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The unhinged paradox – what does it mean for the energy system?

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ABSTRACT

In man-made energy systems like the electricity system, new concepts have the potential to influence and shape the development of the system. Sometimes the influence leads to a positive development and in other cases the new concept may lead into disadvantageous pathways. In this paper we argue that when a new concept is introduced, it may give rise to an *unhinged paradox*. An unhinged paradox implies that introducing a new concept, such as a new governance or management model, might lead to unintended consequences where some parts or the whole system become more unstable, or less *resilient* or *unhinged*. The transition of energy systems includes many "wicked" problems, i.e., aspects that are difficult to foresee the outcome of. The need for a rapid transition with an urgent need to implement new concepts together with a lack of or delayed feedback loops may give rise to wicked problems and unhinged systems. This *unhinged paradox* is likely to be found even beyond the scope of energy systems and will be further discussed in this paper in relation to the deregulation of the energy market, improved energy efficiency and energy flexibility.

1. Introduction

Science ultimately serves us in the areas of ontology, epistemology and methodology, and established truth and paradigms turn into normal sciences [1]. Normal sciences are at the same time in constant change [2] and in everyday life, we are faced with new concepts, demands for new knowledge and new methodologies leaving old concepts and methodologies behind. A new concept can reframe how a problem is perceived, what solutions are deployed and how much actors engage, etc. [3,4,5]. Man-made energy systems like the electricity system do not have the same built-in resilience as natural systems do (at least in theory) (Andersson et al., 2022). Risk management within the energy system is a rather well-researched area [6,7]. A new and growing area of research within the field of energy systems is resilience management as distinguished from risk management in that it not only includes pre-event analysis, but also post-event analysis of potential disruptive actions and one rarely studied area within resilience management is the lack of a clear approach on how to manage resilience (Gosser et al., 2022). Within the energy system field, the social construction of facts and measurements has been discussed, meaning that not all measures taken are rational in the sense that they are evidence-based but rather rely on assumed knowledge or rules of thumb [8]. The development of energy systems is done within a certain discourse where truths are both established and constructed [9]. Likewise, the development of a resilient energy system is dependent on the ontology or discourse within which the stakeholders, the governance, management or redesign of the system are embedded [10]. In man-made energy systems, like the electricity system, new concepts on for example how to govern or manage a system may heavily intrude and affect the system. Sometimes the influences are positive and in other cases the new concept may not lead to a desired pathway. All new concepts in the energy system are introduced into an existing system developed over time, where it might be difficult to foresee the final outcomes. Still, the urgency of climate change requires rapid action and new ideas and concepts to be tried out. When a new concept is introduced, it may however give rise to an *unhinged paradox*. The aim of this paper is to introduce the concept of the unhinged paradox and provide ideas on how to reduce the potential negative effects of this.

The very essence of an *unhinged paradox* is that when introducing a new concept such as a new governance or management model aiming to create a more stable and resilient solution, over time may result in some parts or the whole system becoming more unstable, or less *resilient* or *unhinged*, see Fig. 1. Wicked problems originally arose from the context of regional planning where it is impossible, i.e., wicked, to forecast the outcome [11]. Energy system-related changes such as improved energy efficiency may also give rise to wicked problems [12]. Climate change mitigation is such a wicked problem, but the problems occur after an energy system-related project has been carried out within the scope of

