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Europe's Critical Infrastructure and Its Vulnerabilities – Promises, Problems, Paradoxes

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Prologue

Critical infrastructure (CI) can be damaged, destroyed, or disrupted by deliberate acts of terrorism, natural disasters, negligence, accidents, computer hacking, criminal activity, and malicious behaviour. To save the lives and property of people at risk in the EU [European Union]... any disruptions or manipulations of CI should, to the extent possible, be brief, infrequent, manageable, geographically isolated... The recent terrorist attacks in Madrid and London have highlighted the risk of terrorist attacks against European infrastructure. The EU's response must be swift, coordinated, and efficient.¹

With these opening words, the European Commission, the executive body of the EU, urged an EU-wide program for the protection of critical infrastructure in 2005. Several types of events – in this book we shall speak of “critical events” – triggered this new sense of infrastructure vulnerability and risk. The ball started rolling in the United States in the mid-1990s. Hackers had just used the Internet to rob Citibank of \$10 million, email-bombed the Internet service provider America Online, and broken into computer systems at the Department of Justice, the CIA, and the US Air Force. During 1995 no fewer than 250,000 attempts to hack Department of Defense computer files were registered, most of which were successful. President Bill Clinton then set up a commission on critical infrastructure – that is, infrastructure critical to the economy, society, and administration. Such infrastructure urgently needed protection, for “a satchel of dynamite and a truckload of fertilizer and diesel fuel are known terrorist tools. Today, the right command sent over a network to a power generating station's control computer could be just as devastating.” Worse, “we found all our infrastructures increasingly dependent on information and communications systems that criss-cross the nation and span the globe. That dependence is the source of rising vulnerabilities... The capability to do harm... is real; it is growing at an alarming rate; and we have little defense against it.”²

Several high-profile terrorist attacks involving public infrastructure further boosted the debate. In the United States the attacks of September 11, 2001 showed that infrastructure was vulnerable not only to cyber threats; four commercial airliners were hijacked and used as weapons against the Pentagon and New York City's World Trade Center, killing about 3000 people. In the aftermath, local power, communication, and transport systems broke down as well and severely hampered emergency response efforts. The event triggered a range of security policies in the United States, Europe, and elsewhere.³ Subsequent attacks on ground transportation on European soil showed still other possibilities to harm societies through their infrastructure. In the morning of March 11, 2004, terrorist bombs hit four commuter trains in Madrid, killing almost 200 and wounding another 1800. In the rush hour of July 7 and 8, 2005, four suicide bombers attacked the London subway system and a double-decker bus, killing over 50 and injuring around 700. EU policy-makers needed to respond. They, too, established a critical infrastructure protection program.

By then the ground for such a program in Europe had already been prepared by a third type of event – a series of internal infrastructure disruptions. EU policy-makers were particularly shocked by the so-called Italian blackout of September 28, 2003, in which the failure of a Swiss-Italian power line during an Alpine storm eventually plunged the entire Italian peninsula and some 56 million people into darkness. The blackout trapped some 30,000 people in railway and metro cars, and hundreds in elevators. It disrupted road traffic due to traffic-light failure, interrupted the water supply, spoiled refrigerated foodstuffs, and halted industry's continuous production lines. That same year, other blackouts struck southern Sweden, eastern Denmark, London, Helsinki, and Athens. Europe's infrastructure vulnerability was perhaps most persistently demonstrated by the 2006 European blackout, in which a power failure in northern Germany instantly turned off lights in countries as far away as Croatia and Portugal. This rolling blackout even cascaded into northern Africa through the Spain–Morocco submarine cable. Repeated Russia-Ukraine gas crises, too, caused energy-supply problems throughout much of Europe; even Italian and French consumers were shown to depend significantly on Russian gas exports via Ukraine.⁴

To EU ministers and commissioners the lesson was clear: Europe was at risk and an “all-hazards approach” was needed, addressing terrorist attacks, natural disasters, and technical malfunctions. Moreover, in Europe the problem had a particularly transnational character since the “damage or loss of a piece of infrastructure in one M[ember] S[tate] may have negative effects on several others and on the European economy as a whole... This means that a common level of protection may be necessary.”⁵ By 2006, some common legislation was in place, though negotiations delayed the most visible piece of EU legislation – the critical infrastructure directive – until 2008.

Introduction

The ongoing policy debate about European critical infrastructure introduces the topic of this book in several ways. Clearly, infrastructure vulnerability and its

governance are pressing issues today in Europe, the United States, and many other places in the world. They concern politicians of many flavors, a host of sector and civil society organizations, citizens, and scholars: critical infrastructure features prominently among the vulnerabilities of modern technological culture that are in urgent need of a better understanding.⁶ Moreover, leading critical infrastructure researchers argue that infrastructure vulnerabilities reside particularly in their transborder character. Yet the vast majority of existing critical infrastructure studies take a (sub)national perspective and leave transborder dynamics poorly understood.⁷ Those few studies that do address cross-border vulnerabilities tend to follow the EU policy trajectory, but rarely ask how and why infrastructure connects some regions, countries, and peoples more than others, or how such asymmetries affect the geography of Europe's infrastructure vulnerability.⁸ To do so is a major purpose of this book.

