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Legal governance of smart heat infrastructure development under modes of liberalization; how to analyze and overcome deadlocks in heat projects

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Abstract

The *background* of this article is how the challenge to accomplish a sustainable energy transition—in service of various objectives, such as environmental and geopolitical concerns—has recently brought the development of smart heat infrastructures to the public agenda. Especially in Metropolitan regions, with more closely knit combinations of urban functions, establishing smart heat infrastructures and possibly connections between infrastructures, to form a heat infrastructure, is regarded as a serious option for developing an alternative energy market next to electricity and natural gas.

Orchestration seems key to overcome a stalemate in the realization of heat infrastructures (*context*) through concerted energy infrastructure planning. This conceptual article aims to support such orchestration by presenting a legal governance typology for heat infrastructures that combines the nature of the infrastructure-regime with the complexity of the infrastructure-functionality. Thus, four ideal-type positions are defined, each with a particular dominant/lead actor position, as standard types of legal governance orchestration, with many in between hybrid positions. Orchestration is further discussed in the context of levels of action situations, contrasting top-down and bottom-up mechanisms influencing orchestration in collective choice towards establishing heat infrastructures. In the *conceptualization* of this typology in context, the article addresses the example of (considered) changes in Dutch Heat Energy Policy to support multilateral public orchestration, with the ambition of especially promoting the establishment of smart, open heat infrastructures, and avoiding failure of uni- or multilateral private orchestration. The proposed model is presented as a first step towards developing a policy-implementation tool to support the development of smart heat infrastructures.

Keywords: Heat infrastructures, Infrastructure typology, Legal governance, Orchestration, Action situations, Energy transition

Background

Introduction

In the next decades, many government face a major challenge. A more sustainable energy system has to be realized in order to reduce CO₂ emissions and to prevent a (further) climate change. One example is that of the Dutch government, given that although the Netherlands

has committed itself to Brussels' policy ambition that aims for a competitive CO₂-carbon economy in 2050, only 4.5% of Dutch energy consumption in 2013 came from renewable sources [1].

Policy-makers in the Netherlands and elsewhere are hopeful that regional initiatives can bring the much-desired increase in the share of renewable energy. They expect that new technologies will make it possible to produce a significant amount of decentralized renewable energy. They also assume that if regional initiatives are started at a large(r) scale, an increased share of renewable energy at the national level can indeed be achieved [2].

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One of the most promising options in the energy transition is a more efficient use of heat. Although this is technologically realizable and local governments often take a positive stance, heat projects remain only marginally successful. The challenge seems to be in arranging the proper type of legal governance structure in the organization and use of heat infrastructures. The organizations involved may take diametrically opposite positions because they have different interests, different problem perceptions and suggest different solutions. Therefore, the planning process for establishing heat infrastructures suffers a considerable risk of ending in a deadlock.

To illustrate, this article will briefly discuss the latest Dutch Heat Vision [3] by the Dutch Minister of Economic Affairs. It is of particular interest as it emphasizes the importance of creating an ‘equivalent position of heat in addition to natural gas and electricity in (the) energy system’, to achieve a substantial growth in the range of renewable heat—to be safeguarded by adjustments to the Dutch Heat Act (*Warmtewet*). The Dutch policy approach formed the inspiration to conceptualize a legal governance typology for heat infrastructures. In presenting this typology this article provides an answer to the following key question: how can a legal governance typology assist in handling the complexity of the policy- and decision-making processes about heat infrastructures?

We believe our typology makes it possible to classify heat projects, which in turn can clarify the impact of preferences of stakeholders in the legal governance of heat infrastructures, while placing them in a particular legal governance context. The latter context is addressed as one of modes of liberalization: differentiating between contexts of fully liberalized (‘free market’) conditions versus ‘regulated markets’ for heat infrastructure services—all of which stands aside from government managed, ‘public enterprise’ heat infrastructure energy facilities. While the energy sector as a whole reflects the aura of liberalization, and regulation is particularly absent in new areas, such as that of heat infrastructures, public policy objectives concerning mitigation of climate change may lead to more regulated settings, fostering sustainable options through orchestration of initiatives, albeit within a liberalized context. The goal behind this article is to support the legal governance analysis of barriers and opportunities relevant to establishing waste heat infrastructures and provide an orchestrated way forward. Local administrators can use the legal governance typology to prevent or break open any deadlocks in the planning and development of heat infrastructures, while national level policy-makers can use the typology in the design of new policies and modes of orchestration towards enhancing decision-making pertaining heat infrastructures. Not only is such a typology relevant to the Dutch policy practice, but also to policies

in other liberal states where attempts are made to develop heat infrastructures. While the typology may also be said to have relevance also to other energy sectors, such as gas and electricity, the article is focused on its application in the heat sector, particularly given the sometimes relatively nascent state of policy development in this field.

Before the typology is presented, we will briefly elaborate (in Public energy interests and sector reform, particularly in the Netherlands) on the Dutch policy context. Although this context is merely to illustrate the legal governance issue at hand, a proper understanding is required, particularly when, later (in From a ‘bottom-up’ perspective) we discuss, again as illustration, the modes of regulation that are being considered. Next (in A legal governance typology of heat infrastructures) we present an ideal type legal governance typology of heat infrastructures. This ideal type is to be understood to reflect a situation of absence of regulation dedicated to heat energy, implying a free market of heat infrastructure services, in which the typology specifies key legal governance aspect of heat infrastructure development. In the context section (Context—some examples) we would have, ideally, presented an approach and related results of in-depth empirical study, but because of the many ‘stalemates’, and related stakeholder reluctance to comment on the state of affairs, we will only refer to some Dutch examples of (problematic) district heating projects, so to provide some context to our quest. Because the ideal types state of affairs is not often reflected in practice and when it is, it need not necessarily come with a fitting (ideal) practice, we will next (in Conceptualization—legal governance orchestration) discuss a legal governance typology which can contribute to the necessary ‘governance orchestration’ of decision-making on heat infrastructure initiatives, by firstly (in Levels of Action Situations) looking at different levels of action situations for decision-making, and next (in From a ‘top-down’ perspective and From a ‘bottom-up’ perspective) explaining the ‘top-down’ and ‘bottom-up’ orchestration involved in such levels. The relevance of this modelling is illustrated (in Constitutional interventions—the Dutch example) as we subsequently apply this legal governance typology to the context of considered changes in the institutional environment of the Dutch Heat Act. We conclude (in Conclusion: movements in legal governance of heat infrastructures) with some final remarks.

