**Abstract**

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# Governance of Heat Grids. Towards a Governance Typology for Smart Heat Infrastructures.

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**PAPER FOR THE 2016 ESEIA CONFERENCE**

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

To actually get heat grid projects underway, as a first step towards such a heat energy market, however proves to be a serious challenge. Aside from technological issues, to properly align stakeholder interests and reconcile different views on what kind of (perhaps smart) heat grid to establish and how, is no mean feat, and often stakeholders fail to come to terms and their project ends in a deadlock. It seems essential that in the absence of hierarchical options proper modes of governance are developed with fitting types of orchestration to support the realization of heat grids through concerted energy infrastructure planning.

The paper will present a governance typology for heat grids by combining the nature of the grid-regime with the complexity of the grid-functionality. The spectrum of the nature of the grid-regime ranges from an exclusively private to an exclusively public nature of the relevant rule set. The spectrum of functional complexity ranges from a simple & closed grid to a complex & open grid, depending on functionalities and actor configurations. Combining both spectrums yields four ideal-type positions (a. low complexity/public nature; b. high complexity/public nature; c. low complexity/private nature; d. high complexity/private nature), which point at particular dominant/lead actor positions that correspond with standard types of governance orchestration (a. unilateral determination; b. multilateral determination; c. unilateral exchange; d. multilateral exchange) – defining a governance space with many in between hybrid positions.

From the example of trends in Dutch Heat Energy Policy we demonstrate how indeed many projects never surface and how government considers further legislation whereby orchestration moves in the direction of multilateral public orchestration, with the ambition of especially promoting the establishment of smart, open heat grids, 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 grids.

# Governance of heat grids: towards a typology of governance structures of heat infrastructures

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## 1. Introduction

In the next decades, Dutch government faces a major challenge. A more sustainable energy system has to be realized in order to reduce $CO_2$ emissions and to prevent a (further) climate change. Although the Netherlands has committed itself to Brussels' policy ambition which aims for a competitive $CO_2$-carbon economy in 2050, only 4.5 per cent of Dutch energy consumption in 2013 came from renewable sources (Centraal Bureau voor de Statistiek, 2014).

Policymakers are hopeful that regional initiatives can bring the much desired increase in the share of renewable energy. They have the expectation 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® scale, an increased share of renewable energy at the national level can indeed be achieved (Sanders & Hoppe, 2013).

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 take a positive stance, heat projects remain only marginally successful. The challenge seems to be in arranging the proper type of governance structure in the organization and use of heat grids. The organizations involved sometimes seem to take diametrically opposite positions because they have different interests, different problem perceptions and suggest different solutions. Therefore the planning process for establishing heat grids suffers a considerable risk of ending in a deadlock.

Against the backdrop of the latest Dutch Heat Vision (Warmte Visie; 2015) by the Dutch Minister of Economic Affairs, emphasizing the importance of creating an 'equivalent position of heat in addition to natural gas and electricity in our energy system', to achieve a substantial growth in the range of renewable heat, and possible future adjustments to the Dutch Heat Act (Warmtewet), this paper presents a governance typology for heat grids. This typology (in development) is intended to assist in understanding the complexity of the policy and decision making processes about heat infrastructures, taking due account of relevant legal principles. The typology makes it possible to classify heat projects, which in turn can clarify the impact of preferences of stakeholders in the governance of heat grids. This also helps in analysing barriers and opportunities, which may preclude the use of waste heat or, respectively, provide them a proper perspective. Local administrators can use the typology to prevent or break open any deadlocks in the planning and development of heat infrastructures.

Before the typology is presented, we will consider (in section 2) the Dutch policy context in which local authorities are working on developing heat infrastructures. Next (in section 3) we present an ideal type governance typology, we highlight some examples of district heating projects (paragraph 4) and discuss (in section 5) how our typology can contribute to the 'governance orchestration' of decision-making on heat grid/infrastructure initiatives. Then (in section 6) we place this typology in

the context of the institutional environment of the Dutch Heat Act, after which we conclude with some recommendations.