In order to open up this topic, we delve below the surface of our introductory story and place the emergence and governance of critical infrastructure in a historical perspective. Europe's infrastructure vulnerabilities and coping strategies did not fall from the sky, nor did they emerge mysteriously from a vague and abstract process called "globalization." Instead our present infrastructure has a long, very concrete, and traceable history, and so do the vulnerabilities and governance responses that they evoked.⁹ Take, for example, the case of Russian natural gas exports. In the later decades of the Cold War, Russian gas proved a welcome and reliable relief for strained energy supply systems in much of Central Europe, and pipelines came to stretch from Siberian gas fields to German, French, and Italian consumers. Decades later, in a very different political context, the EU regards the very same supply lines to be one of Europe's major energy vulnerabilities. Or consider fundamental computer protocols, such as the two-digit date representation of years. This was designed when the Internet was a mere dream and the new millennium still in the distant future. Yet in the late 1990s it took a panic and great effort to mitigate the cascading effects of the so-called Millennium Bug that threatened individual computers as well as the financial, military, and other sectors relying on networked information and communication technology (ICT) services.¹⁰ Infrastructure, it has been said, develops in historical time, which transcends individual, political, and media time.¹¹ Accordingly, to understand its dynamics, vulnerabilities, and governance, we need to revisit the concerns, priorities, choices, and conflicts of its makers. We need to engage with history.

Such a historical perspective does more than track down the emergence and governance of Europe's transnational infrastructure vulnerabilities. It also brings into view remarkable long-term ironies that deserve serious consideration and reflection. Consider the very notion of critical infrastructure. We know from previous research that over the last two centuries many individuals, groups, and international organizations have eagerly stimulated transnational infrastructure development. Protagonists in the League of Nations, the International Labour Organization, the United Nations (UN), the Organisation for Economic Co-operation and Development (OECD), and a host of dedicated transport, communication, and energy organizations argued that infrastructure integration

would boost Europe's prosperity by creating larger markets. It would also invoke peace on a war-prone continent by fostering economic interdependencies and mutual understanding. Also, the EU's founding document, the 1992 Maastricht Treaty, obliges the EU to stimulate Trans-European Networks as levers for economic and social cohesion.¹² The term "critical infrastructure" that is currently in vogue confirms the success of this collective effort. It underscores the fact that infrastructure has indeed become omnipresent and critical to the functioning of modern economies, societies, and administrations. Simultaneously, the term signifies a major downside of Europe's infrastructure transition: precisely because modern societies have become (inter)dependent on cheap and steady infrastructure services, they are also vulnerable to infrastructure abuse and disruption. When infrastructure became omnipresent, Europe faced new risks. As we shall see repeatedly in this book, this profound historical irony shows up in many forms. Even the very security arrangements of the past might produce new vulnerabilities later on. To mention just one example here, about a century ago, power companies started to connect electricity grids across borders to increase mutual system stability and enable mutual support in case of breakdown, in short, to reduce the risk of blackouts. Simultaneously, such connections introduced the historically novel vulnerability of failures cascading across borders, as demonstrated in recent transnational blackouts. Yesterday's solutions can cause today's problems. Such ironies underline the paramount importance of a careful and reflective historical examination of critical infrastructure vulnerabilities.

Still we need to delve deeper. So far we have talked about "Europe" as a fixed container taken for granted for the purpose of our historical inquiry into transnational infrastructure vulnerabilities. Worse, our opening example tacitly equates "Europe" with "European Union." Further historical scrutiny of our introductory story suggests that this will not do. Consider that for half a century the EU and its forerunners advocated a particular version of "Europe" in terms of geography, governance model, and values. Yet political and popular support failed this project repeatedly. In the last decade, EU analysts observe, the European Commission has discovered the common enemies of transnational health, environment, and security threats as a promising way to bypass such stasis and resistance: the EU project took a qualitative and quantitative leap when the EU developed a new "security identity" and successfully claimed the governance of transboundary threats from food safety, avian influenza, and natural disasters to emergency response, terrorism, and critical infrastructure.¹³ When French and Dutch voters turned down the European constitution in 2006, the EU responded with a new charm initiative that placed center stage the fight against climate change – the ultimate "common threat" demanding a "common approach."¹⁴

What, then, is EU-critical infrastructure protection about? Is it about protecting infrastructure, about protecting the EU version of European integration, or both? This question becomes even more compelling when we take into account resistance to the program. The electric power sector and the financial sector, for instance, found their infrastructure sufficiently protected, not at risk (of technical or terrorist breakdown at least!), well on track in terms of European cooperation

outside EU institutions and transcending EU territory, and certainly not in need of the EU substituting these sector's own transnational governance arrangements. Indeed, most sectors managed to steer clear of the EU-critical infrastructure directive, which, after protracted negotiations, came to apply only to energy and transport – out of 11 sectors originally proposed.¹⁵ Sector negotiators resisted making their own sector collaborations subordinate to the particular form of Europeanization that the EU-critical infrastructure program represented. The lesson for historians is that they should not treat the EU as a natural, self-evident container for the history of Europe's critical infrastructure vulnerability and governance.¹⁶ Rather, stakeholders in the critical infrastructure playing field were (re)negotiating the very meaning of European integration – its territoriality, core values, governance modes – for their particular sectors.

This leads us to the broader historical question of what kind of “Europe” was built in the sphere of critical infrastructure vulnerabilities, most of which emerged before the EU could exert any significant influence on infrastructure matters.¹⁷ Did the geography, governance forms, and priorities of this “critical infrastructure Europe” differ from, contribute to, or simply reflect “political Europe” so familiar from history class, with its quarrels between nation-states, its prominent Cold War division, and most recently the increasing momentum of the EU project? What is needed is a transnational history that actively inquires about the emergence and governance of infrastructure vulnerability entwined with the territorial and political shaping of modern Europe. Such is the thrust of this book. In the following sections we shall sharpen the conceptual tools that inform our study. Next we will briefly sketch the logic and structure of the book. The individual chapters are not introduced in this General Introduction but in the introductions to the three main parts. The Conclusion (Chapter 10) picks up the threads laid out in both the general and the part introductions and it reflects on our findings.