Public energy interests and sector reform, particularly in the Netherlands

Alike governments in the energy sectors of most other liberal states, the Dutch government has the task to safeguard three public interests in energy: the affordability of energy, (ii) the reliability of power infrastructures, and (iii) the sustainability of energy ([4]: 22). Simultaneous to

many other (EU member) states, to safeguard these interests, the Dutch energy sector has gone through major reforms, implemented over the last two to three decades. The most notable changes are the EU-driven liberalization of the energy market and the energy transition.

In the 90s of the last century, the European Commission was one of the major drivers of liberalizing the energy market. In its liberalization directives, it presupposes a functioning internal energy market and adequate consumer protection ([5]: 13). On this market, the consumer has a freedom of choice; without any monopoly dependency. This idea is to be realized in an economically efficient energy supply through the market, which ensures the affordability of energy. In the Netherlands, the Minister of Economic Affairs initially favored to privatize the then vertically integrated energy companies as a whole (i.e., production, distribution, and network management). This proposal was, however, blocked by parliament. Parliament found it important to also ensure the security of supply, the crisis resistance, and the security of the distribution (i.e., the reliability of the infrastructure). It decided to secure both: the affordability and reliability by separating the energy networks economically, and legally the production and supply of energy [2].

At the same time, climate change moved up the political agenda. In its 2001 Fourth National Environmental Policy plan the former Dutch Ministry of Housing, Spatial Planning and the Environment declared that CO₂ emissions had to be reduced to prevent a further climate change. Achieving a sustainable energy system was presented as the key to significantly reducing emissions of CO₂ ([6]: 128). Since then, the Dutch use the term ‘energy transition’ to point at the policy interventions that government undertakes, in cooperation with private partners, to achieve a transition in the energy system towards renewable energy use and less dependency on fossil energy [7].

Policy-makers often paint a rose-tinted picture about the way in which the liberalization of the energy market and the energy transition could strengthen each other. A sustainable economy would be favorable to the price stability of energy and thus the competitiveness of the Dutch economy [8]. At the same time, the large-scale production of renewable energy could reduce the dependence on politically unstable fossil energy-producing countries [8]. However, the actual share of renewable energy in the Netherlands, to date, demonstrates that very little has in fact been achieved. To increase sustainability of the energy system while simultaneously ensuring energy affordability and uninterrupted energy supply appears to be a bumpy path. As said, for the effort that yet remains to be made, many have set their hopes on regional renewable energy initiatives and

improving the effectiveness and efficiency of heat is seen as one of the most promising options [3].

A legal governance typology of heat infrastructures

Nearly 60% of energy consumption in the Netherlands is used for heating buildings and for industrial processes ([9]: 63). In many cases, after only using a portion, the residual heat is discharged in the environment as cooling water, through cooling towers or by flue gases. The energy can be used much more efficiently by using new technologies to reuse this residual heat, such as by business and/or by nearby inhabitants. By reducing residual heat, the consumption of fossil fuels is decreased and thus also the related CO₂ emissions [3]. A more efficient use of heat energy is therefore one of the pillars of the Dutch Energy Agreement ([9]: 63).

Infrastructures for residual heat are needed to enable trading. In the simplest form, heat is supplied via a pipeline to a building nearby. It is however much more effective and efficient to realize large-scale heat infrastructures. These are infrastructures that connect one or more heat producers with more than 5000 customers [10]. Such pipelines are planned or realized in the Dutch cities of Arnhem, Deventer, Hengelo, Nijmegen, and Rotterdam (see Context—some examples).

Although technologies for large-scale heat infrastructures are available and local government officials appear to be generally positive about such infrastructures, in fact those kinds of infrastructures are barely used in practice. The challenge seems to be in the aspect of a proper legal governance structure for the design and use of heat infrastructures. Organizations sometimes seem diametrically opposed to each other because of different interests in and perceptions of the problem and in the development and realization of such infrastructures, favoring different approaches and solutions. The realization of a heat infrastructure turns out to be a complex governance challenge.

We propose an ideal type typology for heat infrastructures in the free/fully liberalized market, to reduce complexity towards deciding on a proper legal governance structure for their establishment. In this ideal type typology, two basic factors are distinguished: (i) the regulatory nature of the infrastructure regime and (ii) the technical complexity of the infrastructure functionality.

-The *regulatory nature* of the infrastructure is basically about whether the regime for an infrastructure, which does not necessarily have a dedicated form, carries a public or private character. Unlike gas and electricity networks, this question arises because the Dutch Heat Act does not currently separate energy production on the one hand and the supply and transport of energy on the other hand—the ideal type state of absence of

dedicated heat energy market regulation.¹ Neither is the delivery and maintenance of a heat infrastructure a task that is, by any regulatory provision, exclusively dedicated to public or for private parties. The regulatory nature of the infrastructure regime is therefore mainly dependent on the actual and particular interplay between stakeholders concerning the choice for a (more) public or a (more) private regime of the local or regional network. While using this distinction, we need to emphasize that literature does not present us with a clear characterization of what is a public and what is a private regime. Some authors have suggested that the terms public and private cannot be placed in opposition to each other, as they have a multidimensional character ([11]: 16). Within the organization of public services, multiple dimensions of public and private regulation may apply, such as (i) legal form, (ii) ownership, (iii) actor value orientations, (iv) financing, (v) actor tasks/activities, (vi) market environment, and (vii) autonomy to government (officials) ([11]: 17). These dimensions are also applicable to heat supply. In our ideal type analysis, we focus on infrastructure related dimensions (i–iv) only, given that we assume to be on ‘unregulated territory’, so contextual dimensions (v–vii) may be assumed to reflex a free market.²

