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TITLE: Europe goes Critical:
The Emergence and Governance of
Critical Transnational European Infrastructures

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Abstract:

This text is an abridged and updated version of the EUROCRIT proposal as submitted in Sept. 2006 to the ESF Eurocores “Inventing Europe” program. The EUROCRIT collaboration is investigating the historical construction and societal consequences of the increasing intertwinement of critical infrastructures across and through national borders in Europe. A major issue is whether the additional layers of complexity necessary to ensure transnational coordination of infrastructures and their services have not also introduced new vulnerabilities and catastrophic potentials. The project focuses on electrical power, natural gas, emergency services, air traffic control, telecommunications and nuclear energy.

Europe goes Critical:
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CRP aims and objectives

Winter, 1921. An extraordinary drought in Northern Italy reduced hydro-electricity yields and threatened the industries in Italy's economic heartland. Swiss and French power companies came to the rescue: Swiss hydroelectricity was exported to Italy, Switzerland interrupted its exports to France, and French coal power stations now supplied power to Zurich and Geneva. These emergency measures were only possible due to recent interconnections of the French, Swiss and Italian power systems. The League of Nations used this example to argue for further integration of electricity networks across national borders, in particular in Europe (ATCCT 1922).

Autumn, 2003. A severe storm caused a tree to tip over a power line carrying Swiss electricity exports to Italy. The line break ignited a chain reaction of power overloads in the Swiss, French and Italian power systems. The French and Swiss cut their connections to Italy to reduce the risk of blackouts at home. While Switzerland suffered local power breaks, the entire Italian peninsula plunged into darkness in Italy's biggest blackout ever. The Swiss, French and Italian power authorities blamed each-other, but the international Union for the Coordination and Transmission of Electricity concluded that the problem transcended the national level and that it resulted from design choices made long ago, and which were out of touch with the current use of the network. The system was designed with occasional cross border emergency supply in mind, not the high level of power exchanges that characterize the current era of liberalization (UCPTE 2003).

These two anecdotes reveal a historical process in which transnational infrastructures created new interdependencies between Europe's nations, and thereby also a new type of – transnational – vulnerabilities. The anecdotes speak to current debates on "critical infrastructures" in the EU and in the US, partly triggered by terrorist attacks demonstrating the vulnerability of infrastructures and society's dependence on these. In a recent EU Green Paper "On a European Programme for Critical Infrastructure Protection" (November 2005) the concept is defined in the following way: "Critical infrastructures include those physical resources, services, and information technology facilities, networks, and infrastructure assets which, if disrupted or destroyed, would have a serious impact on the health, safety, security or economic well-being of citizens or the effective functioning of governments" (European Commission 2004). Much effort is currently devoted in Europe (and on the other side of the Atlantic) to finding ways and means to reduce the risks of such disruptions, both intended and unintended. We welcome this debate because it spotlights how infrastructures intertwine with political, social and economic life. However, historical perspectives in the current debate seem to be largely missing, and this, we argue, is a weakness.

The purpose of this CRP is to put the current discussion on critical infrastructures in Europe in a historical and transnational perspective. It takes as its point of departure the expansion of infrastructures in Europe both through the interconnection across national borders and through interconnections of different kinds of infrastructures with one another. We will refer to the former type of interconnection as "horizontal" integration and to the latter as "vertical" integration. The project studies how these two kinds of infrastructural interconnections (i.e. horizontal and vertical) have created ***new forms of interdependencies*** and ***shared vulnerabilities*** among nations in Europe. It inquires how actors of different kinds have interpreted such interdependencies and vulnerabilities, and how they have developed institutions for handling them.

More specifically, there are five major research questions in this CRP:

1. How have interconnections of infrastructures across national borders contributed to their growing intertwinement with economic and social activities of various kinds in Europe?
2. What kinds of mutual dependencies and shared vulnerabilities have arisen due to transnational interconnections of infrastructures, and how have these been interpreted and negotiated?
3. What responses have actors developed to handle the transnational vulnerabilities, such as new forms of governance (e.g. contracts, standards and gentlemen's agreements), new technical designs (e.g. converters and system architectures with higher redundancies) and joint emergency procedures?
4. How have these processes and responses differed between regions and over time, and how does this reflect the unity and diversity of Europe?
5. How can we better understand the characteristics and nature of "critical infrastructures", and what concepts and perspectives are most fruitful for analysing them?