Infrastructure's paradox

How can we unravel the historical coevolution of critical infrastructure, its vulnerabilities and governance responses, and contemporary Europe? An important premise of this book is that notions of infrastructure, vulnerability, and Europe and the relations between them cannot be understood straightforwardly in terms of univocal correlations between well-defined variables. Rather, these concepts themselves had ambivalent meanings for different stakeholders, and became entangled in different constellations in a variety of historical processes. This is why stakeholders might persistently disagree about the appropriate interpretations of, and governance responses to, infrastructure vulnerabilities.¹⁸ To appreciate the historical and social latitude of our key concepts, we prefer to think of them not as sharply defined variables but as paradoxes that carry potentially conflicting meanings.¹⁹ These paradoxes, in turn, set the stage for our investigation of which and whose meanings of infrastructure, vulnerability, and “Europe” were prioritized in historical processes.

Consider, to start with, the concept of infrastructure. Late nineteenth-century railway builders invented the term to denote the structure supporting the rails

(embankments, cuttings, bridges and so on), but NATO and others redefined it in the 1940s as the structures underlying modern organizations or societies.²⁰ Since then the term has been used in broader and narrower meanings. Some people associated infrastructure with what we today call the network industries, providing transport, energy, communication, and water services. Others expanded the term to cover all sorts of basic facilities, including education, financial services, and healthcare. At times, infrastructure carried the additional connotation of natural monopoly or public good, which made the concept highly contested when the boundaries between public and private were redrawn in the neoliberal era. All of these meanings, however, shared a common view of infrastructure as technologies of connection that played a constitutive and integrative role in economies and societies. The more recent concept of “critical infrastructure” underscores the “underlying structure that keeps society together” aspect.²¹ Related terms such as “networks” or “large technical systems” likewise share connotations of connectivity and an integrative foundation for modern societies.²²

It is important to realize, however, that this connective meaning of infrastructure echoes the rhetoric of its historical protagonists. The concept is laden with stakeholder ideology, which preceded the term infrastructure itself: already in 1852, Michel Chevalier claimed that “Railways have more in common with the religious spirit than we think; never has there existed an instrument of such power to link together scattered peoples.”²³ In capacities that varied from imprisoned social reform thinker to French government advisor and senator, Chevalier articulated, developed, and promoted his vision that modern means of communication, such as railways, telegraphy, and steam navigation, would overcome barriers of nature and space, improve the human condition, and propel economic prosperity and equality across national and class borders. The religion metaphor may have disappeared since, but each later generation of infrastructure proponents seems to have revived Chevalier’s old promise of connectivity and socioeconomic leverage. Nineteenth-century railway and telegraphy pamphlets, interwar proposals for European electricity, telephone, aviation and motorway infrastructure, postwar visions of TV broadcasting and the “global village,” 1990s celebrations of the Internet, and present-day social media marketeers share and highlight this one assumption: infrastructure connects.

We do not dispute infrastructure’s connective qualities. Instead we wish to point out that by foregrounding connections, other infrastructure features fade from view. If critical scholars call connectivity claims “the myth of the network,” it is because these very claims obscure how infrastructure connections for some peoples or territories often imply the non-connection or even disconnection of others.²⁴ Examples abound of new canals, railways, and motorways that literally cut local communities in two. Even high-profile international infrastructure connection projects might involve disconnection: the famous Gotthardt railway line and tunnel, opening in 1882, was a symbol of the penetration of the Alps to integrate Northern and Southern Europe. At the same time it bypassed the Gotthard pass above the tunnel, disconnecting from transnational trade flows one of its most prominent hubs for millennia, condemning its expensive road infrastructure

to disuse and its mail-coach system to nostalgic memory.²⁵ In other cases, infrastructure was designed to bypass. The business model of the Great Nordic Telegraph Company's huge telegraph network, stretching from London via the Copenhagen hub across Russia to China and Japan by the 1870s, was to connect East and West while bypassing imperial Germany. Britain's submarine telegraph network that spanned the globe by 1900, too, served to bypass land-based telegraph systems on territories outside British control.²⁶ The incorporation of the Baltic states into the Soviet Union after the Second World War involved cutting telephone connections to the West and rerouting all telephone traffic through Moscow. We could go on and on.²⁷ In terms of access, too, some social groups were "more equal than others": since 1992 the Channel Tunnel has served the free flow of businessmen, tourists, and freight, while at the same time much effort was dedicated to prevent those flows of illegal immigrants and asylum-seekers that the tunnel also attracted.²⁸ This is our first paradox: the very same infrastructure can at once connect and fragment.²⁹

A paradox, of course, is not a contradiction. It is an apparent contradiction that serves stylistic or, in our case, analytical purposes. Our infrastructure paradox of connection and rupture reminds us not to take at face value the myth of ever-increasing connectivity, and instead appreciate the latitude of historical agents (as well as present-day ones) to employ infrastructure as tools that not only connect but also create difference. Infrastructure's paradox thus translates into the historical research question regarding when, by whom and for what reasons infrastructure was made to connect or splinter. We ask why historical agents chose some infrastructure-development trajectories and rejected alternatives, who they sought to connect and who they bypassed, and how they dealt with borders in the age of connectivity.³⁰ Such historical choices, we suspect, were important constituents of Europe's infrastructure vulnerabilities and the governance responses that these evoked.