-The factor *technical complexity* refers to the functional infrastructure properties that have an impact on the complexity of the multiactor configuration. To a large extent, the parties involved in the heat chain determine this complexity. The heat chain basically consists of four links, namely, (i) production, (ii) transport, (iii) distribution, and (iv) delivery. Because the Dutch Heat Act prescribes no vertical unbundling, one party can carry out all these activities. It is also highly conceivable that these activities are carried out by different organizations. More generally it can be assumed that as more players with divergent interests are involved in the initiative, the strategy development, decision-making, and project implementation is more complex. The scale of the infrastructure is also important for the determination of the complexity of the multiactor configuration of a heat infrastructure. If an infrastructure

will be realized within the limits of a municipality then just one spatial-jurisdictional regime is in force. In the case that an infrastructure is realized across municipal boundaries, the initiative must fit within different spatial-jurisdictional regimes. Finally, it is of importance to know whether a heat infrastructure is generated from a single source or from several sources. An infrastructure that operates only through heat from a waste incinerator is (at least from the supply side) easier established and managed than a project that, besides residual heat, also uses biogas and solar energy. The characteristics that we distinguish are (i) scale, (ii) production, (iii) distribution, (iv) transport and delivery, (v) consumption, and (vi) energy sources.

Table 1 provides a summary of the characteristics.

The operationalization makes it possible to classify initiatives and distinguish different types of heat infrastructures. Furthermore, the typology can help to determine the influence of (changing) preferences of stakeholders under free market circumstances, merely in terms of the impact of the regulatory nature and technical complexity of the infrastructure on the legal governance structure of the process of establishing a heat infrastructure. These preferences are important in the planning of new projects, but are also significant when organizations negotiate on the conditions about how existing routes can be linked together to achieve a more robust energy infrastructure.

Our typology leads to a distinction of four ideal type operational forms of infrastructures: (i) public regimes with low complexity, (ii) private regimes with low complexity, (iii) public regimes with high complexity, (iv) private regimes with high complexity (see Table 2). We speak of ideal types because, within an unregulated context, these types are analytically purely monochrome. In regime terminology, ideal typical projects are fully public or fully private, and at the same time, simple or complex in terms of technical functionality. While it is conceivable that these ideal types do exist in practice, it is more likely that in the field there will be ideal type approximations or indeed hybrid forms. Both operational characteristics are presented in Table 2, as variations across from public to private and from complex to simple,

Table 1 Two categories of heat infrastructure/infrastructure characteristics

Regulatory nature of the infrastructure regime (public/private)	Technical complexity of the infrastructure functionality (low/high)
1. Legal form (public/private)	1. Scale (one spatial regime/several spatial regimes)
2. Ownership (100% government/100% private)	2. Production (monopoly/different producers);
3. Value orientation (sustainability and or reliability or a business oriented infrastructure)	3. Distribution (monopoly/different distributors)
4. Financing (100% government/100% private)	4. Transport and delivery (monopoly/several traders)
5. Activities (legal structured/market activities)	5. Consumption (one consumer/different consumers)
6. Market environment (monopoly/competition)	6. Energy sources (one source/several sources)
7. Autonomy to government (dependent/independent)	
(5–7 here assumed to indicate ‘privateness’)	

Table 2 Regulatory nature × technical complexity of heat infrastructures

Regulatory→ ↓Technical		Regulatory nature of the infrastructure regime		
		Public	Hybrid forms	Private
Technical complexity of the infrastructure functionality	Low	Ideal type form 1 Public/simple		Ideal type form 2 Private/simple
	Hybrid forms		Hybrid forms	
	High	Ideal type form 3 Public/complex		Ideal type form 4 Private/complex

including hybridity, built upon the characteristics of the regulatory nature and the technical functionality of the infrastructure—while assuming absence of regulation or regulatory impacts. While hybridity is often present, we believe that for descriptive, explanatory or design purposes, the ideal type analysis can be a useful starting point.

Context—some examples

As said in the Introduction, Dutch initiatives on regional heat infrastructures were the inspiration to a general legal governance typology, with an eye on fostering such infrastructure development. In fact initiatives to connect heat projects have been launched in different parts of the Netherlands, with the aim to achieve so-called regional heat infrastructures. Mostly, local government officials take the lead in such operations. They have the positive expectation that big steps can be taken in the realization of a sustainable energy system through the realization of such pipelines.

While initially making an attempt at field work, we encountered a strong and, in terms of requirements of proper empirical studies, prohibitive reluctance to respond to our many requests for information. This has led us to here merely point at the existence of initiatives, and to proceed (in Conceptualization—legal governance orchestration) with explaining how our typology could be useful to these and other similar initiatives, and how it relates to movements in Dutch national energy policy as regards heat infrastructures, given the stalemate position it seems to be in. The below concise descriptions are almost entirely document based.

An example case that is well known, at least certainly in the Netherlands, is the regional heat infrastructure in Arnhem-Nijmegen (in and around these two Dutch cities). In the long term, the Dutch province of Gelderland (of which Arnhem and Nijmegen are neighboring cities) is committed to energy neutrality [12]. That ambition must by 2020 achieve up to 20% energy savings, compared to 2010 and see at least 14 percent of the Gelderland energy consumption come from renewable sources [12]. The regional infrastructure is crucial in achieving these goals. The planning is based on a growth model in which over time different projects are connected to one regional heat

infrastructure [13]. In 2030, the pipeline with no less than 90,000 connections must be realized [14].

Not only government officials in the Arnhem–Nijmegen region are busy with analyzing heat projects that can be connected to a regional infrastructure over time. For example, local government officials also started exploring the possibilities for cooperation between the heat infrastructures in Hengelo and Enschede (two neighboring cities in Twente; a region in the Dutch province of Overijssel). A study into this project indicates that it should be feasible to connect more than 17,500 homes and 800 businesses on the line ([15]: 12). This initiative would contribute strongly to the sustainability of the regional economy [15].

Also elsewhere in the Netherlands, the possibilities of a regional heat infrastructure are explored. For example, in the Amsterdam Metropolitan Area and the region of The Hague [16].

Again, while we remain hopeful that at some stage further in-depth empirical study into this projects will be possible, we refer to these initiatives here only to provide some context from practice to the conceptual endeavour of this article.