## 2. Public energy interests and sector reforms

In the Dutch energy sector, as in many others, government has the task to safeguard three public interests in energy: the affordability of energy, (ii) the reliability of power grids and (iii) the sustainability of energy (Sanders, 2013: 22). In connection with safeguarding these interests, the Dutch energy sector has in recent decades been reformed – as have many others in EU Member States. The most notable changes are the, also EU-driven, liberalization of the energy market and the energy transition.

In the nineties 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 (Kist et al 2008: 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 favoured to privatize the then vertically integrated energy companies as a whole (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 (ie the reliability of the grid). It decided to secure both: the affordability and reliability by separating the energy networks economically, and legally the production and supply of energy. (Sanders & Hoppe, 2013).

At the same time climate change moved up the political agenda. In its Fourth National Environmental Policy plan the former Dutch Ministry of Housing, Spatial Planning and the Environment declared that $CO_2$ 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 $CO_2$ (Ministry of Housing, Spatial Planning and the Environment, 2001: 128). Since then, in the Netherlands the term 'energy transition' is used to refer to 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 (Regieraad Energietransitie, 2010 ).

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 favourable to the price stability of energy and thus the competitiveness of the Dutch economy (Ministry of Economic Affairs, Agriculture and Innovation, 2011). At the same time the large-scale production of renewable energy could reduce the dependence on politically unstable fossil energy-producing countries (Ministry of Economic Affairs, Agriculture and Innovation, 2011). However, the actual share of renewable energy to date, demonstrates that very little was in fact 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 (Ministry of Economic Affairs, 2015).

## 3. A governance typology of heat grids

Nearly 60 per cent of energy consumption in the Netherlands is used for heating buildings and for industrial processes (Economic and Social Council, 2013: 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 $CO_2$ emissions (Ministry of Economic Affairs, 2015). A more efficient use of heat energy is therefore one of the pillars of the Dutch Energy Agreement (Economic and Social Council, 2013: 63).

Residual heat infrastructures are needed to enable trading. In the simplest form heat is supplied via a pipeline to a building nearby. Socially, it is however much more attractive to realize large-scale heat grids. These are infrastructures that connect one or more heat producers with more than 5,000 customers (CE Delft, 2009). Such pipelines are planned or realized in the Dutch cities of Arnhem, Deventer, Hengelo, Nijmegen and Rotterdam.

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

We have developed a typology to unravel the complexity of heat grids and to advise on the proper governance structure for their establishment. In the typology two basic factors are distinguished: (i) the regulatory nature of the grid regime and (ii) the technical complexity of the grid functionality.

The regulatory nature of the grid is basically about whether the regime for a 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 separate energy production on the one hand and the supply and transport of energy on the other hand. The delivery and maintenance of a heat grid is not a task that is exclusively reserved for public or for private parties. The regulatory nature of the grid 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 (Van Montfort, 2009: 16). Within the organization of public services, for example, Van Montfort makes a distinction between a number of dimensions within the terms public and private, namely: (i) legal form, (ii) ownership, (iii) autonomy to government officials, (iv) tasks / activities, (v) financing (vi) market environment, (vii) value orientation (2009: 17). These dimensions are also applicable to heat supply.

The factor technical complexity refers to the functional grid or infrastructure properties that have an impact on the complexity of the multi-actor configuration. To a large extent the parties involved in the heat chain determine this complexity. The heat chain consists of four links, namely: (i) production, (ii) transport, (iii) distribution and (iv) delivery. Because the Dutch Heat Act prescribes no split, one party can carry out all these activities. It is highly conceivable that these activities are

carried out by different organizations. In general 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 multi-actor configuration of an heat grids. If an infrastructure will be realized within the limits of a municipality then just one spatial regime is in force. In the case that an infrastructure is realized across municipal boundaries the initiative must fit within different spatial regimes. Finally, it is of importance to know whether the heat is generated from a single source or from several sources. A grid that operates only through heat from a waste incinerator is 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, (vi) energy sources. Table 1 provides a summary the characteristics.

