-drawing*" is the second mechanism of reinforced international diffusion. In the context of lead markets, it refers to the process of learning how to support markets for a specific climate-friendly technology, and results in the diffusion of a specific supporting instrument of policy mix. Lesson-drawing is similar to Arthur's mechanism of "adaptive expectations" – although it is *policy* learning. Similarly to enforced technology diffusion, reinforced policy diffusion depends to a high degree on expectations, where increased prevalence in the global policy arena "enhances beliefs of further prevalence" (Arthur 1988).

Box 3. Reinforced International Diffusion by "Lesson-Drawing"

1. "Trendy solutions" (Chandler 2009) of pioneer countries are adopted by other countries as a strategy to avoid domestic trial-and-error.
2. "Adaptive expectations": increased diffusion enhances beliefs of further diffusion.
3. Role of "critical masses", i.e. the stage in the process at which diffusion becomes self-perpetuating.

The anticipated probability that a certain regulation will become an international standard (also supported by international harmonisation) has become a strong driver of policy diffusion (Jänicke/Jörgens/Tews 2005). A *critical mass* of countries adopting a certain *trendy solution* (Chandler 2009) reinforces the diffusion (see also Witt 1997). At this stage, the diffusion process achieves sufficient momentum to become self-perpetuating.

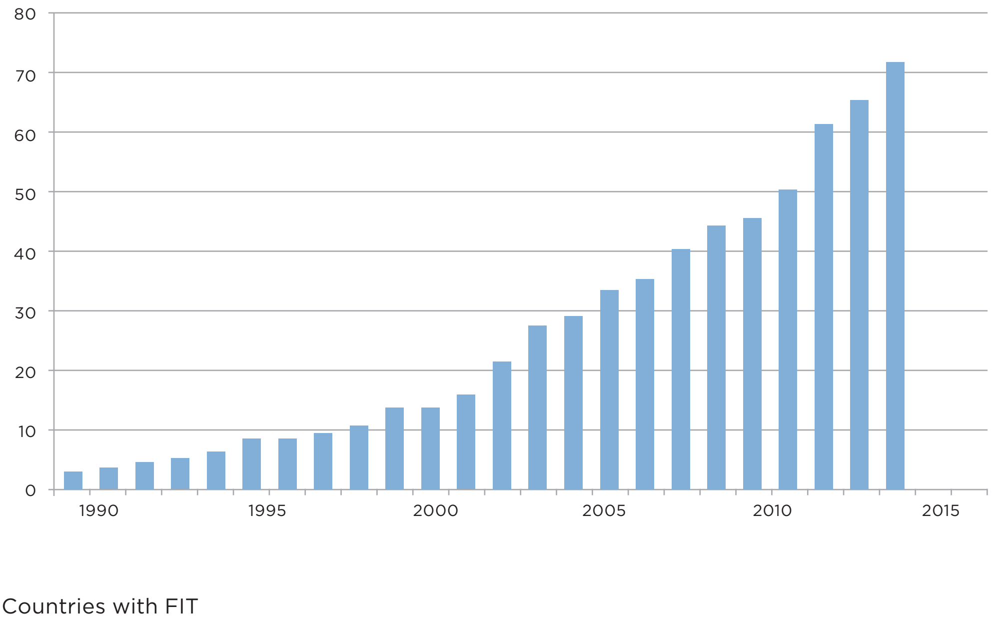


Fig 5: *The international diffusion of feed-in tariffs 1990 – early 2013 (data from REN21 2013).*

The speed of diffusion and lesson-drawing in technology-related climate policy has been in many cases remarkable. The diffusion of the instrument of feed-in tariffs may be used as an illustration (Figure 5 above). The diffusion of targets for green electricity occurred even faster. By 2012, 138 countries had introduced green targets for renewable electricity, a number that doubled since 2007 (REN21 2013). Even policies to support energy efficiency, which is often regarded as the more difficult part of climate policy, can have a high speed of international diffusion: out of 85 countries analysed by the French institute ADEME, the share of countries with national targets for energy efficiency doubled within only five years to 80% (ADEME 2013). This speed of diffusion is in clear contrast to the slow progress in international climate negotiations. Lesson-drawing has been characterised as "governance by diffusion" (Busch/Jörgens/Tews 2006). It is remarkable that it is a completely voluntary process, significantly different from global climate governance by legally-binding international obligations.

A special *reinforcement* of a lead-market process takes places when another feedback from the international markets occurs, which is driven by second-mover countries entering the original lead market by successfully producing similar products at lower prices. The Chinese solar industry and its booming exports to Europe may be taken as an example (Quitzow 2013). The case marks a situation where a former lead market has to find a new role in the competition for innovation. This may create difficulties for the former pioneer. However, in terms of climate protection, this reinforcement of diffusion based on lower prices is a clear advantage.