Conceptualization—legal governance orchestration

In our ideal type setting, stakeholder positions and preferences following the typology of a heat infrastructure are crucial for legal governance of collective action towards the actual establishment of the particular infrastructure. They form the backdrop to a process for stakeholders to come to an agreement, by desire or necessity, upon some form of ‘governance orchestration’ of their collective action towards realization of a heat infrastructure project. With ‘governance orchestration,’ we refer to a type of direction in collective action which is, ideally, broadly accepted by all participants in multiactor governance, and has (some) potential to contribute to achieving a shared objective (e.g., establishing a local or regional infrastructure). We use the term orchestration [17]³ to accentuate the setting of collective action in the absence of hierarchy. No stakeholder can act as ‘unmoved mover,’ given mutual dependencies between all stakeholders; which applies particularly to settings of multiple suppliers and consumers,

assuming energy needs/scarcity and/or a desire to optimize opportunity, so that alternative strategies to hierarchy are needed to bring stakeholders to cooperate. Such agreed or accepted strategies provide a rule-guided structure to the ‘action situation’ [18] in which decisions about establishing, operating, and maintaining an infrastructure are taken. Some stakeholder could thus be the ‘project entrepreneur’ (akin to Abbott and Snidal’s ‘regime entrepreneurs’ [19]) to orchestrate the project and avoid a ‘tragedy of anti-commons’ stalemate [20].

Positions of economic and legal power, following the nature of the infrastructure’s regulatory regime, and of techno-functional power, following the complexity of the infrastructure’s functionality, will have a strong influence on who will take the lead position(s). They may in fact be distributed and vary to such extent that a stalemate is almost unavoidable, such as when one private entrepreneur owns all links in the heat chain (i.e., production, transport, distribution, and supply), while the relevant future users prefer a so-called open net. To create an open net or ‘open infrastructure’, various heat suppliers would have to be connected to the infrastructure and end-users would have to be free in choosing their heat supplier. Should open infrastructures become the preferred standard, then within Table 2 we would witness a shift from supplier preferred ideal type 1 or 2, to demand preference ideal types 3 or 4. Continued absence of a spontaneous agreement on orchestration, or government rejection of such an agreement, such as on grounds of distributive justice, may, however, call for an outside regulatory intervention to orchestrate the process of decision-making. This possibility alone points at the need to broaden our ideal type perspective and to look at one or more levels beyond the level of the operational setting of an envisaged infrastructure in practice, as described above. Therein, it was assumed that the infrastructure-related stakeholder positions solely determined the state of regulatory affairs; as a matter of the regulatory nature of the infrastructure itself (aside its functional technical complexity). When we do draw in wider, contextual regulatory variables, for reason of outside rule-guided regulation, we need to reflect on the origin and nature of the multilayered context this would draw upon.⁴

Levels of action situations

In respect of orchestration and the role of project entrepreneurs within action situations, we apply the analytical separation between three levels of collective action situations (cfm. Ostrom [18]).

The top-level *operational situation* is that of a *particular* heat infrastructure that is in place and running. This level is in essence the most relevant as it is about the definition of the type of heat infrastructure that is to be established. However, we will now look at this level in terms of how, upon a decision at a next, deeper level, decisions are taken about the design of the infrastructure and how it will operate—following the characteristics of Tables 1 and 2. (i.e., regulatory nature of the regime and complexity of the technical functionality). For example, establishing an infrastructure at operational level may have to follow an open infrastructure management system that has various input, throughput and output connections, as prescribed at a deeper level.

At the next deeper, middle level *collective choice situation* decision-making takes place towards establishing a *particular* heat infrastructure (or changing or terminating its operations). Stakeholders have to decide—together or some mode of agreement—on the basis of positions and rules for decision-making determined at the next level, to bring about (or change or terminate) an infrastructure.

The next deeper, bottom level *constitutional* action situation is about powers to take decisions (at collective choice level) on establishing heat infrastructures, which are, once in place, operated at operational level. At this constitutional level a public hierarchy, such as the state, may dominate, but it may also be that with or without explicit state consent, the settings for collective choice are left to the workings of supply and demand in (the) competitive market(s) or private cooperative initiatives from within civil society. The way we have presented legal governance of heat infrastructures in the Netherlands so far, points at a constitutional setting in which there is a Heat Act which regulates existing heat infrastructures without arranging for any public hierarchy nor (explicitly) for any alternative orchestration of actual initiatives towards establishment of such infrastructures.

Table 3 represents the three levels as described above (with the arrows showing how deeper levels are supportive of higher level activity).⁵

This leads us to, firstly, focus on the top-down mechanism, where collective choice (2. in the above Table) follows operational level (1.) settings, and to next consider the bottom-up mechanism, where the constitutional level (3) regulates the collective choice initiatives.⁶

What is implicit here is that while ultimately what counts is the realization of the infrastructure at operational level, the collective choice level is where we find

Table 3 Levels of related collective action situations

1. Operational level	Situation of factual activity of establishing, operating and maintaining an infrastructure
2. Collective choice level ↑	Situation of collective decision-making on which infrastructure to establish and how to do so and operate and maintain it
3. Constitutional level ↑	Situation of decision-making about who can take the decisions and how at collective choice level (i.e., granting power)

the rules about how that realization can take place. The latter rules can follow from an express instruction at constitutional level (bottom-up) or, in absence of such instruction, follow from regulation in keeping with operational level settings (top-down) as indicated above as ideal type scenario. We will next look into both scenarios with some more detail (in From a 'top-down' perspective and From a 'bottom-up' perspective).