State of the art

This CRP addresses first and foremost two research agendas that are currently *en vogue* in history of technology:

The first is to transcend the national framing of historiography and to engage in transnational (European) history. Transnational history has developed into an important corrective to nation-focused modern/contemporary history; its point is not to exclude national developments, but to inquire how the national and international are linked (Therr 2003; Iriye 2004; Clavin 2005). For the history of technology as a whole, this concern was adopted by the Tensions of Europe programme (Schot, Misa and Oldenziel 2005). Infrastructure history reflects this general development: until recently it overwhelmingly focused on national and subnational developments (occasionally making cross-country comparisons). Historians of technology (Van der Vleuten and Kaijser 2005, 2006; www.tie-project.nl) and economic historians (Merger, Carreras and Giuntini 1994; Dienel 2004) have started to address the development of transnational networks. This CRP pushes this approach further: it not only investigates the emergence of transnational European networks, but addresses above all a number of important issues that relate more specifically to the evolving relations between transnational infrastructures and the corresponding interdependencies and vulnerabilities between peoples and countries in Europe.

The second research agenda is to combine the customary focus of explaining the societal shaping of technological change with studies of the technological shaping of economies and societies. The argument that technology's societal consequences can and should be investigated in non-technological-determinist ways was made over a decade ago (Nye 1990; Fischer 1992; Misa 1994), but only in recent years became broadly accepted as a research theme, and it is still evolving (e.g. Coutard et al. 2005). This CRP is making a novel step and studies how the shaping of transnational network designs intertwined with the emergence of transnational socio-economic interdependencies and vulnerabilities, and inquires what kind of 'Europe' was shaped in these processes.

We also build upon an older agenda of Large Technical Systems (LTS) research. This tradition is rooted in the work of the American historian Thomas Hughes in the 1980s, but was developed conceptually and empirically since (for an extensive review and references, see Van der Vleuten & Kaijser 2006, chapter 11). LTS research takes infrastructural systems, not artefacts or machines, as its unit of historical inquiry (Hughes 1983). It focuses on the *sociotechnical* nature of systems and tries to explain the development of systems, and their functioning and implications for societal stability and change. Avoiding weaknesses in the original approach, current LTS research does not make *a priori* assumptions about (centralized) management, but studies systems characterized by centralized as well as distributed control. Also, it does not regard system building as a harmonious enterprise, but as the outcome of negotiation and conflict; system building is a multi-actor game (Coutard et al. 2005; Van der Vleuten and Kaijser 2006). In this CRP we are going beyond the study of

single systems and are focussing on the vertical interconnection of infrastructural systems, a phenomenon that has also been called "internetworking" (Edwards 1998).

Our CRP also incorporates sociological studies of risk in sociotechnical systems, a field in which Charles Perrow's book *Normal accidents* (Perrow 1984, new edition 1999) was a pioneering work. Perrow argued that certain sociotechnical systems (like nuclear power plants) characterised by both a high degree of complexity and a tight coupling between their constituent parts are inherently risk prone. Even if the operators are very skilled they simply have no chance to perceive and prevent all potential disastrous events that can occur, and accidents thus become "normal" outcomes of these systems. Perrow has also warned that safety devices meant to reduce the risk of errors can increase overall complexity and coupling and thus result in systems that are more prone to error than previously (Perrow 1994) However, the "normal accident"-approach has been contested. Researchers studying the same kind of systems as Perrow did have found that they in fact often perform quite safely, and have tried to explain why (La Porte and Consolini 1991, Rochlin 1991). They have introduced the concept of High Reliability Organizations (HRO), i.e. organizations that successfully manage complex, tightly coupled, systems and have tried to identify the characteristics of such organizations. Constant training of operators, redundancy in daily operations, flexible organizations and many channels of direct communication are some of the salient features of HROs. Thus, while the "normal accident theory" emphasizes structures, the "high reliability" theory emphasizes processes (Summerton and Berner, 2003). However, both these approaches study only contemporary systems and do not inquire how such systems and their vulnerabilities are the outcome of long-term, historical processes.