Ambivalent vulnerabilities

What, then, is infrastructure vulnerability about? Notions of infrastructure vulnerability and criticality are relatively recent additions to the thinking about risks of technological systems. Charles Perrow's famous work on living with high-risk technologies from the 1980s illustrates the tone of this debate well. For him, modern technology had become so complex, with many causal feedback loops and possibilities for cascading failure, that it had become susceptible to breakdowns that cannot be predicted, anticipated, or managed: small disturbances may cause unexpected chains of events that lead to bigger failures, especially in tightly coupled systems where such processes happen very quickly and cannot be halted. Prominent examples include failures in nuclear power plants, chemical plants, air-traffic control, and electric power systems. In his Normal Accident Theory, Perrow saw breakdown and accident as an inherent, "normal condition" of such systems.³¹

Like infrastructure, the terms "risk," "vulnerability," and "criticality" have been subject to considerable interpretive flexibility. Many quantitative risk studies

define risk narrowly as the probability of an unwanted event multiplied by its impact. In social theory, by contrast, the terms risk and risk society have become encompassing. Ulrich Beck argues that modern societies are increasingly organized in response to human-made technological risks that spur doubts about the present course of modernization and affect social structure.³² Vulnerability, too, is used in narrow and broad meanings. It may refer to specific people, organizations, or places but also to technological systems and even technological cultures that are susceptible to harm, and their ability to anticipate, resist, cope with, and recover from events that could impede their functioning.³³ The notion of vulnerability in critical infrastructure discourses sometimes refers to disturbance or breakdown of the infrastructure system itself, and at other times to the consequences for households, industries, and other users of infrastructure services. In this book we will speak of “system vulnerabilities” and “user vulnerabilities” to distinguish between these two kinds of vulnerability. For all of these nuances and overlaps, however, these related concepts share one dominant message foreshadowed by Perrow: harm is coming our way.

As in the case of infrastructure connectivity, we should not take this key message of harmful infrastructure vulnerability at face value. For starters we should recognize our own bias when discussing risk and vulnerability. The psychology of fear tells us that the human mind is wired to foreground threat at the expense of opportunity, and routinely defies rational choice and behavior. Scores of experiments confirm that humans are notoriously poor at estimating risk. A morbid yet telling example is the estimated 1500 additional road accident deaths in the year following 9/11, when Americans massively substituted plane travel with interstate highway travel.³⁴ Also, human-made technological risks outside our direct personal control (nuclear accidents, terrorist attacks on infrastructure, gas import disruption) tend to trigger our sense of vulnerability more than natural risk (including earthquakes but also major health killers, such as diabetes, cardiovascular disease, or asthma) or technology-related risks that we claim to control (think road accidents). This mental vulnerability bias is further amplified in our contemporary culture of fear, which, according to sociologists, has emerged since the 1970s and skyrocketed after 9/11.³⁵ The point here is not, of course, that risk and vulnerability do not exist. Rather, the associated fear is simultaneously real and hyped for psychological, commercial, political, and media reasons. A recent OECD study observes that the improvement of cybersecurity is important; yet at the same time public cybersecurity debates suffer from “exaggerated language,” “sensationalism,” and “grossly misleading conclusions.” Cyber espionage, password phishing, or hacktivist attacks are regularly interpreted as threats to (inter)national security or even signs of an emerging cyber war, rather than innovative forms of old social practices, such as spying, theft, and public protest.³⁶ Another commentator in the policy debate on European critical infrastructure protection – a security sector entrepreneur – observed that fears of an “electronic 9/11” are deliberately overstated: “Nobody is getting blown to bits. It’s not real terrorism. But if you add ‘terrorism’ to things you get more budget.”³⁷

As in the case of infrastructure connectivity and rupture, the sheer observation that our sense of harmful infrastructure vulnerability is psychologically, historically, and socially situated leads us to more fundamental paradoxes. Consider, for instance, that similar critical events have historically provoked opposite reactions. In New York the Great Northeast Blackout of 1965 was celebrated for stimulating local neighborhood solidarity with candlelight dinners and street dances. Yet in a context of social unrest, the New York blackout of 1977 sparked looting, arson, and violence.³⁸ The same type of infrastructure breakdown, it seems, may turn out to be both hopeful and harmful for users. Harmful user vulnerability should not be assumed by definition; instead we should investigate the historical processes that produced these different outcomes. A similar argument applies to system vulnerability. Infrastructure vulnerability and breakdown should not be treated as inherently malicious; they may also create hope and opportunity for much-needed innovation and change – for instance, in the direction of increased sustainability or democratic control of modern technological systems.³⁹ Indeed, hopes for a sustainability transition in energy or mobility depict the crisis of present-day fossil-fuel-based infrastructure as well as the ongoing financial crisis as windows of opportunity for radical change.⁴⁰