From a 'top-down' perspective

Assuming that indeed at constitutional level no per se regulation takes place of collective choice legal governance of initiating heat infrastructure projects,⁷ we believe the operational perspective of four ideal types of heat infrastructures in action (of Table 2) will project four ideal types of collective choice legal governance. Thus, the nature of the regime is seen to place either public or private interests in a dominant position, whilst the complexity of the functionality leads to projects being decided either by one (or very few) actor, or by many actors. This excludes the option of complex systems being decided upon by one actor and simple infrastructures by many, but our assumption is that considerations of effectiveness and efficiency make these options unlikely choices—probably also from a constitutional action perspective. Having 'many actors for simple infrastructures' risks inefficiency, in having too many/unnecessary interactions to establish a system, and having 'one actor for complex infrastructures' risks ineffectiveness, having too few interactions to cover all functional interdependencies to provide what is needed to function. The four ideal types of collective choice legal governance read as follows:

1. *Public interest driven mono-actor/unilateral project entrepreneurship*, which entails that the structure of the action situation places one public actor in a dominant position to (ultimately) take the key decisions on the operational action situation in a way which follows its public interest orientations (such as on universal access) and may come with de jure binding consequence for others, especially users (e.g., excluding other energy sources);
2. *Private interest driven mono-actor/unilateral project entrepreneurship*, which entails that the structure of the action situation places one private actor in a dominant position to (ultimately) take the key decisions on the operational action situation in a way which follows its private interest orientations (such as profit from heat sales) and may come with de facto binding consequences for others, especially users (e.g., excluding other energy sources);
3. *Public interest driven multiactor/multilateral project entrepreneurship*, which entails that the structure of the action situation is driven by public interest, but

without any public actor being placed in the dominant position to (ultimately) take the key decisions, so that decision-making will have to take place by cooperation/negotiations between public actors, each of which has a specific task in service of the public interest (e.g., infrastructure management, environmental protection, and public infrastructures). These public interests may not fully align, but the assumption is that they can either basically agree with a particular mode of collective choice making with each other, or that there is a general regulatory framework following constitutional situations' decision-making which places one or some public actor in a lead/project entrepreneur position.⁸

4. *Private interest driven multiactor/multilateral project entrepreneurship*, which entails that the structure of the action situation is driven by private interests, without any private actor being placed in a dominant position to (ultimately) take the key decisions on the operational action situation, so that decision-making will have to take place by private negotiating between private stakeholders, each of which may have their own distinctive private interest in the matter (e.g., profit, people, and planet). These private interests may not fully align, but the assumption is that they can either basically agree with a particular mode of collective choice making with each other, or that there is a general regulatory framework following constitutional situations decision-making which places one or some public actor in a lead/project entrepreneur position.⁹

These basic patterns or legal governance modes should be regarded as a basis for successful decision-making upon a shared-rationality/common strategic understanding of the type of action situation for collective choice, which has a top-down fit with the type of infrastructure that is to be established at operational situation level. Of course, this rational/strategic understanding offers no guarantee that the interactions within this collective action situation will always be successful. Public and private stakeholders in modes 3 and 4 may (have to) conclude that they do differ too much in their views on what is to be achieved to become successful, while in modes 1 and 2 public and/or private actors may find that their monopoly positions do not lead to viable infrastructure business models. While the top-down collective choice legal governance modes are seen to generally indicate a balanced requirement of effective, efficient, legitimate, and lawful decision-making, they do not exclude the possibility of failure, of proper collective action.¹⁰

Following this top-down approach of collective choice orchestration, two points need to be made.

Firstly, collective choice modes 1 and 2 (single public/private actors) do not appear to be about *collective* choice, but about hierarchy-based in (operational level) ‘public command-side’ or ‘private supply-side’ monopolies (whether by economical, technical, or legal power). We assume, however, that even in minimal complexity there are still some legal, economic, and/or technical interdependencies that dominant actors have to account for, if only in terms of hierarchy/monopoly not being a strong generator of loyal partnerships. So, even hierarchy/monopoly needs to be tailored to the specific setting; whether this is public participation in mode 1, or consumer protection and competition law in mode 2.

Furthermore, reality will feature hybrid forms, some of which may be positioned close to positions 1 and 2, thus causing the choice of collective choice mode to take ideal types 1 and 2 as point of departure for settling on the particular legal governance mode of collective choice. The particular one public or one private party will then be lead actor, operating as project entrepreneur: setting the stage, having an important say, but not irrespective of other stakeholders’ interests and opinions.

Secondly, what kind of de facto orchestration, by project entrepreneurs taking the lead, are we to expect in in positions 3 and 4? Basically, our top-down presumption is that the operational setting will express dominance of a particular interest, public or private, thus provide rational and strategic guidance in negotiations, if only because private or public actors will understand that the lead position lies with actors of another persuasion. In absence of (bottom-up) counter-indications, all stakeholders are in it together and should allow others to take the lead position, or take that position themselves, inspired by their own private or public interest; transaction costs permitting. Having said this, as with positions 1 and 2, we need to keep in mind, again, that reality often does come with approximate or hybrid settings that may point at a (more) dominant position of one or some of the public or private actors. We have suggested that this could follow from the characteristics of the infrastructure as envisaged at the operation level. That does not, however, take away from the chance that actors at collective choice level may find it difficult to unite on an

operational characteristic that then places one actor in the leading position at collective choice level. Hence, in practice actors may be left with a deadlock, statically (as inaction) or dynamically (e.g., by continuous changing of ambitions), through mere undecidedness, competitive considerations, and/or anti-commons. This may give rise to a bottom-up constitutional level intervention in orchestration at collective choice level, away from our default assumption of an absence of top-down orchestration by constitutional silence, leaving collective choice on establishing heat infrastructures to the mere interplay between stakeholders as stakeholders see fit.

Before we reconsider such express constitutional level interventions, the below Table 4 presents the collective choice typology overview, built upon Table 2, based upon top-down legal governance.