Building and expanding on the above three research strands, our CRP is developing a novel approach which furthers the recent interest in studying transnational infrastructures and their societal consequences and connects it to sociological risk studies of sociotechnical systems. We seek to utilize concepts and perspectives from these two fields and in so doing also make contributions to both.

Research strategy

Our research strategy is based on a comparison between different types of critical infrastructures and the ways in which they have been interconnected horizontally and vertically. We have tried to find cases that have the potential to enlighten us about both these types of critical interconnections. For the study of horizontal interconnections and the corresponding criticalities, we have chosen to focus on energy infrastructures, particularly electricity and natural gas networks.[1] For the study of vertical interconnections, we have chosen to investigate a number of infrastructures that have undergone a "cybernetization" process. This concerns in particular the introduction of complex IT systems in infrastructures such as air traffic, emergency services and electricity (see also 'Collaboration' below).

In our approach we will focus on three aspects of infrastructures that we believe to be crucial for their degree of criticality. One has to do with the number of users that a system has and their dependency on its services. Another has to do with the availability of alternatives for getting a similar service. And a third has to do with the technical character of the systems and particularly their degree of complexity and tight coupling. Furthermore, the concept of critical event, referring to infrastructure failures or disruptions of different kinds, will also be of importance for our analysis. The releasing factor of such failures and disruptions can be unintentional, such as storms or floods, malfunctioning components, or operator mistakes, or intentional, as in the case of blockades of supply by exporting countries or by trade unions or deliberate attacks by terrorists or military forces. We believe that critical events provide fruitful research sites in several ways. Managers and experts have negotiated extensively on how to anticipate and prevent critical events from occurring. When such events still happen, they illustrate very clearly the degree of dependency and the availability of alternatives. And after a critical event there have often been intensive discussions on how

[1] AP 2 goes in part beyond the focus on energy, by comparing it to the horizontal interconnections of telecommunications networks.

to prevent it from occurring again, and such discussions have at times led to far-reaching changes in the design and governance of infrastructures.

But as historians of technology, we pursue a specific type of analysis of such systems and their critical events. As historians we have an abiding interest in how the emergence and interlinking of critical infrastructures in Europe and the corresponding interdependencies and shared vulnerabilities *change over time*. For example we focus on how the nature of critical events and dependencies in different infrastructures have changed through time, and how alternatives have emerged and disappeared. Complexity and tight coupling, too, are analyzed from the perspective of change – perhaps most notably in our study of vertical interdependencies, with the far-reaching impact of the IT revolution in a number of infrastructures.

As noted above, the individual projects in this collaboration are chosen so as to enable a thorough study of both horizontal and vertical interdependencies in European infrastructures. Appendix 1 provides short presentations of each of the individual projects (IP) and associated projects (AP). Participants in these projects are listed in Appendix 2.

Horizontal interdependencies will be investigated in IPs 1, 2 and 3 as well as in APs 1 and 2. IP 1 aims to investigate historically the emergence of critical (inter)dependencies in the European transnational natural gas infrastructure. In particular, the IP aims to explain why certain bilateral natural gas connections could be established, but others not. The IP will study both successful and unsuccessful attempts to create such linkages in Europe, and the evolving roles that perceived criticalities of transnational gas relations have played in this process. IP 2 focuses on electricity infrastructures in Europe, inquiring why and how transnational electrical networks have interlaced (or segregated) the economic and social life of Europe's peoples and countries, the associated risks, and measures to deal with these risks. IP 3 complements IPs 1 and 2 by investigating the criticality of energy infrastructures and their horizontal expansion across European borders from the perspective of interconnections across the Iron Curtain, as exemplified by three cases of Finnish-Soviet infrastructural integration. It focuses, first, on the integration of Finland into the Soviet nuclear power complex, and secondly, it compares this nuclear interconnection with Finnish-Soviet interconnections in crude oil and natural gas. AP 1, similarly to IP 3, problematizes the East-West dimension in the history of European infrastructures, but from a more Southerly perspective. The AP analyzes the emergence of Bulgarian energy interdependencies – particularly in nuclear power and electricity – with the Soviet Union as well as later attempts to reorient Bulgarian transnational connections in more Westerly directions. AP 2 also has a Southern European focus. Thematically, it takes a special interest in the history of the technologies employed in order to connect different national European networks, usually versions of a technology known as 'converter' technology. It emphasizes the connections between Greece's electricity and telecommunications networks and the networks of Greece's neighbouring European states, including connections and interdependencies with various Balkan states as well as with non-Balkan ones such as Italy.