**Table 1 - Two Categories of Heat Grid /Infrastructure Characteristics**

| Regulatory nature of the grid regime (public/ private)[1] | Technical complexity of the grid functionality (low/ high) |
|---|---|
| 1. legal form (public/ private);<br>2. ownership (100% government/ 100% private;<br>3. autonomy to government (dependent/ independent);<br>4. activities (legal structured/ market activities);<br>5. financing (100% government/ 100% private);<br>6. market environment (monopoly/ competition);<br>7. value orientation (sustainability and or reliability or a business oriented grid). | 1. scale (one spatial regime/ several spatial regimes);<br>2. production (monopoly/ different producers);<br>3. distribution (monopoly/ different distributors)<br>4. transport & delivery (monopoly/ several traders);<br>5. consumption (one consumer/ different consumers);<br>6. energy sources (one source/ several sources); |

The operationalization makes it possible to classify initiatives and distinguish different types of heat grids. Furthermore, the typology can help to determine the influence of (changing) preferences of stakeholders, in short, the impact of the regulatory nature and technical complexity of the infrastructure on the governance structure of the process of establishing a heat grid. These preferences are important in the planning of new projects, but (as we will illustrate in the following section) 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 distinguish four ideal type operational forms of grids or 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 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 1, as variations across from public to private and from complex to simple, including hybridity, built upon the characteristics of the regulatory nature and the technical functionality of the grid. However, for descriptive, explanatory or designing, the ideal type analysis

can be a useful starting point.

<table>
<tr><th colspan="5">Table 2 – Typology of Heat GridsRegulatory nature x Technical Complexity of Heat Grids/Infrastructures</th></tr>
<tr><td colspan="2" rowspan="2">Regulatory ➔<br>➘Technical</td><td colspan="3">Regulatory nature of the grid regime</td></tr>
<tr><td>Public</td><td>Hybrid forms</td><td>Private</td></tr>
<tr><td rowspan="3">Technical complexity of the grid functionality</td><td>Low</td><td>Ideal type form 1<br>Public/Simple</td><td rowspan="3">Hybridity</td><td>Ideal type form 2<br>Private/Simple</td></tr>
<tr><td>Hybrid forms</td><td></td><td></td></tr>
<tr><td>High</td><td>Ideal type form 3<br>Public/Complex</td><td>Ideal type form 4<br>Private/Complex</td></tr>
</table>

## 4. Regional heat infrastructures

Initiatives have been launched in different parts of the Netherlands to connect heat projects together. The aim is 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 a pipelines.

A well known example is the regional heat infrastructure Arnhem-Nijmegen. In the long term the Dutch province of Gelderland (of which Arnhem and Nijmegen are neighbouring cities) is committed to energy neutrality (Province Gelderland, 2012). That ambition must by 2020 achieve up to 20 per cent energy savings, compared to 2010 and see at least 14 percept of the Gelderland energy consumption come from renewable sources (Province Gelderland, 2012). 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 (Province Gelderland, 2014A). In 2030 the pipeline with no less than 90,000 connections must been realized (Province Gelderland, 2014B).

Not only government officials in the Arnhem Nijmegen region are busy with analysing 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 grids in Hengelo and Enschede (two neighbouring 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 (Province of Overijssel, 2013: 12). This initiative would contribute strongly to the sustainability of the regional economy (Province of Overijssel, 2013).

But also elsewhere in the Netherlands the possibilities of a regional heat infrastructure are explored. For example in the Amsterdam Metropolitan Area and the Hague Region.