From a ‘bottom-up’ perspective

As said, the bottom-level *constitutional choice situation* is that of establishing (or changing or terminating) a regime of positions and rules that regulate collective choice for the making of heat infrastructures at operational level. So far our default assumption is one of constitutional silence as absence of constitutional regulatory interventions, leaving only top-down, ‘on the ground’ operational level dominance-factors determining the collective choice setting—as described above. We already saw that, especially in types 3 and 4 situations, this top-down approach may provide some guidance, but stakeholders in the collective choice setting may still face a wicked deadlock, calling for a constitutional level intervention. In addition, types 1 and 2 situations may cause constitutional level concerns about macro-effectiveness and efficiency of dominant operational preferences and the ensuing collective choice pattern, as well as on the legitimacy and lawfulness of these (especially related to single actor legal and/or economic dominance—as an issue of distributive justice). These concerns about possible ‘top-down failings’ could give rise to bottom-up remedial interventions which pre-structure the collective choice arena. At a constitutional level, instantiation of certain ideal type infrastructures could be formally/legally banned or restricted while others could be favored and facilitated. This could be done either directly, such as

Table 4 Types of collective choice legal governance orchestration in heat infrastructures

Regulatory→ ↓Technical	Regulatory nature of the infrastructure regime			
	Public	Hybrid forms	Private	
Technical complexity of the infrastructure functionality	Low to modest	1. Obligate in the general interest (unilateral decision)	Hybrid regimes and/or functions	2. Obligate in dominant private interest (unilateral exchange)
	Hybrid forms	–	–	–
	Modest to high	3. Attuning general interests (multiactor/public cooperation)	Hybrid legal governance and orchestration	4. Attuning private interests (multiactor/private negotiation)

by prohibiting private monopoly over supply and distribution or indirectly, such as by reliability requirements which de facto exclude the possibility of having only one supplier. Either would imply a resetting of collective choice rules and a possible reframing of actor ambitions at operational level. Constitutional regulatory interventions could also declare dominance of some party within a types 3 or 4 situation. A public task provision in a type 3 situation (multi/public) could trigger political and perhaps legal accountability, and a targeted subsidy arrangement in a type 4 situation (multi/private) could (compensate transaction costs and thus) incentivize private initiative and lead, but would also pull in public power, through appointing a particular office with the power to subsidize—aside from other instruments of channelling behavior by obligations and/or facilitation influencing the legal governance mode and lead positions in orchestration of collective choice decision-making. All of this to ultimately facilitate the best options for an operational level realization of heat infrastructures, through influencing the collective choice mechanisms bottom-up.

Constitutional interventions—the Dutch example

The possibility of constitutional level interventions, to remedy legal governance failure at operational and/or collective choice levels, to secure effective, efficient, legitimate, and lawful heat infrastructures, typically comes with a general and abstract legislative form; directed at anyone involved in any case of setting-up, operating, and maintaining heat infrastructures.

This is particularly the case when markets fail, such as because dominant parties have interests in return on investment in existing but suboptimal infrastructures or because firms are deterred by the necessary high sunk costs, and so there is an incentive for governments to remedy such failure. Likewise, failure at public cooperation between (lower) public authorities could call for a remedy instigated at constitutional level—such as by declaring or creating dominance of one particular actor/stakeholder to so invoke a particular type of orchestration.

The Dutch heat act as institutional environment

This brings us back to the example of the Dutch Heat Act. In the section above, we stated that presently this act does not prescribe a public regime nor does it insist on a high or low level of technical complexity as regards infrastructure functionality. We now need to add some nuance. The Dutch Heat Act was introduced with the intent of (a) enabling a viable development of residual heat use, with sufficient investments for enhancing sustainability and (b) to protect the position of heat consumers. As regards the latter, presently there is no ‘exit option’ (i.e., a capability of switching between heat

infrastructures), but there are safeguards concerning maximum nationwide tariffs (set by the Dutch office of fair trade and consumer protection—the ACM), the use of contracting powers (the right to shut-off), compensation for service interruptions, and regulations concerning monitoring and measuring and conflict resolution. In case of large-scale infrastructures, of more than 10 users and producing more heat than 10,000 GJ/annum (see Article 9 Heat Act) a permit requirement applies, with the Minister of Economic Affairs as competent authority, especially to test on organizational, financial, and technical quality of the intended supplier, to secure reliable services.

As a matter of legal governance, the Heat Act prescribes a ‘regulated market’: a hybrid institutional environment placed between the institutional environments of state ‘public hierarchy’ and ‘competitive market’. Building upon work done by Klok and Van Heffen [21] and Ruiters [22], Lammers and Heldeweg [23] have explained how such institutional environments not only *describe* a pattern of behaviour that may exist in practice but also *prescribe* that pattern so to create normative opportunities for and constraints to actions in collective choice and/or operational action situations.

The latter is exactly what the Dutch Heat Act is doing with respect to heat infrastructures, both at operational level (e.g., through a permit requirements) and at collective choice level (e.g., decision-making on permits, but also constraints on contracting). These and alternative regulatory interventions at constitutional level impact on the freedom of stakeholders to, at collective choice level, self-determine the (ideal type) form of orchestration in legal governance of decision-making that is to lead to new or improved heat infrastructures. It is hoped that these can also help stakeholders to, again at collective choice level, overcome their inability to break out of a deadlock. In doing so, the Heat Act would provide remedies against top-down failure by prescribing a particular mode of governance orchestration at collective choice level. Ideal-typically, this could happen through (a) public interest and ‘voice’ driven command and control, following state public hierarchy, (b) private interest and ‘exit’-driven exchange in competitive markets, and (c) collective/common interest and loyalty-driven cooperation in civil networks [24–26]. As said, regulated markets are an example of a hybrid between the competitive market and the public hierarchy, with the latter setting unilaterally binding boundaries at constitutional level, for market contracting at collective choice level.¹¹

Policy momentum

Current policy initiatives in the Netherlands demonstrate how state-government may, also outside of the Dutch example, consider making changes in the institutional

environment of the heat energy sector as a constitutional level intervention towards greater bottom-up legal governance orchestration. As said, the existing Dutch Heat Act currently already presents a regulated market, constraining contracting, which mainly concerns the operational situation of an infrastructure being in place, but also that of a permit to operate, which is relevant to collective choice decision-making. Clearly, so far the Heat Act is keeping distance from public hierarchy, as it does not compel any type of command and control orchestration nor does it hold any other rules that come down to supply-side regulation. It is, however, interesting to see that, given the government ambitions referred to in the opening section of this article, government is reconsidering its influence on collective choice orchestration, which may lead to more regulation and a shift that moves orchestration closer to hierarchy and away from cooperation or negotiation.