Vertical interdependencies are investigated in IPs 4, 5 and 6. IP 4 studies this type of interdepencies from the perspective of electricity, focusing in particular on the integration of ICT with high-voltage electricity transmission networks. This "cybernetization" – a key concept in the study of vertical interdependencies – of electricity networks creates possibilities for enhancing both the security and the efficiency of the electricity networks. The Europeanization of these networks, however, creates significant challenges for ICT-standardization, and the neoliberal shift encouraged the use of ICT-strategies for efficiency rather than for enhanced security. The integration of ICT into the high-voltage transnational networks are looked upon as an important way of handling risks. IP 5 analyzes the cybernetization trend in European infrastructures from the perspective of air traffic control. Particular focus will be put on the creation of the transnational air traffic control system Eurocontrol, but also on the ways in which tensions between European efforts and nation-level security considerations shaped the emergence of interdependencies in air traffic as a transnational infrastructure. IP 6 studies the cybernetization process from the perspective of transnational emergency communication networks. When systems fail, such emergency communication networks should maintain society's most vital services (e.g. police, ambulance, fire brigade). The IP studies the emergence and governance of transnational

emergency networks in Europe after the Second World War. It also examines how emergency communication functioned during actual system failures and disasters.

Ongoing research

A project like Eurocrit with eighteen participants from seven countries is a stimulating challenge, both socially and intellectually. Our perspectives and ideas are shaped by our different cultural and professional backgrounds and we have embarked on a common tour during which we get to know and learn from each other. The eight project leaders met during the preparations of our proposal, and some of us knew each other well from earlier collaborations. But the team at large had not met when the project started.

Recurrent workshops are a crucial medium for shaping our cooperation. Nothing can replace the opportunity for face to face discussions that workshops provide. They are the source of new ideas and perspectives. The workshops also imply deadlines for contributions and thus stimulate progress. And they give possibilities for gradually concretizing and sometimes modifying plans as the research develops. We have planned to have one workshop every semester, a larger one with invited participants from other Inventing Europe CRPs and with outside experts each spring and a smaller one with only Eurocrit-participants each autumn. So far we have had two such workshops, one in Utrecht in November 2007 organized by the Dutch participants of the project, and one in Sigtuna in May 2008 organized by the Swedish participants.

The Utrecht workshop was a kick-off for the project. In preparation for the workshop all participants had read a number of key articles and books chosen by the organisers dealing with vulnerability and risk concepts, critical infrastructure studies and transnational history. We had intense discussions about concepts and definitions that we will be using in our work, especially of vulnerability, risk and criticality. We agreed that we need to look at these terms historically and be aware of the fact that they may have been defined differently in different times, places, and situations. The concept of transnational was also discussed. Borders are not fixed, and at times national infrastructures have become transnational due to border changes, as well as the other way around.

Furthermore, we discussed the different concepts used in risk management today, and how they could be used in our research. How has risk management been pursued in different countries at different times? Risk management is also about governance, control, trust, and fear. How are these concepts related to each other and our research? Are we more afraid of a risk the further away from our control it is? And can risk management be used to govern infrastructures? There was also a discussion about how our research project should relate to policy making, and reaching out to other audiences and fields. At the end of the workshop we visited Schiphol Airport, behind the passenger lounges, and were given an impression of how a critical international hub of this kind works, and how it tries to manage risks and vulnerabilities of many kinds.