So far, lead markets in rich countries have provided the basis for clean technologies to diffuse from industrialised and emerging economies into international markets A more recent development is the role of lead markets in *emerging countries* like India, where the lag markets are developing countries. Most interestingly for a sustainable energy future are lead markets for *frugal innovations* (Tiwari/Herstatt 2012). Frugal innovations are not only cheap, simple and robust but also try to save resources at all stages of the supply chain (Jänicke 2013). They are worth mentioning here, because, due to a generally low profit share, they depend on large-scale markets. The existence of such large markets in emerging economies can lead to the advantage of falling unit costs to increased output as a mechanism of reinforcement (Arthur 1988).

5. Multi-Level Governance: the vertical Reinforcement of horizontal Diffusion

5.1. The Role of the Sub-National Level

Multi-level governance "characterises the mutually dependent relationships – be they vertical, horizontal, or networked – among public actors situated at different levels of government" (OECD 2013). *Multi-level reinforcement* is the most interesting aspect (Figure 6). Schreurs and Tiberghien have used this formula to explain the dynamics of climate policy in the European Union and its member states (Schreurs/Tiberghien 2007, see also Jordan et al. 2012). However, it is also relevant in the global context. Here it is used to explain the dynamic interaction between the national and the sub-national levels.

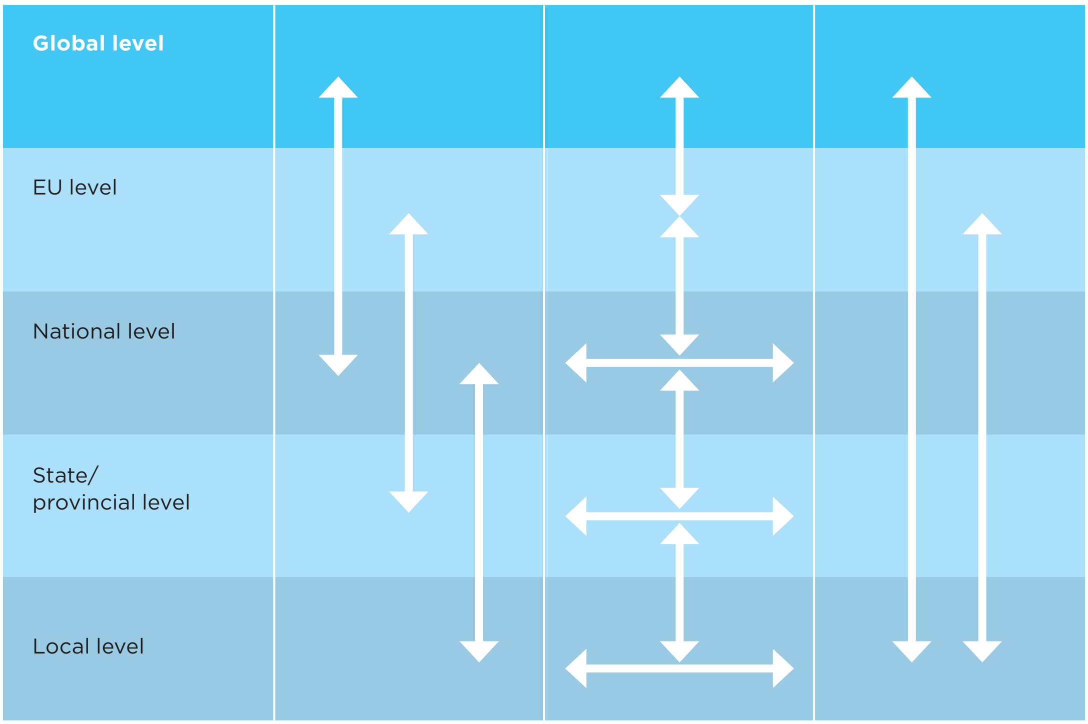


Fig 6: *Possible interactions of multi-level governance (Jänicke 2013).*

At each level of the multi-level system of global climate governance, a broad variety of motives and opportunities can be observed. At the level of *provinces/ regions or federal states*, the following motives to support or to adopt climate-friendly technologies exist: rich regions can be motivated to transfer their successful economic policy to the new field of climate policy. Poor regions, on the other hand, can try to support renewable energies or energy-saving investments in the housing sector to overcome unemployment. Another driver may be competition between the region and the national government (as in the case of Scotland or California). Geographical advantage might provide another reason to support renewables (such as wind energy in coastal zones). Political scientists often point to the party constellation of a certain regional/state government (Delmas/Montes-Sancho 2011, Chandler 2009). In the EU there are several responsibilities for climate and energy – beyond emissions trading – at the regional level (Wolfinger et al. 2012). There exist horizontal networks such as the Network of Regional Governments for Sustainable Development, which has been established at the World Summit in Johannesburg (2002).

Cities and local communities have important responsibilities in policy areas that are relevant to climate policy. Housing and the energy consumption of households, transport regulations and infrastructures, land-use and urban planning or waste policy are important policy field in this regard. Most important is the responsibility for local energy supply, where cities in Europe or the US can have strong influence (cp. OECD 2013). The fact that 80% of EU greenhouse gas emissions are related to urban activities illustrates the importance of the local level. Thus, cities are also important places for climate policy experiments and innovations (Bulkeley/Castán Broto 2012). Horizontal international networks such as International Council for Local Environmental Initiatives (ICLEI) or the Covenants of Mayors play an important role (Kern/ Bulkeley 2009). In addition, national networks such as the German “100%-Renewable Energy” network or the Chinese Low Carbon Eco-Cities Association can play a role. Local climate mitigation and horizontal lesson-drawing between cities are being explicitly supported by the EU Commission and also by the central government in China (Zhou et al. 2012).