From the Dutch Heat Vision [3] of the Dutch Ministry of Economic Affairs, it becomes clear that the central Dutch government is considering specific constitutional level interventions towards a more distinct positioning of certain stakeholders, to further effective orchestration within the regulated heat market. Constitutional level decisions are considered to change the institutional environment which shapes collective choice situations for decision-making towards establishing heat infrastructures:

“To promote a more sustainable use of heat production it is of great importance to not only look at the development of heat production but also at the market model for heat delivery.” [3; 18]¹²

When looking at the market model for heat, the ministry also relates this market to the markets for gas and electricity and suggests that the heat market could be ‘emancipated’ by, for example, terminating the existing requirement, in the Gas Act, for housing to be connected to the natural gas infrastructure and (thus) allowing a local ‘future proof’ deliberation on choosing between gas and heat infrastructures. It is interesting to see that in this context typically public law interventions are also being considered:

“A municipality can introduce a heat plan to declare if a heat infrastructure will be established and if, in case of new resident housing, there will be an obligation to connect to a heat infrastructure.” [3; 19]¹³

The next quote perfectly fits this line of reasoning:

“As stated before, heat generation and use usually form a closed system, without competition or free choice for the consumer. To improve this situation, the possibilities for connecting more sources of heat

to local infrastructures should be looked at in the further development of the heat market. Hence local governments would do good by, in the course of planning (and permitting) for the establishment of new heat infrastructure, opting for ‘open networks’. This would allow the user of heat the opportunity to choose between different suppliers and various producers could feed their heat into this infrastructure. This model is alike that of electricity and gas. Furthermore, an open network promotes both competition and reliability, because it enables entry of new producers.” [3: 21]¹⁴

Clearly, a greater complexity of the infrastructure functionality is propagated in combination with a greater public responsibility in orchestration. This begs the question whether this is a first step towards a stronger and more hierarchical public regime. We do see a movement in the direction of collective choice type 3, within the hybrid area of the triangle 2-3-4 (of Table 4), fitting to the regulated market. Whether the latter fit is still the ministry’s preferred institutional environment may however be questioned considering the next ministerial statement:

“In this model an independent infrastructure operator manages the heat infrastructure in a way similar to such management in the gas- and electricity market. Presently this model is feasible only if the owner of the infrastructure is cooperative. Within the framework of the evaluation of the Heat Act I will assess if it is possible to establish legislation that commands of owners to cooperate (“Third Party Access”-regulation).” [3: 21–22]¹⁵

This legislative type of obligating regulation of collective choice action situations at local or regional level pushes the orchestration of decision-making on establishing heat infrastructures even further in the direction of a public-hierarchical (perhaps even type 1) direction—away from private self-regulation—making orchestration a more forceful instrument.

Meanwhile, there are indications that the minister is also considering a less commanding and more facilitative public orchestration, within the current regulated heat market:

“It was agreed in the Energy Covenant that each regional heat cluster is to establish an action plan. I intend to support orchestration in promising regional (residual) heat projects, upon submitting their action plan, in the initial phase, when necessary and called for (...). In this context I also intend to revitalize the existing heat expert-centre. (...) I want to, especially,

further strengthen the cooperation with the private sector. The heat expert-centre can, together with the private sector provide support to, *inter alia*, the yet to develop heat plans and residual heat plans.” [3: 23]¹⁶

These citations demonstrate how, at least at the time, the Dutch state government was looking for a more prominent mode of orchestration which would bring, within a regulated market, a stronger public dominance as regards taking initiatives towards establishing heat infrastructures. As such they are a mere example of the policy challenge that rests upon many states’ shoulders to decide on whether or not change the mode of legal governance for establishing heat infrastructures from a bottom-up perspective.¹⁷

Conclusions: movements in legal governance of heat infrastructures

The leading question of this article reads: how can a legal governance typology assist in handling the complexity of the policy- and decision-making processes about heat infrastructures? The question was triggered by concern over stalemate in current heat grid projects, against the backdrop of how, potentially, these types of projects could be helpful in respect of the energy transition.

An example in case is the Dutch project named in Context—some examples, involving a ‘north branch’ of the heat infrastructure of Arnhem (‘Noordtak warmtenet Arnhem’), where the Dutch province of Gelderland is active in supporting the energy transition [27]. The project seems technologically and economically feasible, but the involved stakeholders hold very different views about the operational characteristics of this particular branch, causing an impasse in the collective choice process of this project. It is the kind of case where, as a point of departure, the typology of operational settings of infrastructures, as described in the first section of this article (particularly A legal governance typology of heat infrastructures) and elaborated in the later top-down viewpoint (of From a ‘top-down’ perspective), may explain such deadlock and open the perspective to consider scenarios to find a way forward.

In elaborating on a top-down viewpoint and also on a bottom-up perspective, the leading question to this article is placed in a multilevel legal governance context. While in this context, the ultimate focus remains on ‘on the ground’ activities (establishing, operating, and maintaining heat infrastructures) at operational level, much of the problems lie with failing collective choice collective action. In absence of hierarchy, following liberalization (or mere absence of dedicated regulation) no adequate project orchestration seems to take off. Where such failure is not solved by operational level stakeholders agreeing on a

feasible and legitimate top-down scenario, constitutional level regulatory interventions may be needed. These need not necessarily amount to collective choice action becoming a matter of public hierarchy, as a regulated market scenario also holds opportunities and constraints that can support operational level stakeholders in agreeing on their course of collective choice action.

In response to its leading question, this article has thus taken an ‘operational level first’ starting point, with an assumed ideal type context of full liberalization, without dedicated heat grid regulation. On this basis, a legal governance typology was presented, partly as an analytical/diagnostic tool, but also as a possible tool to support legal governance design to circumvent or overcome stalemates—as typology of legal governance at collective choice level. This is also helpful to more complex cases, with persistent deadlocks, where the top-down perspective is failing. The typology, placed in the said multilevel perspective, offers a point of reference for constitutional level interventions, unlocking the regulatory instruments of government (factors v–vii in Table 1), to overcome operational/top-down failure, without necessarily moving to public enterprise—away from liberalization—but by orchestrating collective decision-making in the hybrid zone of the typology (e.g., in some shade of a regulated market).