Next to this paradox of harm and hope, stakeholders may disagree completely about whether or not an infrastructure is vulnerable to begin with. To EU policy-makers the transnational blackouts of 2003 and 2006 suggested instant vulnerability and alarm. Yet, as we shall see in this book, the electric power sector saw the very same events as confirmation that Europe's electricity supply was reliable, secure, and well organized. Paradox again. We cannot reduce this paradox of simultaneous vulnerability and reliability to the issue of "who is right," for both parties had good arguments. EU policy-makers saw how local incidents could instantly ignite economic and social disruption thousands of kilometers away, and made it their job to address such long-distance vulnerabilities. The electric power sector, by contrast, had identified the possibility of rolling blackouts long ago, defined its task in terms of anticipating and mitigating such cascading vulnerabilities, and now found its security arrangements tested and working well: the lights stayed on for the great majority of the population and the entire system was repaired quickly, mostly within half an hour. For power sector spokespersons, the daily reliability gains of cross-border grid connection greatly outweighed incidental and rapidly contained cross-border failures.⁴¹ This paradox of simultaneous vulnerability and reliability resonates in academic vulnerability scholarship itself: Perrow's Normal Accident Theory, which we mentioned above, triggered the emergence of High Reliability Theory, to study why supposedly inherently vulnerable technological systems in fact rarely break down. Normal Accident Theory uses electric power systems and air-traffic control as examples of inherently vulnerable technologies. High Reliability Theory highlights the same infrastructure as illustrations of high reliability.⁴² Present-day critical infrastructure studies still echo and reproduce this ambivalence.⁴³

As in the case of infrastructure connectivity and rupture, the paradoxes of simultaneous harm and hope and of simultaneous vulnerability and reliability force us

to acknowledge the latitude of stakeholders to interpret and anticipate infrastructure vulnerability and its implications in radically different ways. Again, these paradoxes translate into historical research questions. How did stakeholders come to assess, prioritize, and anticipate vulnerabilities and their implications in concrete historical processes of transnational infrastructure development?⁴⁴ As we shall see in this book, historical agents time and again were confronted with different infrastructure design options that might have conflicting implications in terms of opportunity and harm, and of reliability and vulnerability. Hence they needed to weigh and trade different vulnerabilities against each other. Gas imports from Russia could solve Bavaria's threatening energy shortages but would create new import dependencies; Bulgarian nuclear power projects would make its electricity production less dependent on Russian coal but introduce the new risk of nuclear accident; Greek power authorities feared the risks of nuclear power and accepted dependence on power imports and polluting domestic lignite power stations. ICT would improve the precision of air-traffic control but make air travel vulnerable to ICT failures; standards for emergency communication should condemn endemic miscommunication during disasters to oblivion but might also be a source of new communication problems themselves. These were all complex issues. As the parties involved disagreed, negotiated, and struck compromises, they inscribed hope as well as harm, increased reliability, and potential new vulnerabilities in the design of transnational infrastructure. This book studies which and whose vulnerabilities were prioritized in such historical processes, and how these came to make up Europe's nascent infrastructure vulnerability geography.

Finding Europe

What does it mean, finally, to study Europe's infrastructure vulnerabilities? Given our discussion so far, the reader will not be surprised to find that we reject an ahistorical up-front definition of "Europe" as a stable container for our inquiry. Instead we set out to inquire how contemporary Europe itself was shaped in the processes of emerging and governing infrastructure vulnerabilities.

Of course, the historical and social variability of the term "Europe" is much better known than the ambivalences of infrastructure and vulnerability that we discussed above. Europe has always been a highly contested political project. Already the boom in political projects for a united Europe in the 1920s and 1930s made clear that historical agents did not see Europe as an invariable entity "out there" but as something to create, build, and work hard for. These projects also revealed substantial disagreement about how this Europe should look in terms of external reach (Should Britain, Russia, Turkey, and the colonies be included?), internal structure (Should regions, countries, or new empires be the main building blocks?), and governance (Should national autonomy be mitigated by inter-governmental, (con)federal, supranational, or non-governmental decision- and rule-making?).⁴⁵ Postwar projects for European integration show similar discrepancies. The UN worked hard for all-European economic integration from Ireland to Soviet Russia. It even breached its core principle of universal organization and

set up its first regional commission, the UN Economic Commission for Europe (UNECE), to help forge an all-European economy. But the new organization competed with other Europe-builders that worked on a much smaller territorial scale. The European Communities, forerunner to the EU, involved only six states in the 1950s and 1960s, and welcomed only six more in the 1970s and 1980s. Gunnar Myrdal, the first UNECE secretary general, loathed such claims to Europe for the happy few: “I always reacted... to the increasingly common application of the term ‘Europe’ to that narrow strip of our Continent and the term ‘European’ to its subregional organizations. This type of propagandistic terminology... indicates a deeper inclination which is intensely inimical to the work governments are trying to do in this [United Nations] Commission”.⁴⁶ After 1989, controversy about the meaning of Europe remained. EU membership quickly increased and the term “Europe” was increasingly associated with EU territory, polity, and values – partly following the deliberate EU cultural policy to forge a common European identity.⁴⁷ Yet when the European Commission heralded the Channel Tunnel between France and England as a sign of successful EU-led European integration, Eurosceptics revolted: “If one were to judge by the Commission’s report... cross-border transport and free movement of goods in Europe could not exist without the E.U. Needless to say, governments are capable of freely cooperating... without needing to surrender their powers to an unelected, supranational authority.”⁴⁸

Such persistent and highly politicized disagreement about the meaning of Europe in terms of territory, governance, and values once more forces us to treat Europe not as a fixed concept but instead to inquire how Europe historically took shape in relation to our topic – the emergence and governance of transnational infrastructure vulnerabilities. Again, teasing out a few paradoxes helps us on our way. First, consider the following paradox of European integration. The Turkish government applied for full political membership of the European Communities in 1987, but negotiations regarding EU membership remain troublesome today. The last decade even witnessed an increase in popular and political resistance to Turkish inclusion in the EU. By contrast, in that very same decade, Turkey was fully integrated into Europe’s largest electric power collaboration: in 2000, Turkish electric power authorities applied for integration into the Trans-European Synchronously Interconnected System (currently called the Continental European Synchronized Area), and since the summer of 2010, Turkish electrical machines, motors, and consumer appliances move at exactly the same frequency, in tune, and in immediate interdependency (and joint vulnerability), with their German, French, Dutch or Portuguese counterparts. This feat is even more remarkable when we consider that power authorities and companies in Britain and most of Scandinavia had chosen not to join “Europe’s electrical heartbeat” in the 1960s, and still today cooperate with continental European partners in an asynchronous, and thus less immediate, mode than Turkey does.⁴⁹

