

THE CENTRAL EUROPEAN UNIVERSITY

ABSTRACT OF DISSERTATION submitted by: Johan LILLIESTAM

for the degree of Doctor of Philosophy and entitled: Energy security and renewable electricity imports: the case of a Supergrid connecting Europe, North Africa and the Middle East.

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To mitigate climate change, European countries need to decarbonise the electricity sector by 2050. Decarbonisation options include importing solar electricity from the Middle East and North Africa through a long-distance transmission system, a Supergrid. Such imports raise questions about energy security: will Europe become vulnerable to coercion and embargoes, or to terrorist attacks and extreme natural events?

In this dissertation, I assess the impacts of a Supergrid scenario (Desertec) on European energy security in comparison with the present situation, a business-as-usual and a decarbonisation scenario from the Global Energy Assessment.

First, I define energy security as 'low vulnerability of vital energy systems'. I contextualise this generic definition by identifying which vital energy systems and vulnerabilities are priorities in the European context, based on an analysis of empirically observed policy measures. European energy security policy focuses on mitigating physical supply disruptions and excessive price volatility, caused by a small number of threats to national and regional electricity and gas systems. I could not identify any environmental or social aspects of energy security.

Second, I develop and apply new methods for assessing the vulnerability to energy coercion, infrastructure failures and terrorism in scenarios. I base these methods on the ideas of power balances, chokepoint failures, action attractiveness to hostile states and non-state actors, and energy system resilience.

I show that all scenarios and the present system are well-diversified and sufficiently resilient, which makes them not vulnerable to coercion or chokepoint failures.

No single country has power to coerce Europe, as single-country export cuts inflict high and sustained costs on the exporters themselves, but not on Europe. Single-country interruptions cause costly but short-lived end-use outages in Desertec, but not in the present system or in the other scenarios. However, if embargoes are coordinated among the majority of electricity or gas exporters, the costs for Europe may be both sustained and higher than for the exporters in Desertec, the other scenarios and the present system.

Similarly, 3-5 failures of energy import chokepoints would cause short end-use outages in Desertec but not in the present system or the other scenarios. Large and lasting outages only follow 10 or more simultaneously disabled chokepoints. However, disabling a large number of chokepoints and causing lasting end-use outages is difficult, making energy infrastructure an unattractive terrorist target. Likewise, simultaneous failures of multiple chokepoints are very unlikely outcomes of natural or technical events.

Thus, I show that the Desertec scenario does not cause significant worsening of European energy security, related to the two assessed threats, compared to today or to the other scenarios. I obtain these results by novel, context- and threat-specific methods, and the results are in partial contrast to assessments using the widely used but generic diversity indices also carried out here. Further research may build on this dissertation with a more detailed representation of (a) energy security policy concerns (beyond reflection on policy measures), (b) coercion events (taking into account 'political' costs and actors' willingness to accept damage), and (c) alternative terrorist motivations (beyond causing outages).

Keywords: energy security, renewable electricity, Supergrid, power balance, critical infrastructure vulnerability.