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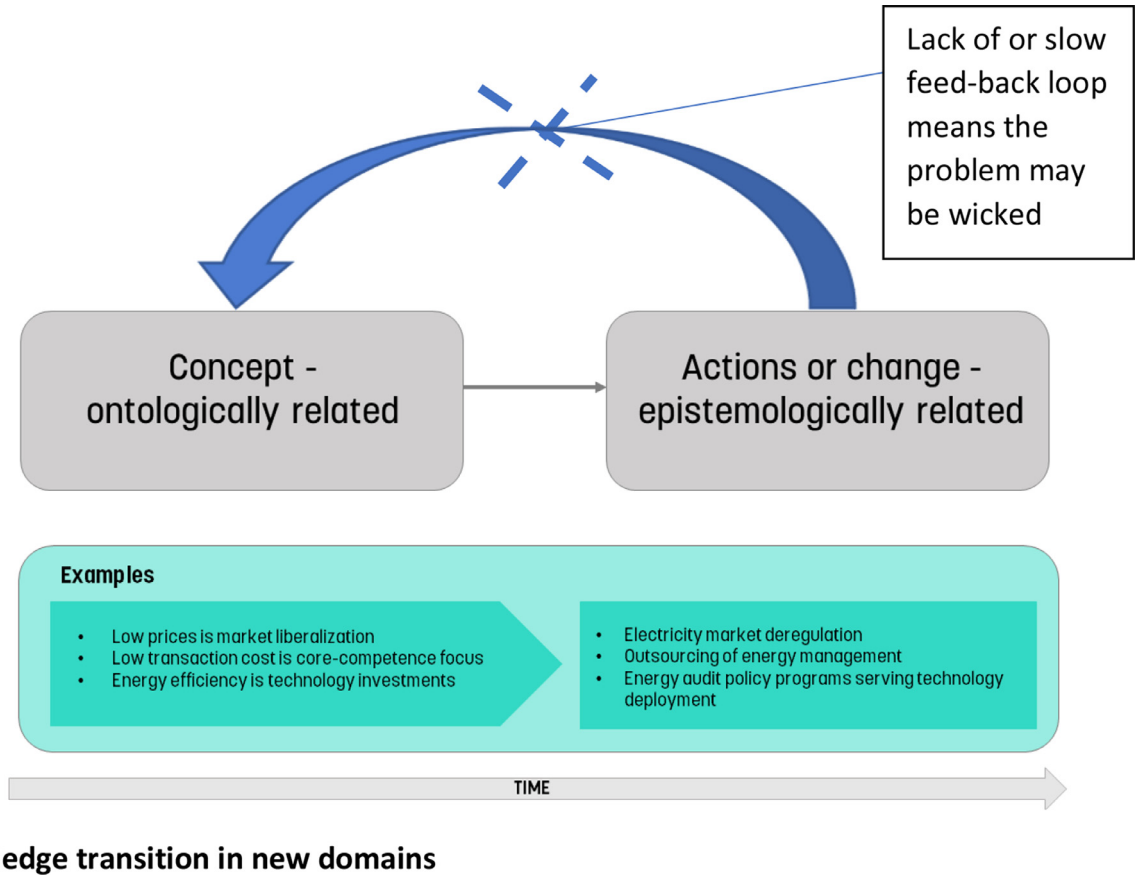

Fig. 1. A simplified model for how a transition occurs ranging from concept to actions and how a lack of or slow feedback loop may indicate a wicked problem and the existence of an unhinged paradox.
Knowledge transition in new domains.

wickedness. An *unhinged paradox* is related to wickedness and is an unintentional effect of implemented changes. The paradox can however be weaker or stronger. If the initiation process of a new concept is embedded in existing theoretical and practical knowledge and a feedback loop can be put in place rather quickly, the paradox has the potential to become weaker, while if the new concept is less embedded in an established ontology with a nonexistent or slow feedback loop it has the potential to become stronger. This will be further discussed in relation to four key areas in the energy systems field: energy management, the EU deregulation of the electricity market, energy policy programs and energy flexibility.

A conceptual change and its ontological and epistemological implications

Before a new phenomenon is physically seen in a transition (if it ever becomes visible), a new concept or ontology is ultimately there, often creating visual and physical change. The introduction of a new concept relates to Aristotle's three primary forms of knowledge, where in short *phronesis* is translated as practical experience or wisdom, *episteme* as scientific knowledge and *techne* as skills and crafts (professional knowledge). Phronesis is about understanding what matters to people and making decisions based on what is best for them. It goes beyond knowledge that comes from analysing facts (episteme) and technical knowledge or know-how (techne) and it involves judgement and decision-making skills like those of a skilled social actor [13]. A new concept or ontology needs to be accepted in practice, by science and by the craftsmen. The practical process can be described as a feedback loop and Linder et al. [14] have in relation to environmental habits discussed that there are feedback loops reinforcing or weakening routines and habits. But what is it like when new concepts are to be introduced and implemented when there is a weak support from all three forms of knowledge? A weak support would imply that the change in ontology needs to occur in a more or less linear process, where the concept leads to action with no or a weak or time-delayed feedback loop, as illustrated in Fig. 1. These linear processes can also be an important explanation for the occurrence of *unhinged paradoxes* in relation to a large-scale transformation of our energy systems.