The Sigtuna workshop focussed on the theme Transnational Infrastructures: Coping with Scarcity and Vulnerability. (Sigtuna is a small medieval town 40 km north of Stockholm.) We invited a dozen colleagues from outside our project (half of them from other CRPs) with special insights in the topic for the workshop. The workshop started with an open seminar at KTH to which we had invited two “practitioners” who talked about two recent critical events that have been very much discussed in Sweden in recent years: The Estonia disaster and the Tsunami in Asia. There were also presentations by two scholars and the seminar ended with a panel discussion.

The following two days we discussed the eighteen papers that had been distributed and read before the workshop. They were grouped under three headings:

- Critical events in transnational infrastructures – and the responses
- Perceptions of scarcity and vulnerability
- The emergence of critical infrastructures in Europe

The Sigtuna workshop will be described in an upcoming Working Paper. Interested readers are referred to that WP.

Both the workshops so far have been very conducive for our work. We have gotten to know each other and have begun an exciting exchange that will be continued at coming workshops. The next one will take place in October 2008 in Lisbon in conjunction with the annual SHOT conference and other Inventing Europe events. This workshop will be devoted to planning the joint book that we will produce as part of our project and also a detailed planning of the coming workshops. (We see the workshops as closely connected with the work on our book.)

In May 2009 our Finnish participants are planning a workshop in Helsinki with the preliminary theme Conflicting Borders and Critical Infrastructures. This workshop aims to trace the relationship of transnational infrastructures to general European history, and we intend to invite outside scholars as we did at Sigtuna. In autumn 2009 we have preliminary plans for a workshop in Norway dealing with governance. And in the spring of 2010 we are planning for a final workshop in Greece focussing on discussions of the draft chapters of our joint book.

In addition to the workshops, we – or more correctly our colleagues from Eindhoven – have made a web site for our project with the wonderful address: www.eurocrit.eu. This website has been useful for arranging the workshops and hopefully we will also use it for internal discussions and of course for informing others about what we are doing.

APPENDIX 1

SHORT PRESENTATIONS OF THE SIX INDIVIDUAL PROJECTS AND TWO ASSOCIATED PROJECTS

IP 1

Natural Gas: Trusting the Enemy

This IP aims to historically investigate the emergence of critical (inter)dependencies in the European transnational natural gas infrastructure. In particular, the IP aims to explain why certain bilateral natural gas relations could be established, but others not. The IP will study both successful and unsuccessful attempts to create such linkages in Europe, and the role played by the perceived criticalities of transnational gas relations in this process.

The actual existence of a European natural gas infrastructure – with a complexity that has increased dramatically during the past couple of decades – is intriguing: it provides an example of a truly trans-European infrastructure with large-scale flows not only between countries belonging to specific European subregions (such as the EU or the Nordic countries), but above all across the Iron Curtain as well as between Europe and the Arab world.

Natural gas differs from other sources of energy in terms of the very complex material networks (in the form of pipelines) that have been necessary for enabling the transportation of gas to customers and users. This in combination with the fact that only very few countries have direct access to large domestic gas resources have created incentives to link different countries' gas infrastructures with one another, which over time has resulted in the creation of a wide and complex transnational gas infrastructure in Europe.

Questions to be addressed in this IP include the following: Why have different countries chosen to integrate their natural gas infrastructure with certain neighbours but not with others? How have they perceived and anticipated the emergence of associated transnational interdependencies? To what extent have they discussed *alternatives* to those connections that have become reality? How have organizational and institutional solutions been created in those cases where the transnational relations involve one or more transit countries, such

as in the Soviet-German case? How has it been possible to create sufficiently strong transnational actor-networks in order to actually create the physical connections? How have actors on both sides of the borders imagined that the connections will be used, and how has it turned out in reality? Which actors and groups have tried to resist the emergence of the links, and why?