## 5. Governance orchestration

In practice, establishing heat grids and connecting separate heat grids has proven to be a wicked policy challenge. Not in the least because objectives, interests and demands about the governance of heat grids seems to differ considerably over stakeholders involved. An simple example of this is when one private entrepreneur owns all links in the heat chain (i.e. production, transport, distribution and supply – see Grontmij 2011: 11-12), while the future users prefer a so-called ‘open net’. To create an

'open grid', various heat suppliers would have to be connected to the grid and end-users would have to be free in choosing their heat supplier. Should 'open grids' 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.

*Stakeholder orchestration*

Stakeholders will generally have certain basic positions and (developing) preferences as regards the desired complexity of a grid's or infrastructure's technical functionality, combined with its (more) public or private regulatory regime nature. These positions and preferences will generally be an important structuring point of departure in the choice of the governance-type for collective action necessary towards the actual establishment of the particular grid or infrastructure. As stakeholder positions and preferences may change over time, the setting for decision-making on establishing a grid or infrastructure is also likely to changes, sometimes radically, such as when a government initiative or push falls away as government privatizes the ownership of a previously public grid, and private self-governance has to take over. All to easily does this lead, as said, to a stalemate in decision-making and non-realization of a heat grid project. We believe that the risk of such deadlocks can be avoided or at least reduced by taking the ideal type characterization of the aspired heat grid or infrastructure (of Table 2) as a point of departure in deciding on the type of governance in the collective action towards establishing the particular grid – as a means of 'taking some distance' and 'lock-on' to a basic governance-mode. That particular mode would imply that stakeholders agree to a settled form of 'governance orchestration'. With 'governance orchestration' we mean a type of giving direction to collective action in a way that is broadly accepted by all participants within a mode of multi-actor governance that is fitting to meeting a collective objective (e.g. establishing a local or regional grid or infrastructure), given the interdependencies between stakeholders – especially as heat grids or heat infrastructures involve more than one heat supplier, and/or more than one heat consumer, and possibly other stakeholders, such as grid managers.

The term orchestration, which is drawn from the context of transnational regulatory governance (Abbott & Snidal, 2009), is used here to accentuate that our focus lies with collective action, more particularly collective action without hierarchy, so that alternative strategies are available in bringing stakeholders to constructively cooperate. Ideally, such a strategy involves that stakeholders can be united around a set of rules of the game which together structure, in the terminology of Ostrom (Ostrom, 2005), an Action Situation, within which interactions take place towards establishing the outcome of a particular type of heat grid. The aforementioned ideal type heat grids thus shape the pattern of collective action on the basis of technical specificity and jointly accepted rules-in-use.

Given the absence of hierarchy, orchestration is the alternative to unilateral power as a means to collective action between 'actors' within the Action Situation. The question is which stakeholders will become the 'project entrepreneurs' (akin to Abbott's 'regime entrepreneurs'; Abbott, 2014) to take the lead in surmounting what seems a 'tragedy of anti-commons' (Heller, 1998), or at least a stalemate, by tying together a local or regional Action Situation within which all relevant stakeholders (by and large) agree on the decision-making mode to take all the necessary decisions towards establishing a heat grid or infrastructure. Clearly, (the distribution of) positions of economic and legal power (following the nature of the grid's regulatory regime), and the technical-functional positions (following the complexity of the grid's functionality) will decide which stakeholders can indeed take such lead positions in bringing stakeholders together and aligning their actions. Again, we assume that although there may be dominant positions, no single (public or private) stakeholder can unilaterally command the establishment of a heat grid, so the project entrepreneur(s) will, generally speaking, seek to involve others by the use of persuasive instruments, such as informing,

educating, convincing, inspiring, coordinating, standardising and economically supporting – to overcome what may be a 'negative dominance', by stakeholders who cannot command establishing a heat grid or infrastructure, but are able to (perhaps also implicitly, by non-action) veto this on the basis of their crucial economic, technical or legal position (with or without a situation of anti-commons in the sense of there being very many veto positions or just a few).