5.2 The Case of the European Union

The EU has provided best practice in climate mitigation and multi-level climate governance. By 2012 renewables accounted for 70% of new electricity capacity (REN21 2013) and total greenhouse gases emissions from electricity generation declined by about 18% between 1990 and 2012. Multi-level climate governance was often a purposeful strategy. The EU has a special policy framework for regions/ provinces and also includes relatively innovative cities. Other characteristics of EU countries that facilitate a *green opportunity structure* include green political parties and public media. EU Directives also permit members states significant flexibility (scope for innovation) in deciding how best to structure their national policies to achieve a high level of environmental protection. This often leads to “regulatory competition” between pioneer countries (Héritier et al. 1994). The World Bank recently confirmed, that the EU has a specific “environmentally sustainable growth model” (World Bank 2011).

Climate policy as a process started in the EU at the national level. Pioneer countries like Germany, Denmark and the United Kingdom (UK) generalised and integrated many political and economic experiments and best practices that had already taken place at lower levels, paving the way for their implementation at higher levels. Thus, the process of climate policy then proceeded to the European and global levels. Extending the national policy innovations to the European Union has often been a governmental strategy to stabilize the national pioneer role, but also to create a European market for domestic innovations in climate-friendly technologies. *Europeanisation of climate policies* was accompanied by the establishment of lobby organisations, which articulated an economic interest for clean energy at the EU level. Examples include the European Renewable Energy Council, the European Alliance to Save Energy, the European Insulation Manufacturers Association, Lighting Europe or the European Heat Pump Association.

Meanwhile, a process of feedback can be observed at the local level, reinforcing earlier initiatives: cities and local communities, often organised as networks (Kern/Bulkeley 2009), use national and European policies and incentives – whether regulations, subsidies or public procurement – to mobilise economic interests for climate-friendly technologies. These can be investments in forms of renewable energy or low-energy buildings.

Most remarkable is the role of the Covenant of Mayors with more than 5,000 (2013) participating local communities. It was launched by the European Commission together with the EU climate and energy package in 2008. Under it, the participating local authorities have to present action plans and a greenhouse gas (GHG) reduction target of at least 20%. The economic dimension is underlined by the fact that the European Investment Bank is strongly involved in the financing of implementation measures. The Smart Cities Partnership Initiative of the EU Commission is another economic mechanism. The horizontal dynamics – particularly the competition between cities – are stimulated by an official Benchmark of Excellence, which is also a database of best practice (Covenant of Mayors 2013).

Private ownership of green power seems to be a strong driver of change at the local level in several countries. In Germany, more than half of all renewable energy installations are owned by private individuals. Already a quarter of the country is organised as 100%-renewable-energy regions, which have been created basically at the local level (UMWELT 12/2012). Europe, when compared with other global regions, has not only the advantage of a strong supranational level of climate governance, but also the highest proportion of decentralised and local ownership.

It seems that the *local level is a late mover in the process of climate policy*, but *now it is the most dynamic level of technical change* towards a low-carbon energy system. An evaluation of the Covenant of Mayors shows that 63% of the local communities being assessed by the EU are planning to reduce their GHG emissions by more than 20%. So far, a reduction of about 370 million tonnes is expected by 2020 (EndsEurope 24. 6. 2013). The database of the Covenant provides empirical evidence that in recent years, the climate policy process has mobilised strong economic interests at the local level, mainly in the building sector (30% of the activities) and in local energy production.
The former policy initiative at the higher levels has created the necessary preconditions for this booming development at the sub-national level. The EU Directive on Energy Performance of Buildings, for instance, has stimulated strong activity among local communities, with pioneer cities such as Freiburg, Manchester, Copenhagen and Malmö playing an important role (REN21 2013a).

5.3 Pioneer Countries

It seems that the former pioneer countries – Germany, Denmark and the United Kingdom– are again leading countries as far as these local dynamics are concerned. The three countries have achieved the highest GHG reduction rates. They have also the most ambitious GHG reduction targets for the period 1990–2020 (Germany and Denmark: 40%, UK: 50% by 2025). They are also cases of best practice regarding the mobilisation of economic interests at the subnational level.

Early on, Germany translated its environmental and climate policy into the language of industrial policy (OECD 2007). At the state level, individual states have only recently engaged in pioneering activities. Moreover, the state of Hesse intends to be "climate-neutral" (Hölscher/Radermacher 2013). The most remarkable development, however, has occurred at the local level. The private generation of green power has proven to be a strong driver for this development.