IP2

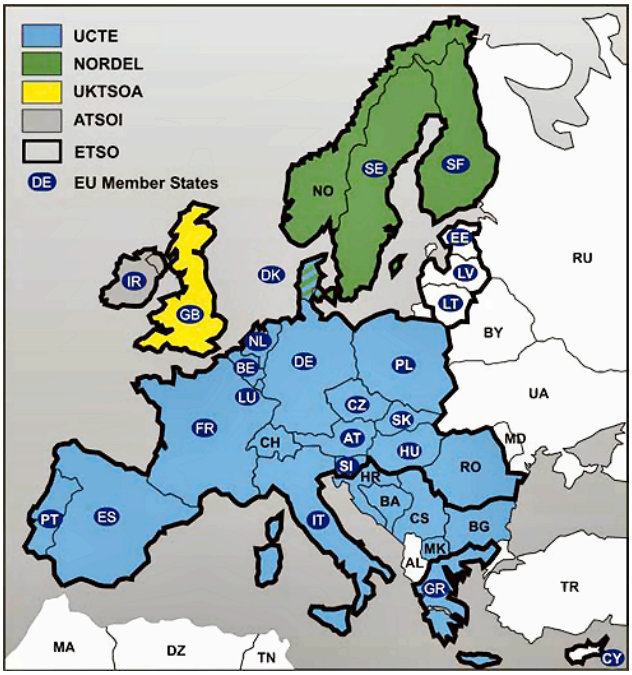
From Reliability to Liability: European Electricity Networks and the Shaping of Transnational Interdependencies and Risks

This IP inquires why and how transnational electrical networks interlaced (or segregated) economic and social life of Europe's peoples and countries, the associated risks, and measures to deal with these risks.

During the 20th century, electricity supply increasingly became an omnipresent and vital infrastructure. Virtually all sectors of society, including other infrastructures, require electricity to function properly. Electricity supply became a cornerstone of economic and social life. In parallel to this process, corporate and national electricity networks in Europe were to a large extend interwoven or integrated.

This electrical integration of Europe – largely invisible to the broader public - had great advantages, such as enabling electricity trade between countries rich in energy resources and countries lacking such resources, making electric energy available to all. Moreover, in case of a local electricity supply breakdown, emergency supplies could be drawn from neighbouring countries. In such cases transnational power networks supported economic and social development across national borders.

On the other hand, transnational interconnection also introduced new types of - transnational- risks, embedded in the system architecture and largely beyond the control of corporate or national network operators. For instance, the great November 2006 blackout originated in Northern Germany and cascaded through the network as far as Portugal and Croatia, shutting down the lights, televisions, computers and engines for more than 15 million European households. Such events reveal a veritable transnational vulnerability: power system failures in one country may disrupt economic and social life in others.



The IP asks questions such as: Which interdependencies were built into Europe's transnational power systems, technically and institutionally, from 1945 until today? How did international network organizations as the UCPTE (1951) in Western Europe, Nordel (1963) in Scandinavia, and the CDO/IPS (1962) in Central Eastern Europe build and interpret such interdependencies? How did they interpret issues of reliability and failure in emerging transnational power systems? How did they anticipate failures, in terms of system architecture and institutional/governance arrangements? Did transnational interdependencies vary in these three electrical regions? How did actual power failures expose transnational interdependencies as well as interdependencies between electricity supply and economic and social life?

IP 3

An Uneasy Alliance: Critical Connections across the European Border

This project investigates the concept of 'criticality'. We are trying to answer the question: What makes a normal infrastructure critical? There are number of things which can turn infrastructures critical, but we believe the key is technology. Technology is not an autonomous force acting independently in society, but intimately connected to political, cultural and economic structures.

During the Cold War, when the world was divided in two hostile camps, super powers (Soviet Union and the United States) struggled to gain political and ideological hegemony. They also raced to win the dominant position in the field of nuclear technology.

Finland was drawn into this competition during the 1950's when the country prepared to go 'nuclear'. Finnish engineers, managers and politicians did not want to purchase nuclear technology from the Soviet Union, because eastern technology was considered unreliable and even dangerous. However, the Soviet Union pressured the Finnish government to accept the offer and the Soviet designed VVER-reactor was installed in the Loviisa Nuclear Power plant. Because of this purely political decision, the Finnish energy supply as well as Finnish nuclear technology became 'critically' depended on the Soviet Union.