An example of an unhinged paradox resulting from a linear process is described by Prahalad and Hamel (1991) in their paper on core competence. In the paper the authors proposed a new concept for reducing transaction cost advocating to focus on the *core competence* areas in a company. The trend of outsourcing had started and the implications when deploying this concept in relation to industrial energy management were, to say the least, intricate leading to fewer resources being allocated to non-core areas. Since energy management by definition cannot be a core competence since it does not contain a revenue stream, only reduced costs, energy management received less funding or was outs-sourced [15]. In this example a theoretical (episteme) approach determined the introduction of the concept, and less consideration was taken to the experiences of the practitioners (phronesis) or the craftsmen (techne). In theory this was an excellent idea, but in practice it had flaws. If all three of Aristotle's knowledge forms had been applied and feedback loops put in place, the results could have been different, and the energy management might not have been dismantled.

Research in relation to sustainable transition in industry has found that the knowledge creation takes form as feedback loops between the various forms of knowledge and that interdisciplinary teams possessing all three areas of knowledge need to be formed in a future where complex challenges are present, e.g. sustainability transition [16]. Processes

characterized by linearity and broken feedback loops are arguably cases where wicked problems are found [11].

One other example of an *unhinged paradox* in the energy field was the market deregulation of the European electricity market in 1996 where the former way of governing national electricity systems was through government, i.e., governance by a public authority. This new concept or ontology was that of "market deregulation" which would lead to more control being given to market actors, and less to the state and its authorities. This in turn would lead to a more efficient energy market and system which would result in lower prices for customers. The results in the long run have been (as also forecasted in Dag [17]) that the electricity prices in countries with low electricity prices initially dropped, but then rose to a higher level than the original. In this case phronesis knowledge was given precedence over episteme and techne. Episteme was partly present through theoretical economic modeling, but other sciences were not given the same access to decision-makers. A more inclusive decision-making process where all knowledge forms had been present might have resulted in another design of the system.

Another example are energy audit policy programs founded in the concept of diffusion of more energy-efficient technologies. Being one of the foremost means of serving industry, households and the public sector with information about potential energy efficiency measures, energy audits in non-energy intense and small and medium-sized companies (SMEs), where most energy end-use is found in so-called support processes such as ventilation, compressed air, space heating and lighting, have worked well. However, as Sorrell (2007) states, the transaction costs for providing both indirect and direct energy services towards production processes are high, leading to a low inclusion of such in e.g. energy audits for industry. Thus, for energy-intensive companies having most of the energy use in the production processes, the concept of energy audits may be prove less effective.

A final example is related to end-use flexibility in the electricity grid. The need for decarbonizing the electricity sector and shifting from fossil fuels to renewable energy sources has imposed a challenge for the grid. The grid was built to handle centralized, controllable, and predictable loads and not volatile and non-dispatchable renewable energy sources. A way to respond to this challenge has been to start seeing the demand as a resource which could be made flexible and responsive to the market when the supply cannot be [18]. The end-users should shift, reduce or increase their demand depending on the needs of the grid and the way to go seems to be price signals [19]. Citizens do not however have a flexible everyday life but need to sleep, eat, work and entertain themselves in accordance with rather fixed schedules [20]. Most people do not have the resources such as smart equipment that could support them to become flexible, many cannot afford the equipment and others do not have the right knowledge or information to understand what to do [21]. The introduction of end-user flexibility has however led to an *unhinged paradox* where the users need to adapt their life to the system instead of the system serving the users and this without thorough investigation of which customer segments' demand correlates to which peaks [22]. In this case the decision-making process lacks phronesis knowledge, that is in the hands of the households. Both episteme (at least partly from a techno-economic perspective) is present and also techne, but what is lacking is the practical experience from the households, which could have resulted in different conclusions for how to design end-user flexibility.