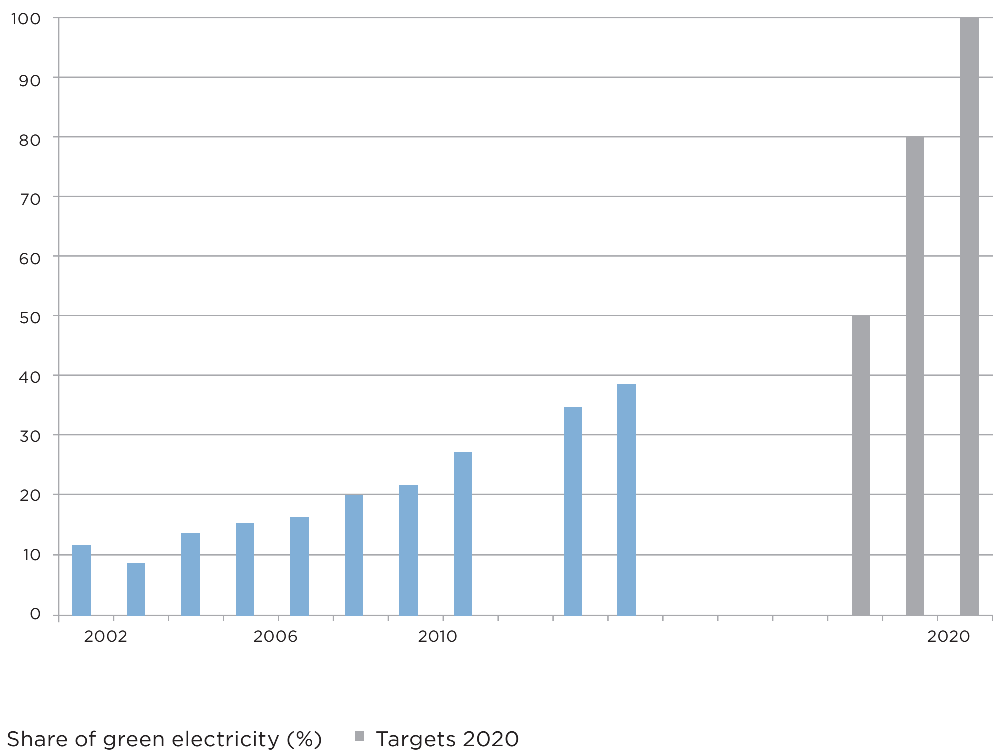


Fig 7: *The share of green electricity 2002–2012 and targets for 2020 in Scotland (Data: Scottish Renewables 2011/2012).*

The UK not only achieved the highest rate of GHG reduction in Europe but has also been a remarkable pioneer at the provincial level. In Scotland, the above-mentioned mutually reinforcing supports for renewable energy can be observed, with a 100% target to be achieved in 2020 (Figure 7). The UK is also relatively strong at the city level. Manchester has the ambition to play a leading role in the global market for energy-efficient building technologies. Most cities have ambitious climate policy targets. London's GHG-reduciton policy exceeds the national target than the country (60% by 2025/1990). Edinburgh plans to have a zero-carbon economy by 2050 (Heidrich et al. 2012).

In Denmark, electricity production based on renewables accounted for 43.1% of domestic electricity supply in 2012. A preliminary statement of Denmark's total observed emissions of greenhouse gases shows an overall reduction of 25.4% from the base year 1990/95 (Danish Energy Agency 14. 11. 2013). Climate policy is also conceived in terms of industrial policy. The Energy Strategy 2050 (adopted in 2011) underlines the advantages for Danish firms in the global market for low-carbon technologies (Danish Government 2011).

Being already a strong exporter of clean energies, Denmark aims to be one of the three leading countries in this respect. At the sub-national level, cities and counties are the main actors. Copenhagen and Aarhus intend to be climate-neutral (by 2025 and 2030 respectively). As in Germany, sustainable power installations are often owned by coopertives and organised at the local level.

5.4 Theoretical Interpretation

How can this multi-level reinforcement process be explained? Why is it an advantage to play a multi-level game, compared with policies preferring one dominant level? The broad variety of agents and possible interactions (Figure 5) seems to be highly important. Networking and learning by doing, as well as competition and cooperation play a similarly strong role. The core mechanism of reinforcement, however, is the leadership role of the higher level – whether the EU or its member states – stimulating the horizontal innovation/diffusion process at the lower level (Figure 8).

Box 4. Reinforcement by Multi-Level Governance

1. Experimentation and first best practice at different levels.
2. Local and regional best practice being generalised and supported by the higher level.
3. Support from the higher level, inducing horizontal dynamics at the lower level: Pioneers (cities or regions) become interesting as benchmarkas benchmarks, partners or competitors.

Political leadership or even political entrepreneurship at the higher levels typically occurs as a process of generalising the experiments, innovations and best practices established at lower levels. The Political innovators find a broader political constituency and economic innovators find larger markets. The second effect of vertical policy intervention of higher levels is *its impact on the horizontal dynamics at the lower level:* If the higher levels take the lead, providing regulatory, financial or informational support to the lower levels, they will strengthen the role of pioneers at the lower levels and induce horizontal lesson-drawing, competition and/or cooperation at the same level. Pioneer cities or provinces/states at the lower levels become benchmarks for others, and the support from above provides new resources for the diffusion of climate-friendly innovation. This includes the extension of markets and the policy arena for innovators at the European and global levels. The mobilisation of economic interests and the translation of climate policy goals into the language of market dynamics is an integrating common factor at all levels.