This apparent contradiction of electrical integration and political non-integration begs the broader historical question of what kind of Europe was built in the realm of infrastructure and its vulnerabilities, as compared with the dynamics of political Europe. In contrast with the formal political integration process,

infrastructure counts as a major arena for Europe's so-called informal or hidden integration.⁵⁰ Indeed, such organizations as the European Broadcasting Union (1950), the European Conference for Ministers of Transport (1954), the European Conference for Post and Telecommunications (1957), and EUROCONTROL (1963) all explicitly claimed to build infrastructure for "Europe." Yet all worked outside the formal EU framework and built "Europes" that differed vastly in geographical coverage and governance modes. For instance, most Europeans do not question the inclusion of Israel in the European Broadcasting Union's Eurovision network and its annual song contests since the early 1970s.⁵¹ This book similarly queries Europe's hidden integration and fragmentation in terms of the historical emergence and governance of infrastructure vulnerabilities. Who was connected in common vulnerability to whom?

Two further paradoxes provide important clues about where to look for such a hidden Europe of infrastructure vulnerabilities. First, we are used to thinking of European integration in terms of delegating tasks to a higher authority and the associated weakening of the nation-state. Yet the postwar era of European integration also witnessed the rise of the nation-state to unprecedented power, budgets, staffing, popular identification, and sociocultural integration. In recent decades even the (micro)region and the city have experienced a revival in terms of citizen identities, and social and economic activity.⁵² The age of European integration, paradoxically, is also the era of the nation-state, the region, and the city. In the infrastructure realm, too, we see simultaneous construction and governance activity on these different scales.⁵³ We suspect that the same may apply to infrastructure vulnerabilities. Hence we examine whether, in the age of international gas crises and blackouts, the national and local remain important units of experiencing, influencing, and governing vulnerability, and how vulnerabilities at very different scales of experience and power coevolved or competed.⁵⁴ Unlike much international history, then, our transnational history of Europe's infrastructure vulnerability needs to embrace, not neglect, these important national and local engines of change. For this purpose we juxtapose studies of transnational infrastructure vulnerability from pan-European, national, and microregional/local perspectives, and examine how these scales historically have coevolved.

Finally, we take a special interest in the dynamics of borders. Here is the paradox: Europe is characterized as often by its many borders on a relatively small territory as by its transactions and collaborations that transcend borders – represented most prominently today by the EU. Translated to infrastructure: on the one hand, infrastructure often serves to transcend Europe's natural and political, internal, and external borders. As argued above, railroads, pipelines, transmission lines, and telecommunication cables cross national and EU borders as well as the Alps, the Urals, the Black Sea, the Bosphorus, and the Mediterranean, challenging geographical distinctions between Europe, Asia, and Africa. On the other hand, just as often, infrastructure followed and reinforced such borders. Parallel electric power lines run on each side of the French-German border, and even in 2011 there is still only a single bridge across the 470 km stretch of Danube River border between Bulgaria and Romania (while there are nine bridges across the Danube in the

Hungarian capital of Budapest alone). The Iron Curtain also became an “Electric Curtain,” separating Cold War collaborations in electricity and telecommunications on either side. These are just a few instances that illustrate how political borders and priorities were inscribed into Europe’s infrastructure geography. This book investigates the contradictory role of borders in the historical shaping of the geography of Europe’s infrastructure vulnerability, taking the most prominent border in modern European history – the Iron Curtain – as its main case.

Structure of the book

We can now lay out our project. Above we translated the important present-day policy issue of Europe’s infrastructure vulnerability and its governance into a set of historical questions. The book studies how and why historical agents interpreted, negotiated, built, and governed infrastructure connections and ruptures; how they anticipated and prioritized vulnerabilities, opportunities, and reliabilities; and, while doing so, how they produced a hidden geography of European vulnerability that both overlapped with and deviated from Europe’s political geography, paying particular attention to the mutual shaping of pan-European, regional, national, and local scales of vulnerability and organization, and the role of political borders.

Given the vast nature of this subject matter, we need to narrow down our inquiry. First we decided to focus on the most critical of all critical infrastructure. As noted above, EU policy documents on critical infrastructure protection identified about 11 sectors that qualified as critical infrastructure, including food, banking, health, water supply, and space infrastructure. Other agencies might work with different lists. There is a remarkable consensus, however, that energy and ICT infrastructure count as the most critical of all. They top the list in EU policy documents. Attempts at the quantitative determination of society’s most critical infrastructure, using theoretical models or real-life data, arrive at similar conclusions. In a study for the UK Cabinet Office, consultancy firm Ernst & Young deconstructed 11 key sectors underpinning the modern economy into their elements and assessed their mutual dependencies, determining telecommunications and electricity supply to be the infrastructure most frequently entangled with basic operations in the economy. A study based on a database of 2517 serious critical infrastructure incidents worldwide, as reported by news media, found an overwhelming role for energy and telecommunications in failures that cascaded across infrastructure boundaries.⁵⁵ This book, accordingly, focuses on energy and ICT infrastructure.