2. Weak and strong unhinged paradoxes

An *unhinged paradox* occurs when not all three forms of knowledge, *episteme, techne* and *phronesis,* are represented in a decision-making process. An *unhinged paradox* can be weak or strong, i.e. more or less easy to overcome. The strength of the *unhinged paradox* is related to evaluation of the measure and the existence of a feedback loop. In cases like the governance of the electricity system together with the green transition of the energy system, a strong *unhinged paradox* has occurred, due to lack of evaluations including all three knowledge forms, leading to electricity prices becoming more volatile. In the case of the introduction of the core business notion, this was an example of a weak *unhinged paradox* where evaluations showed that the introduction of the new concept had to include some old-school management ideas as well, e.g. having some competence in-house of non-core areas (such as energy management) leading to a new stream of insourcing. The *weak unhinged paradox* is likely to occur for areas where there is epistemological development and a physical entity responsible for conducting an evaluation and with the mandate to provide a feedback loop. A *strong unhinged paradox*, is where there is no evaluation done or an evaluation only including some knowledge forms and there is an interrupted feedback loop and the implemented measure will not reach a level of normalization as the very essence is rooted in ontology. In such examples, the principle of caution needs to be very carefully considered.

Furthermore, new concepts face the risk of relying upon an old ontological understanding such as when industrial managers, often graduates from prominent engineering schools, tend to focus primarily on technical solutions, not blending that with the idea of operational excellence as well as strategic measures, when deploying an in-house energy management program. Another example is the case of policies being based primarily on the concept of the technology diffusion paradigm, which works well for less complex energy systems and companies, but evidently less so for electricity intensive companies where the majority of improvement lies in the operations of these systems and processes [23].

2.1. Way forward – how to reduce the negative impact of unhinged paradoxes

The very first question to ask to reduce the negative impact from an *unhinged paradox* is to ask if there is *episteme, techne* and *phronesis* knowledge present in relation to the new concept being introduced and if this is included in the evaluation. If the answer to that question is no, a first solution to mitigate potential negative impact of an *unhinged paradox* is to have multi-, inter-, and transdisciplinary approaches when new concepts are being introduced, meaning not only scientific disciplines but also *techne* and *phronesis* knowledge forms [16]. When initiating a new in-house energy management program in a company, or a national energy efficiency policy program, it may be wise to assess the need for various disciplines in the design and initiation phases. This may mean not only focusing on low-cost technology measures such as new LED lighting, but also focusing on the overall use of and improved knowledge of the technologies and processes. Second, when initiating a transition, e.g., for improved energy efficiency and mitigating climate change, it is important to assess the prevalent concepts and models used and embraced, if those are in fact sustainable and resilient concepts as such or if new revised models and concepts are needed. One example of this is the current knowledge paradigm within the discourse of energy efficiency which is based on the technology diffusion paradigm and mainstream economics, which in short means focus on stand-alone technology measures and on overcoming market failure barriers such as information asymmetries and imperfections. More recent evidence-based research reveals that there is much higher energy efficiency potential in moving focus from stand-alone technology measures and information asymmetries and imperfections to knowledge and viewing potential energy efficiency improvements of a whole system or process [24]. Third, when deploying the new concept, there is a need to advocate for a thorough regular monitoring and follow-up involving stakeholders affected by the transition which in turn emanates from different disciplines. As is the case in many governance situations, the expert model [25] often deployed when designing a new policy, primarily involving academic experts, tends to leave out practitioners and other knowledge areas apart from the academic. This is referred to as polycentric governance within resilience theory [26]. Rolled out in a sound manner, this could very well reveal the need for multiple policy approaches instead of only one,

as is often the case with an energy efficiency policy program focusing only on energy audit programs. Once again, stakeholders should both be interdisciplinary scientifically but also include what Aristotle referred to as *techne* and *phronesis* knowledge areas, thus not only include various *episteme* (scientific) knowledge areas. The higher a new concept is in terms of governance energy system levels, the more important it is to have an inclusive inter-disciplinary regular monitoring and follow-up process.

3. Conclusions

This paper discusses problems that might occur when introducing new concepts without including different knowledge forms and without timely feedback loops. An *unhinged paradox* implies that unintended results may occur when introducing new concepts leading to a less resilient or unhinged system. We can conclude that an unhinged paradox occurs when not all three knowledge forms *episteme, techne* and *phronesis*, are present and when a feedback loop takes time to establish or the feedback is ignored. To avoid unhinged paradoxes, before initiating new concepts it is important to include various disciplines and knowledge areas in the initiation process and also evaluate the need for a new concept compared to if old, adjusted concepts are used. We advocate for researchers from the energy systems area and other fields to further explore and develop our understanding of the occurrence of the unhinged paradox, and equally important also means on how to minimize its potential negative impacts.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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