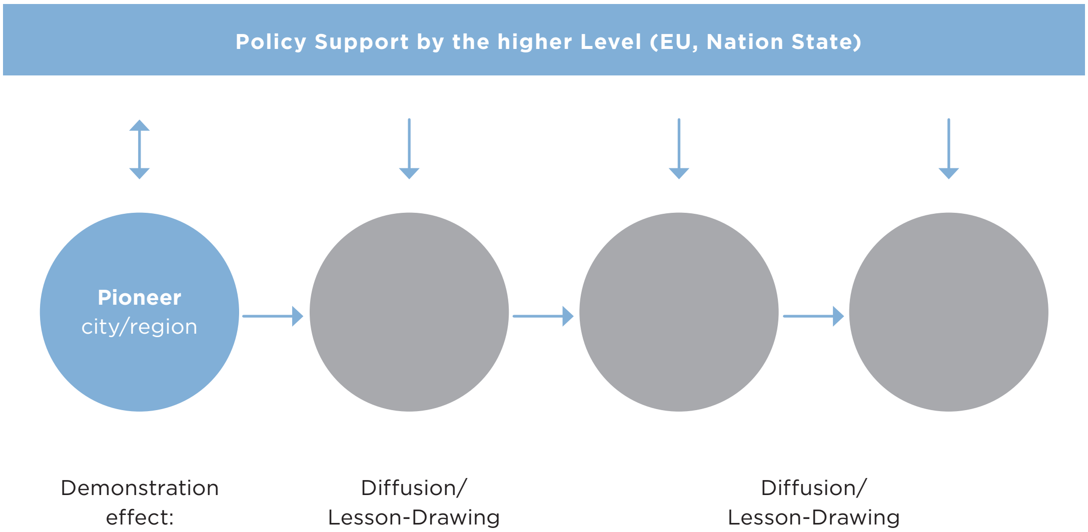


Fig 8: *Horizontal dynamics induced by the higher policy level (Jänicke 2013).*

6. Multi-Level Climate Governance: a Transformation that becomes irreversible

As we have seen, it is no disadvantage that the implementation of climate policy takes place under the condition of a broad variety of actors, dimensions and levels. On the contrary: a polycentric approach (Ostrom 2010) can be a real opportunity. It should be mentioned that this polycentric approach includes not only governments and businesses, but also societal actors (Figure 9). *Civil society* – with networks of all kinds and at all levels of the multi-level game – seems to be the *indispensable context* of the energy transformation, although its highly complex causality is not easy to assess in terms of empirical research.

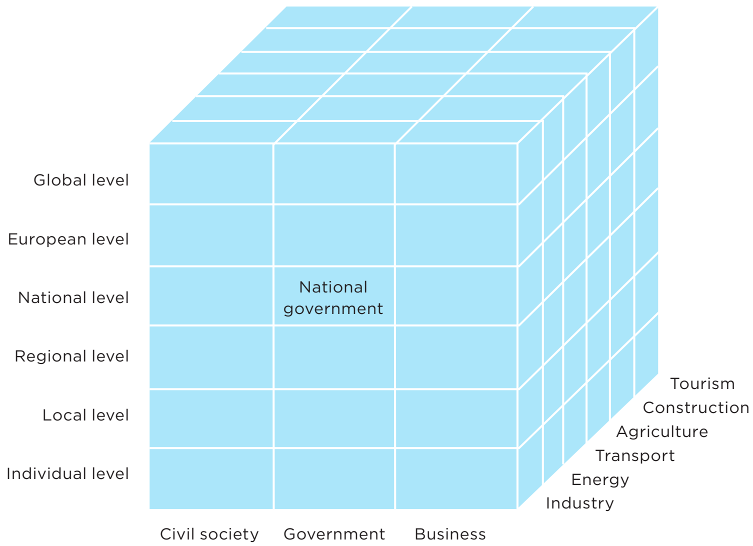


Fig 9: *Dimensions of global environmental governance (Jänicke 2008).*

The extremely high complexity of multi-level and multi-sectoral climate governance may cause the problem of final responsibility: if everybody is responsible, in the end there might be a situation in which nobody actually takes responsibility. So far, reaching a solution is still primarily the *final responsibility of national governments*, acting within broad networks, often as collective players (e.g. G20). National governments, if compared with the small administration of global regimes, such as under the United Nations Framework Convention on Climate Change, have more human and financial resources. They can impose sanctions and penalties. They act under comparably higher pressure to provide legitimacy for their actions. They are the first address in the event of extreme weather and other crises and they are observed more intensively by the public than government actors at other levels of the multi-level system of global governance (Jänicke 2012).