Narrowing down our inquiry still a bit further, we take these two critical infrastructure sectors to illustrate two different sorts of infrastructure vulnerability in contemporary Europe. The European Commission observed how “Europe’s critical infrastructures are highly connected and highly interdependent,” which made them “vulnerable to disruption.”⁵⁶ “Connectedness” here refers to cross-border connections across national borders, which make failures difficult to contain geographically, such as energy-related crises (e.g. international gas crises and rolling blackouts). “Interdependency” refers to the situation where a given

type of infrastructure not only crosses political or geographical borders but also intertwines with other infrastructure. In the nineteenth century, railroads were dependent on telegraphic communication; today, all of society's infrastructure has become entwined with information and communication systems and is thus vulnerable to ICT failure.⁵⁷

Energy infrastructure (particularly the supply of gas, electricity, and nuclear power) and its cross-border interdependencies and vulnerabilities occupy center stage in parts I and II of the book. In Part I, "Connecting a Continent," we study the emergence and governance of transnational infrastructure vulnerability from a transcontinental perspective. This part of the book discusses how Europe's vast infrastructure traverses and transcends the Continent and has produced asymmetrical long-distance vulnerabilities. This perspective also forces us to pay ample attention to Central and Eastern Europe and to avoid implicitly equating "Europe" with Western Europe, as much European historiography once did.⁵⁸ We focus on electricity and natural gas because these systems are so closely intertwined with economic and social activities of all kinds. Today the everyday life of almost all European households is dependent on the uninterrupted flows of these commodities across borders, which are taken for granted until a blackout or "gas crisis" forces them out of complacency.

In Part II, "Negotiating Neighbors," we continue to investigate the connectedness of Europe's critical energy infrastructure. However, here we zoom in on the role of nation-states in shaping and governing both domestic and cross-border infrastructure vulnerabilities. As neighboring countries negotiated their infrastructure connections and tried to anticipate the implications for vulnerability, they built the very bricks that came to make up Europe's wider geography of infrastructure vulnerability. We selected case studies from countries situated at Europe's most prominent internal political border in contemporary history, the Iron Curtain. Studying Finnish, Bulgarian, and Greek infrastructure priorities, concerns, internal struggles, and negotiations with their neighbors brings into view the complex historical choices and processes that produced Europe's vulnerability asymmetries and the ambivalent role of the Iron Curtain as a major European border.

In Part III, "Coping with Complexity," we focus on ICT and its interdependencies with other selected infrastructure, such as air-traffic control, electricity supply, and emergency services. Again, we investigate the vulnerability and governance implications of these processes from different perspectives, including the perspectives of international organization, national concerns, and bilateral negotiations, and cooperation on the microregional scale in cross-border (micro)regions that served as primary organizational units for emergency response.

We conclude this general introduction with one final paradox. The shorthand name for the research program behind this book was "Europe Goes Critical." We were well aware that most readers would interpret this title, at first, to mean European susceptibility to harm following the proliferation of transnational infrastructure. There is, however, a second meaning. In nuclear power engineering a

reactor goes critical when it becomes operational (when each nuclear reaction produces sufficient neutrons to trigger a next reaction and keep the nuclear fission process going). Contemporary Europe too, we argue, became possible and operational in the wake of transnational infrastructure, the enormous flow of goods, ideas, energy, information, value, and people that it carries, and the vulnerabilities that it implies for better or for worse. A study of Europe's infrastructure vulnerabilities should indeed embrace both messages in order to capture the width and depth of this remarkable and important historical phenomenon.

Notes

1. Commission of the European Communities 2005, p. 2.
2. Presidential Commission on Critical Infrastructure Protection 1997, pp. x and i. See United States General Accounting Office 1996, p. 2.
3. For the United States, see Perrow 2007.
4. On these blackouts, see Lagendijk and Van der Vleuten, this volume. On gas crises, see Högselius et al. this volume. For evidence that the 2006 events were drawn into ongoing critical infrastructure policy-making, see Directorate General for Energy and Transport 2007, and Hämmerli and Renda 2010.
5. Commission of the European Communities 2006, p. 3. The proposal includes a list of already existing legislation.
6. Bijker 2006 and 2009; Kaijser 2011.
7. Transnational vulnerabilities are highlighted in Gheorghe and Vamanu 2005, p. 218, and Gheorghe et al. 2007, p. 6. Compare the practice of CI studies in, for example, Goossens 2004; Gheorghe et al. 2006; Murray and Grubescic 2007, and the *International Journal of Critical Infrastructures* 2004–2010.
8. Gheorghe et al. 2006 and 2007; Burgess 2007; Fritzon et al. 2007.
9. For this argument, see Van der Vleuten and Lagendijk 2010a and 2010b.
10. Edwards 1998.
11. Edwards 2003.
12. "Treaty on European Union," published in *Official Journal of the European Union* C 191 (July 29, 1992). Compare Van der Vleuten et al. 2007 and Schot 2010.
13. Boin, Ekengren, and Rhinard 2006.
14. Associated Press, "Low-Carbon Economy Proposed for Europe. Eyeing Warming and Volatility, EU Leaders Expected to Approve it in March," January 10, 2007.
15. The proposal included energy, the nuclear industry, ICT, water, food, health, financial services, transport, chemical industry, space, and research facilities. Commission of the European Communities 2006, Annex 1. On the position of the financial sector, see Financial Services Authority, "Protection of Critical Infrastructure Dossier," available at <http://www.fsa.gov.uk/pages/About/What/International/pdf/DOECIP.pdf> (accessed on February 22, 2011). On the electric power sector, see Van der Vleuten and Lagendijk 2010b.
16. Compare Cole and Ther 2010.
17. This happened from the 1980s. For an overview, see Schipper and Van der Vleuten 2008.
18. This applies to technological risk in general. See Jasanoff 2002.
19. Inspired by Scranton 2011. On paradox as an analytic strategy in organization science, see Scott Poole and Van de Ven 1989.
20. Van Laak 1999.
21. Boin and McConnel 2007, p. 1; Egan 2007, pp. 4–5.
22. For a discussion, see Van der Vleuten and Kaijser 2006, p. 6.