Loviisa Nuclear Power project was followed by other infrastructure projects which connected Finland to the Soviet Union. A natural gas pipeline was built across the border in the 1970's and little later a high voltage electricity line connected the Finnish national grid to the Sosnovy Bor Nuclear Power Station (Chernobyl type NPL near Leningrad). Today, Union Power Company (multinational, but Russian majority owned company) is offering to install another high voltage cable from Sosnovy Bor to Finland.

All these decisions have created vivid debate in Finland. The discussions have focused on safety issues, but also on the style and reliability of the Soviet/Russian technology. It has been argued that by connecting Finland to the Soviet/Russian technological culture, Finnish energy supply has become vulnerable and critical.

AP1

Becoming a Power Hub of the Balkans: The Bulgarian Electric System between National Strategy and COMECON Rules

This Associated Project aims at studying technological, organizational and normative issues in transnational power supply through the lens of developments in the Bulgarian electric power system during the period between 1945 and 1985. The new framework of COMECOM led to radical changes in the Bulgarian electric power industry, which until then had been using (Western) European technology and relying predominantly on private, state and community (municipal) capital. In Bulgaria power production grew tenfold during the 1950s and 60s, developing its own research infrastructure and diversified system of power production (based on water, thermal, and nuclear power stations) and power distribution. It also included several high voltage transmission lines to the Ukraine and the neighboring countries of Greece, Macedonia, Albania, Serbia, and Turkey.

The project addresses the following questions:

- What have been the technological, institutional and organizational principles in building the Bulgarian power system?
- What have been the patterns of electricity system integration with other COMECON countries and with the former USSR?
- How did these processes relate to perceptions of transnational interdependencies and vulnerabilities?
- How was an electrical reorientation towards non-COMECON Balkan countries (Turkey, Greece, former Yugoslavia) possible?

To answer the above questions, we will study the following related issues:

- Analysis of the origin and execution of National Strategy for Electrification (NSE), launched by the communist regime in late 1940s till the early 1960s.
- The process of transnational integration of Bulgarian electric power system in a COMECON context during the 1970s and 1980s. This will help to better understand the challenges in transforming the electric power infrastructure, built during the socialist era into a part of electric power systems of EC.
- The process of accumulation of experience by local managers, engineers and R&D scientists in building and managing an increasingly complex electric power system.

AP 2

Technologies of Network Interfaces: The International Links of Greece's Power and Communication Infrastructure

This AP is focused on the history of the technologies employed in order to connect different national European networks, usually versions of a technology known as 'converter' technology (a generic name used to describe various connecting configurations, including power flow and communication signal 'transformers', 'filters', 'amplifiers', and a whole range of automation and on-line computation apparatuses). It places the emphasis on the connections between the Greek electrification and telecommunication networks and the networks of Greece's neighbouring European states.

We intend to address questions concerning the international dependencies produced by decisions about the mode of network connection, the advantages and risks of certain converter technologies, the vulnerabilities associated with these converter technologies, the international, technical and other bodies set so as to negotiate and maintain technological interfaces, the differences between the converter technologies used in this region and other European regions, especially those studied by our CRP partners.

Our focus will be on the post-World War II decades. During most of this period, Greece was a Western European country that was surrounded by countries representing various versions of the society that we associate with Eastern Europe. Forced to share its networks with the networks of other European countries so as to, for example, increase the reach and stability of its own networks, Greece had to have a flexible technology of network connection, one that could be quickly adjusted so as to accommodate the changing political relationships between Greece and its neighbors. One of Greece's neighbors was under the direct control of the Soviet Union (Bulgaria), one was isolated from both the Soviet Union and Western Europe (Albania), whereas a third one, Yugoslavia, tried to gain its independence from both Western and Eastern Europe by maintaining material links to both. Greece also tried connections that avoided the Balkans altogether, by seeking to connect its power and communication network to the networks of Italy. Turkey, with which Greece shared mainland borders, was a Western ally that was not trusted. Italy, a Western European member could be trusted but was split from Greece by a sea.

IP 4

From Systems to Complexes. Coping with Security and Efficiency in European Electricity Networks.

This IP will focus on three interacting trends that have strongly affected how the European power industry has coped with security and efficiency during recent decades:

- The horizontal, physical expansion of networks across borders.
- The vertical deepening of technology through the integration of information and communication technology (ICT) with the high voltage systems.
- The liberalization and unbundling of the industry.