Polycentric, multi-level systems seem to have certain inherent mechanisms of stabilisation (Sovacool 2011). There is also a high probability that the multi-level system of climate governance already has created conditions that make global climate policy increasingly *irreversible*. In a study on the long-term durability of political reforms, Patashnik concludes that that basic conditions need to be fulfilled if political reforms are to remain stable in the long-run, resisting opposing trends. He mentions: *institutional change;* the *reconfiguration of political dynamics* with reinforcing feedback mechanisms; and the *creation of new vested interests*, resulting finally in a Schumpeterian form of creative destruction (Patashnik 2008, 3f.&26). The creation of climate policy institutions has taken place in several countries that have introduced climate laws and ministries for energy and climate (e.g. UK). Institutional change can, however, still be a weakness of the process, particularly at the global and sub-national levels. However, with regard to the two other conditions – "did new interest groups emerge" and "did the reforms gather momentum and become politically self-reinforcing?" (Patashnik 2008, 13) – a more positive answer can be given. The new interests are particularly strong because they are economic interests. In addition, the momentum has achieved the dimensions of an industrial revolution (Rifkin 2011). The creative destruction of the most powerful opponents – the coal sector – has not been achieved in many countries and the new energy system is still being confronted with veto players (Tsebelis 2002). In countries like Australia, the coal lobby was still able to successfully influence the most recent national elections. However, the global multi-level system of climate governance *in toto* seems to have reached a stage of development where such particularistic interests may have become unable to reverse the process.

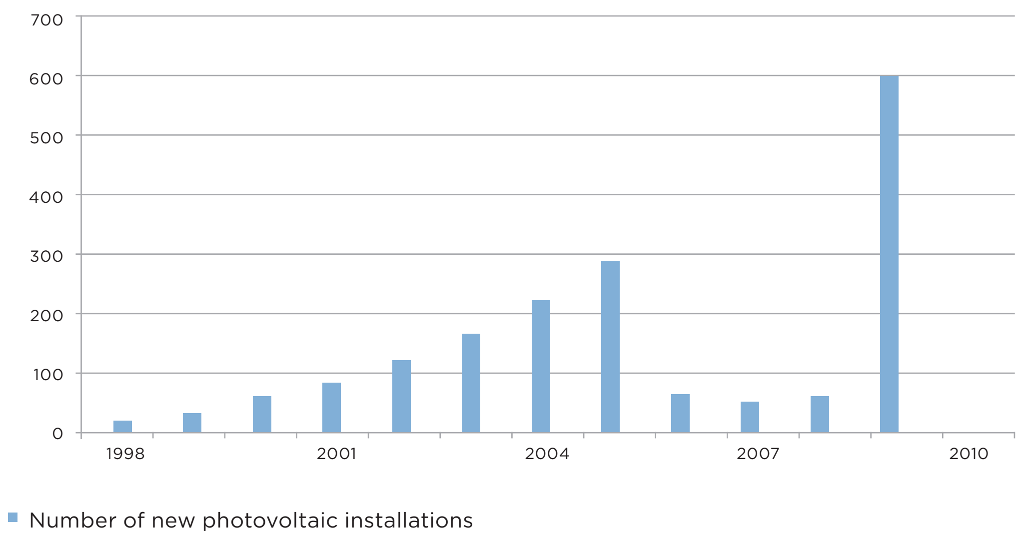


Fig 10: *Number of new photovoltaic installations in Japan 1998–2009 (UMWELT 12/2010).*

High stability and path-dependency at the national level can be observed in Denmark and Japan (Figure 10). In both countries – in Denmark after 2001, in Japan after 2005 – there has been a clear backslash against private policies that were previously very ambitious. The policy of support for renewables was reversed in both cases. However, after a few years, the former policy has reintroduced and even extended (Jänicke 2012). In Japan this was connected with a government change (2009).

Policy Conclusions

It has been shown that the acceleration of the diffusion of clean-energy technologies is a potentially strong option for climate policy. Four mechanisms of diffusion have been presented that are highly likely to reinforce each other, and the list of possible accelerators may be even longer than those presented. One additional likely mechanism of acceleration is the simultaneously rising price of fossil energy and the falling price of renewables.

It seems that the multi-level system of climate policy has already achieved its own *inherent logic*. It can be characterised by typical horizontal and vertical dynamics as well as long-term stabilisation mechanisms and path-dependencies, based on institutional change, new economic interests and policy feedback.

Several mechanisms can be used to support this process and to stimulate acceleration, although a comprehensive strategy still needs to be developed. So far, these processes are mainly the result of an interactive learning-by-doing. The dynamics in most cases have been induced by *competent practitioners*. That means that they are not the result of scientific design; instead, they are most often unintended and unexpected. Instead, they are most often unintended and unexpected.