23. Chevalier cited in Mattelart 1996, p. 103. For a vivid argument, compare Chevalier 1832, pp. 35–39 and 41.
24. Badenoch 2010, especially pp. 52–57.
25. Schueler 2006 and 2008.
26. Headrick 1991.
27. Högselius 2005.
28. Van der Vleuten and Kaijser 2006, pp. 2–3.
29. Graham and Marvin 2001; Coutard 2005.
30. Here we pick up on the Large Technical Systems research tradition that sprung from Hughes 1983. For a review, see Van der Vleuten 2006; for its transnational turn, see Van der Vleuten and Kaijser 2005. For other infrastructure paradoxes, compare Edwards 2003.
31. Perrow 1984 and 2007.
32. Beck 1992, p. 21.
33. Cutter 1993; Sarewitz et al. 2003; Leach 2008; Bijker 2006.
34. For the psychology of fear we rely on Gardner 2009. On post-9/11 road accidents, see Gigerenzer 2006.
35. For the culture of fear debates, see, for example, Furedi 2006 and 2007, and Pain 2009. For fear in connection with critical infrastructure, see, for example, Williams 2002 and Burgess 2007. Observe that psychological fear research and its experiments also stem largely from this period, and may itself be an expression of this cultural phenomenon.
36. Sommer and Brown 2011, p. 80.
37. Bruce Schneier of the UK security firm Counterpane cited in “Critical Infrastructure”, *Euractive.com*, January 26, 2009.
38. Nye 2010.
39. Bijker 2006.
40. This insight informs ongoing research into sustainability transitions. For example, Grin, Rotmans and Schot 2010; Verbong and Loorbach 2012.
41. Van der Vleuten and Lagendijk 2010b; Lagendijk and Van der Vleuten, this volume.
42. Roberts 1990; La Porte and Consolini 1991; La Porte 1996; Rochlin 1996.
43. Compare the vulnerability talk of Gheorghe et al. 2006 and 2007 with the reliability studies of Schulman, Roe and Van Eeten 2004; De Bruijne 2006, and De Bruijne and Van Eeten 2007. On an even more generic level, several authors highlighted the paradoxical coexistence of our present-day preoccupation with risk and vulnerability in such different realms as terrorism, ecology, infrastructure, and parenting on one hand, and historically unprecedented levels of personal, economic and social security on the other – at least in the developed world. Furedi 2007, p. ix. Gardner 2009, p. 10 speaks of the “greatest paradox of our time”.
44. Here we turn to the constructivist tradition in risk studies represented by, for example, Jasanoff 1998, and Summerton and Berner 2003. For an extension to critical infrastructure studies, see Van der Vleuten and Lagendijk 2010b.
45. For a general overview, see Wilson and Van der Dussen 1995, pp. 83ff. Schot and Lagendijk 2008; Kaiser and Schot in press.
46. Myrdal 1968, p. 626. Compare Berthelot 2004.
47. For EU cultural policy, see Shore 2000.
48. Jeffrey Titford (EDD), Debates of the European Parliament, May 30, 2002. Compare Van der Vleuten and Kaijser 2006.
49. Lagendijk and Van der Vleuten, this volume; Högselius, Kaijser and Van der Vleuten in press.
50. For notions of informal and hidden integration, see Wallace 1990, pp. 8ff., and Misa and Schot 2005. For a research agenda on Europe’s hidden infrastructure integration, see Van der Vleuten and Kaijser 2005.
51. For this line of research, see the collected essays in Van der Vleuten and Kaijser 2006; Schot 2007; Badenoch and Fickers 2010, and monographs such as Lagendijk 2008; Schipper 2008; Anastasiadou 2011; Lommers 2012; and Janáč 2012.

52. For example, Milward 2000; Applegate 1999; Storm 2003; and Saunier 2002.
53. On the role of state governments in international infrastructure associations, see, for example, Henrich-Franke 2007 and 2008. For national infrastructure building and regulation, see, for example, Millward 2005; for cities as a unit of infrastructure activity, see Tarr and Dupuy 1988; Graham and Marvin 2001; and Hård and Misa 2008.
54. This is the new transnational history proposed by Tyrell 1991 and 2009. For different forms of transnational history, see Van der Vleuten 2008 and Saunier 2009. On this point we deviate from the transnational histories inspired by the transnational turn in political science in the 1970s, which brought non-state actors into international relations and thereby a priori focuses on the international. This work includes studies of transnational networks by infrastructure experts; see Schot and Lagendijk 2008 and Schot and Schipper 2011.
55. Lukasik 2003, p. 208, and Luijf et al. 2009.
56. Commission of the European Communities 2004, p. 4.
57. Bekkers and Thaens 2005, p. 37.
58. For a compelling critique, see Davies 1996.

The Making of Europe's Critical Infrastructure

Common Connections and Shared Vulnerabilities

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