While this legal governance, typology (in multilevel context, with top-down and bottom-up perspectives in a liberalized energy market) provides a framework that may have greater relevance than to heat energy only, such as to gas and electricity, this article only addresses heat energy, with the Dutch policy challenges as illustration of how the typology may be helpful. We decided to stay close to heat energy, as not only is this, at least in the Netherlands, still not a regulated market to the extent of vertical unbundling (as in gas and electricity) but also because despite the conceptual nature of this article, it was inspired by such Dutch initiatives towards connecting heat projects with the aim to realize regional heat infrastructures, and does want to explicitly address the related problems and the relevant policy momentum (as in Constitutional interventions—the Dutch example.).

In terms of a possible research agenda, it is hoped that soon there will be opportunities for additional research to more systematically assess whether there are indeed patterns in preferences concerning legal governance of heat infrastructures and how they impact the success rate of establishing such infrastructures. Such research should also look into how, aside from the top-down process of operational situation preferences impacting collective choice orchestration, constitutional level regulation of collective choice through arranging a (hybrid) institutional environment can add to the successful establishment of heat infrastructures.

This article presents a first conceptual step in providing a typology and model that is intended to be helpful both in analyzing heat infrastructure projects (and deadlocks) and also to ultimately provide guideline for the design or improvement of decision-making processes.

Endnotes

¹This does not mean to say that there is no market regulation at all, but not of regulation about unbundling generation and supply of heat energy, as is the case in electricity and gas.

²Free market as in absence of public/government regulation dedicated to heat energy (infrastructures)—so with the possible exception of generic regulation which has the sole purpose of enhancing the functioning of the market (for the sake of the market), such as competition and consumer protection law.

³A term we borrow from the context of transnational regulatory governance [17].

⁴One could say that this is where we actually do apply Van Montfort's contextual public v. private dimensions, which we excluded in the above (A legal governance typology of heat infrastructures) [11], to the extent that we open the possibility for these dimensions. (i.e., actor tasks/activities, market environment, autonomy to government (officials)), to indicate some form of public regulation/publicness, impacting on the regulatory nature of the infrastructure.

⁵Ideally, there is a mechanism of (information) feedbacks so deeper levels may adjust should interventions be needed to improve higher level performance.

⁶We realize that we use top-down and bottom-up in a somewhat counter-intuitive way, as the former is generally connected to 'hierarchical' commands and prohibitions, and the latter by 'on-the-ground' demands, but in the Ostrom IAD-framework, the reasoning places the on-the-ground level at the top, underpinned by lower level decision-making.

⁷We use 'per se' to refer to rules specifically dedicated at heat grid infrastructures, or perhaps somewhat broader, energy infrastructures; of course, invariably there will be general constitutional level rules, such as the basics of private and public law (see *infra*, endnote 10).

⁸As indicated in the previous endnote; absence at constitutional level of dedicated regulation does not exclude the possibility of applicable general rules at that level, such as those that arrange a general hierarchy between public offices.

⁹See previous endnote; in the private law area such a general rule would most likely concern the legal positions of owners or ranking of property rights.

¹⁰This assumption rests on the idea that the basic generic framework of public and private law rules (e.g., about the rule of law, democracy, human rights, checks

and balances, property, and contract law, law on legal personality) originates in the need to provide such basic effectiveness, efficiency, legitimacy and justice—while recognizing that special concerns (e.g., sustainable energy provision) may require dedicated rules.

¹¹Our focus remains on legal governance. Of course the relation between technology and the economic/institutional setting of energy infrastructures, as well as their socio-technical design could be further explored—see, for example, [28] and [29]—but we do not want to broaden the discussion too much.

¹²Authors' translation of "Om meer duurzaam gebruik van warmte en verduurzaming van de warmteproductie te stimuleren is het van groot belang om naast de ontwikkeling van productiemogelijkheden ook te kijken naar het marktmodel voor warmtelevering."

¹³Authors' translation of: "Een gemeente kan door middel van een warmteplan voor een bepaald gebied vastleggen of er een warmtenet komt en of hier in geval van nieuwbouw een aansluitplicht komt"

¹⁴Authors' translation of "Zoals eerder gesteld vormen warmteopwekking en -afname doorgaans een gesloten systeem, zonder concurrentie of vrije keuzemogelijkheden voor de afnemer. Om deze situatie te verbeteren, moet bij de verdere ontwikkeling van de warmtemarkt gekeken worden of in sommige gebieden meer warmtebronnen kunnen worden aangesloten op een warmtenet. Medeoverheden doen er daarom goed aan bij (de vergunningverlening voor) de aanleg van nieuwe warmtenetten te overwegen er 'open netten' van te maken. De afnemer kan dan kiezen uit verschillende leveranciers en meer producenten kunnen dan warmte invoeden op het net. Dit model lijkt op de markt voor elektriciteit en gas. Bovendien bevordert een open net zowel de concurrentie als de leveringszekerheid, omdat toetreding van nieuwe producenten mogelijk wordt."

¹⁵Authors' translation of "In dit model beheert een onafhankelijke netbeheerder of exploitant de warmte-infrastructuur zoals dat ook op de gas- en elektriciteitsmarkt gebeurt. Dit model is in de huidige praktijk mogelijk als de eigenaar van de infrastructuur wil meewerken. In het kader van de evaluatie van de Warmtewet zal ik bezien of het mogelijk is om regelgeving te ontwikkelen die eigenaren verplicht hieraan mee te werken ("Third Party Access'-regulering)."

¹⁶Author's translation of "In het Energieakkoord is afgesproken dat regionale warmteclusters een plan van aanpak opstellen. Ik wil regionale (rest)warmteprojecten, na indiening van een plan van aanpak, in de startfase ondersteunen door waar nodig en desgevraagd bij te dragen aan de regie in warmteclusters met veel potentieel. (...) In dit verband wil ik ook het bestaande expertisecentrum warmte nieuw leven in blazen. (...) Ik wil vooral de samenwerking met de private sector verder versterken.

Het expertisecentrum warmte kan samen met de private sector ondersteuning bieden aan onder meer de te ontwikkelen warmteplannen en restwarmteprojecten.”

¹⁷Meanwhile some changes have been made in the 2017 Dutch Heat Act, concerning competition law sanctions) but major changes are still under consideration [30].

Authors' contributions

Authors contributed almost equally to the article, only minor differences causing a non-alphabetical order of author names on the title page. All authors read and approved the final manuscript.

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