Put briefly, the Europeanization of the electricity networks has interacted with the digital and the neoliberal shift. The resulting changes in technology and governance regimes have created new possibilities and new challenges for balancing security and efficiency.

This project will study these processes with a main focus on the integration of ICT with high voltage systems. This "cybernetization" of the electricity network creates possibilities for enhancing both the security and the efficiency of the electricity networks. The Europeanization of these networks, however, creates significant challenges of ICT-standardization, and the neoliberal shift put strong pressure for using the ICT-solution more for efficiency than for enhanced security. The history of the construction and international diffusion of the Norwegian constructed Elcom-standard of data communication will be a point of departure for this project.

The theoretical and conceptual aim of the project is to create a better understanding of the transformation from large technological systems to heterogeneous technological complexes. Within the framework of modern European history, the aim is to describe and explain the development of such technological complexes within the Norwegian, Nordic and European power industry.

IP 5

Air Traffic Control: Facilitating Transnational Trust through Governance and Technology

This IP will analyse negotiations of how Eurocontrol and predecessor air traffic control systems came to operate, the role of air traffic control's technical and organisational vulnerability, and how this endeavour contributed to the shaping of Europe.

Air traffic control centres constitute a worldwide infrastructure directing aircraft in travelling between airports as well as in landing and taking off. Air traffic is a critical infrastructure, as it is indispensable for swift transportation of people and freight. Failure will remove an essential safety component endangering people, goods and aircraft and may cause serious disruption to economy. Safety and efficiency is based upon a net of connected ground air traffic control centres where every node depends upon efficiency of neighbouring control centres. Failure in a centre affects neighbouring centres, often in different counties.

Eurocontrol has facilitated safe and efficient air traffic in West Europe since 1963. Between the 1960s and the 1990s, more efficient air traffic was gained through introducing new, complex technology depending on electronic cybernetic systems and with few exceptions relied on national governance.

The ending of the Cold War eased cooperation between civilian and military air traffic, flying between East and West Europe became easier, and Eurocontrol's sphere of operation expanded and came to encompass most of East Europe. Simultaneously, air traffic was deregulated and air traffic soared. Now, focus in negotiating air traffic control in Europe

shifted from improved technology to governance.

The analysis of cybernetic elements in air traffic control systems and the focus on governance in this IP will provide new insight into shaping, possibilities and limitations of critical infrastructures.

IP 6

In Case of Break-Down: Emergency Communication Systems

Communication networks for emergency services (e.g. police, ambulance, fire brigade) are among societies' most critical infrastructures. This project focuses on the emergence and governance of such networks in Europe after the Second World War. Before the 1990s, all European countries had their own radio communication networks for emergency services. They used different frequencies, standards and operating protocols. As a result, cross border communication between these networks was very hard to achieve. In the late 1980s, after the Schengen Agreements were signed, more efforts were made to enhance the international collaboration between emergency services. In this process, the development of a European communication standard for this sector (called Tetra) by the ETSI (European Telecommunications Standards Institute) played a key role. At the moment, several European countries (e.g. the Netherlands (C2000), Belgium (Astrid), Finland (VIRVE), UK (Airwave)) base their emergency system on this standard. This project also examines how emergency communication functioned during actual system failures and disasters.

This sub-project will focus on three research questions:

1. First, we will analyze how transnational connections between the emergency services of different European countries came into existence. How was the Tetra standard negotiated by these countries?
2. Second, we will investigate some examples of disasters and accidents in Europe to analyze how international communication in emergency situations actually took place. How did differences in (organizational) culture, risk perceptions, technologies, and emergency procedures influence (or hamper) international collaboration in emergency situations? How does this reflect the diversity of Europe? Do our societies' vulnerabilities increase or decrease as a consequence of the European integration of the emergency networks?
3. Third, how can we better understand the character and nature of "critical infrastructures" and what concepts and perspectives are most fruitful for analyzing them?

This sub-project will be investigated using a combination of qualitative research methods: archival research, interviews and in-depth case studies.

APPENDIX 2

Participants of EUROCRIT

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