Climate policy must learn to manage rapid industrial change. So far, there are only a few examples of more conscious action in this direction. The Indian Government has adopted a formula that incorporates a mechanism for enforcing innovation (learning) induced by massive market support for solar energy: "The ambitious target for 2022 of 20,000 MW or more will be dependent on the 'learning' of the first two phases"... "In the second phase, after taking into account the experience of the initial years, capacity will be aggressively ramped up to create conditions for up-scaled and competitive solar energy penetration in the country." (Government of India 2009). This can be seen as a formula to mobilise a triple cycle of innovation described earlier. The EU Commission has postulated a comprehensive lead market and innovation strategy "to create a virtuous cycle of growing demand, reducing costs by economies of scale, rapid product and production improvements and a new cycle of innovation that will fuel further demand and a spinout into the global market" (EU Commission, 2007). So far the EU has not extended this remarkable approach, and a comprehensive multi-level mechanism of reinforcement is not part of this concept. Multi-level governance, however, has taken place in many forms within the EU. The Covenant of Mayors has been mentioned as an effective mechanism to mobilise horizontal dynamics at the local level, in addition to its vertical strategy.

There can be no doubt about the difficulty of translating the complex task of multi-level governance into a comprehensive strategy. There needs to be more research on best practices to draw better and more comprehensive conclusions for government strategies. The main policy conclusions of this explorative analysis can be summarised as follows:

1. Translating climate policy objectives into the language of industrial policy and ecological modernisation (Jänicke 2012) is a strong option for climate policy (while it is not the only solution, since there are limits to technological approaches).

2. Ambitious climate policies that are realistic in terms of a given capacity can induce market growth and interactive technological learning.

3. The mechanism of induced innovation und diffusion can create benefits and new interests that can lead to policy feedback with even greater ambition.

4. It has been possible to mobilise economic interests at all levels of the multi-level system of global governance.

5. Proactive leadership and support from higher levels can stimulate diffusion at lower levels.

6. National governments are still important players in this respect.

Multi-Level Governance	Accelerator	Level	Mechanism	Effect
	Interactive innovation cycles	National	Ambitious policy, market support, R&D, policy feedback	Market growth, innovation dynamics
	Lead market	National/global	National market as basis for global diffusion	International technology diffusion
	Policy diffusion of supporting instruments	National/global	"Lesson-drawing", critical mass of "trendy solutions"	Growing global demand
	Sub-national	Sub-national	Vertically-induced horizontal dynamics	Diffusion of regional/local best practice

Fig 11: *Multi-level dynamics of low-carbon technology diffusion (Jänicke 2013).*

Reinforcement means greater speed of change. Indeed, the shift toward a low-carbon economy has proven to be very rapid (although it is still insufficient in terms of effective climate mitigation). From a policy perspective this experience is historically unprecedented; however, such rapid change is necessary and must be supported via smart policies. New modes of impact assessment and future-oriented stakeholder participation may be necessary to complement this process. In addition, the enforcement of of climate-friendly innovation should include mechanisms to revise and adjust policies as early as possible if negative impacts are foreseeable.

Literature

ADEME (2013): Energy efficiency in the world report (Study produced for the World Energy Council). (ADEME 8. 10. 2013).
Beise, M./Blazejczak, J./Edler, D./Jacob, K./Jänicke, M./Loew, Th./Petschow, U./ Rennings, K. (2003): The Emergence of Lead Markets for Environmental Innovations, Horbach, J. Huber, J., Schulz, Th. (Eds.): Nachhaltigkeit und Innovation. Rahmenbedingungen für Umweltinnovationen, München.
Bergek, A./Jacobsson, S./Carlsson, B./Lindmark, S./Rickne, A. (2008): Analyzing the functional dynamics of technical innovation systems. A scheme of analysis. Research Policy Vol. 37, 407–429.
Busch, P.-O./Joergens, H./Tews, K. (2006): The Global Diffusion of Regulatory Instruments: The Making of a New International Environmental Regime, The Annals of the American Academy of Political and Social Sciences 598, 146–167.
Chandler, J. (2009): Trendy Solutions: Why Do States Adopt Sustainable Energy Portfolio Standards? Energy Policy, Vol. 37, 3247–3281.
Covenant of Mayors (2013): Website. http://www.covenantofmayors.eu/index_en.html
Dierkes, M. et al. (Eds.)(2001): The Annotated Bibliography of Organisational Learning and Knowledge Creation, Berlin.
The Danish Government (2011): Energy Strategy 2050, Copenhagen.
Ernst & Young (2006): Eco-Industry: its Size, Employment, Perspectives and Barriers to Growth in an Enlarged European Union, EU Commission, Brüssel: DG ENV.
EU Commission (2007): A Lead Market Initiative for Europe – Explanatory Paper on the European Lead Market Approach: Methodology and Rationale. In: Commission Staff Working Document; COM (2007) 860 final, SEC(2007). Brussels: Commission of the European Communities.
Government of India (2009): Jawaharlal Nehru National Solar Mission, Delhi.
Hallegatte, St/Fay, M./Vogt-Schilb, A. (2013): Green Industrial Policies – When and How, The World Bank, Policy Research Working Paper 6677.
Héritier, A./Mingers, S./Knill, Ch./Becka, M. (1994): Die Veränderung der Staatlichkeit in Europa, Opladen.
Heidrich, O./Dawson, R. J./Reckien, D./Walsh, C. L. (2012): Assessment of the Climate Preparedness of 30 Urban Areas in the UK, Manuscript.
Hekkert, M. P./Suurs, R. A. A./Negro, S. O./Kuhlmann, S./Smits, R.E.H.M. (2007): Functions of innovation systems: a new approach for analyzing technological change. Technological Forecasting & Social Change 74, 413–432.
Hölscher, L./Radermacher, F. J. (2013): Klimaneutralität – Hessen geht voran, Wiesbaden: Springer.
IPCC (2011): Special Report on Renewable Energy Resources and Climate Change Mitigation (SRREN). Geneva: IPCC.

Jänicke, M. (2005): Trend Setters in Environmental Policy: The Character and Role of Pioneer Countries. In: European Environment, Vol. 15, 129–142.
Jänicke, M. (2012): Dynamic Governance of Clean-Energy Markets: How Technical Innovation Could Accelerate Climate Policies, Journal of Cleaner Production 22, 50–59.
Jänicke, M. (2012a): Megatrend Umweltinnovation, 2. Ed. München: Oekom.
Jänicke, M./Jacob, K. (Eds.)(2007): Environmental Governance in Global Perspective, 2. Ed. Berlin: Forschungszentrum für Umweltpolitik, Freie Universität Berlin.
Jänicke, M./Joergens, H./Tews, K. (2005): Zur Untersuchung der Diffusion umweltpolitischer Innovationen, in: Tews, K./Jänicke, M. (Hrsg.): Die Diffusion umweltpolitischer Innovationen im internationalen System. Wiesbaden.
Jordan, A./v. Asselt, H./Berkhout, F./Huitema, D./Rayner, T. (2012): Understanding the Paradoxes of Multi-Level Governing: Climate Change Policy in the European Union, Global Environmental Politics, Vol. 12, No. 2, 43–66.
Kern, K./Bulkeley, H. (2009): Cities, Europeanization and Multi-Level Governance: Governing Climate Change through Transnational Municipal Networks, Journal of Common Market Studies, Vol. 47, Issue 2, 309–332.
Kingdon, J. W. (1995): Agendas, Alternatives and Public Policies, 2d ed. New York: HarperCollins.
OECD (2007): Environmental Innovation and Global Markets, OECD: Organisation for Economic Co-operation and Development.
OECD (2011): Towards Green Growth, Paris.
OECD (2013): Green Growth in Cities, Paris.
Ostrom, E. (2010): Beyond Markets and States: Polycentric Governance of Complex Economic Systems, American Economic Review, vol. 100(3), 641–72.
Pierson, P. (1993): When effect becomes cause – policy feedback and political change. World Politics 45 (4), 595–628.
Quitzow, R. (2013): The Co-evolution of Policy, Market and Industry in the Solar Energy Sector, FFU-Report O6–2013: Forschungszentrum für Umweltpolitik/Freie Universität Berlin.
REN21 (2013): Renewable Energy. Global Status Report 2013, Paris.
Rifkin, J. (2011): The Third Industrial Revolution, Palgrave Macmillan.
Rose, R. (1993): Lesson-Drawing in Public Policy. A Guide to Learning across Time and Space, Chatham, N.J.
Schreurs, M./Tiberghien, Y. (2007): Multi-Level Reinforcement: Explaining European Union Leadership in Climate Change Mitigation, Global Environmental Politics, Vol. 7, No. 4, 19–46.

Stiglitz,J. E./J. Y., Lin (Eds.)(2013): The Industrial Policy Revolution: The Role of Government Beyond Ideology, New York, Palgrave Macmillan.
Sovacool, B. K. (2011): An International Comparison of Four Polycentric Approaches to Climate and Energy Governance, Energy Policy, Vol. 39, Issue 6, 3832–3844.
Tiwari, R./Herstatt, C. (2012): India – A Lead Market for Frugal Innovations? Hamburg University of Technology, Working Paper Technology Innovation Management No. 67.
Tsebelis, G. (2002): Veto Players. How Political Institutions Work. New York/Princeton: Princeton University Press.
UN (2007): Industrial Policy for the 21st. Century: Sustainable Development Perspectives, New York: UN Dept. of Economic and Social Affairs.
UNEP (2011): Towards a Green Economy: Pathways to Sustainable Development and Poverty Eradication. UNEP.
Zahariadis, N. (1999): Ambiguity, Time, and Multiple Streams, Sabatier, P. A. (Ed.): Theories of the Policy Process, Boulder, Col.: Westview Press, 73–93.
Witt, U. (1997): "Lock-in" vs. "critical masses" – Industrial change under network externalities, International Journal of Industrial Organisation, Vol. 15, Issue 6, 753–773
World Bank (2011): Golden Growth – Restoring the Lustre of the European Economic Model, Washington, D. C.
World Bank (2012): Inclusive Green Growth. The Pathway to Sustainable Development. Washington, D.C.
Zhou, N./He, G./Williams, Ch. (2012): China's Development of Low-Carbon Eco-Cities and Associated Indicator Systems, Ernest Orlando Lawrence Berkeley National Laboratory, http://china.lbl.gov/sites/all/files/china_eco-cities_indicator_systems.pdf

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