*Levels of Action Situations*

In respect of orchestration and the role of project entrepreneurs within Action Situations we need to analytically separate between several Action Situations being set at different levels of collective action (cfrm. Ostrom, 2005): at operational level (of a functioning grid or infrastructure), the collective choice level (of decision making to establish a particular grid or infrastructure) and the constitutional level (of deciding on how to enable stakeholders to decide on establishing a grid or infrastructure). We will elaborate briefly on these levels to better explain how characteristics of a grid or infrastructure can be linked to characteristics of establishing a grid or infrastructure.

- The *operational situation* is that of a *particular* heat grid that is in place and running.
  This level is relevant in terms of the definition of the ideal type (or hybrid type) heat grid that is to be established (at the next level), in terms of how it will operate – the characteristics of Tables 1 and 2. It is possible that in the course of *collective choice* action (see the next level) this definition will change (depending on interests of stakeholders) shift or indeed that there conflicting ideas and competition between them (at the next level). If a definition exists, then its characteristics (i.e. regulatory nature of the regime, complexity of the technical functionality) are leading in terms of outcomes at the next level. For example by establishing an open grid management system that has various input, throughput and output connections.
- The *collective choice situation* is that of decision-making towards establishing a *particular* heat grid (or changing or terminating its operations).
  At this level stakeholders have to work together on the basis of positions and rules that exist (in part on the basis of decisions taken at the next level) to bring about (or change or terminate) a grid. As the nature of the grid regime together with the complexity of the grid functionality leads to (a hybrid or approximation of) an ideal type heat grid, it will be clear that the particular role-patterns, resources, mechanisms & processes fitting to the particular types will have to be the outcome of a collective choice action which in itself is suitable to producing such outcomes effectively, efficiently, legitimately and lawfully. These maxims are defined by the requirements of the operational situation settings (as outcome of the collective choice process) but also by the requirements at a next higher level that is about *constitutional* action settings for collective decision-making.
  From the operational perspective our four ideal types lead us to conjecture that there are four ideal types of collective choice governance, whereby we assume that the nature of the regime places 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) actors, or by many actors. This excludes the option of complex systems being decided upon by one actor and simple grid systems by many, but our assumption is that considerations of effectiveness and efficiency make these options unlikely choices (probably also from a constitutional action perspective) as 'many actors for simple systems' risks inefficiency (in having to many/unnecessary interactions to establish a grid) and 'one actor for complex systems' risks ineffectiveness (having to few interactions to cover all functional interdependencies to provide what is needed to function).

This leads us to the following four ideal type of collective choice governance:

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 multi-actor/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. grid management, environmental protection, 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 regulatory framework following constitutional situations decision-making which places one or some public actor in a lead/project entrepreneur position.
4. *Private interest driven multi-actor/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, 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 regulatory framework following constitutional situations decision-making which places one or some public actor in a lead/project entrepreneur position.

It should be emphasized that these basic patterns or governance modes are meant to provide a basis for successful decision-making, as a shared understanding of the type of action situation for collective choice that suits the type of grid or infrastructure that is to be established (as operational situation), but that this is no guarantee that the interactions within this 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 place them in a position to establish a viable (business model for the) grid or infrastructure. The governance modes are seen to generally provide a proper balancing of requirements of effective, efficient, legitimate and lawful decision-making, which does not exclude the possibility of failure, but minimizes the risk of this by excluding a mismatch between operational needs and collective choice settings, such as not including all relevant stakeholders, or including actors that do not have a real stake, or misinterpreting stakeholder opportunities or constraints, given their interests and their legal positions.

As regards orchestration, two more points need to be made.

Firstly, that one may wonder if collective choice modes 1. and 2. (single public/private actors). are collective choice types of decision-making as they suggest one actor deciding, which may be understood as orchestrating the operational setting, but not of a collective decision-making process itself. In as much as there is collective decision-making, the choices are made through hierarchical orchestration, probably as a mode of exercising a 'supply-side monopoly' (whether by economical, technical or legal power). We assume here that even in minimal complexity there are still some interest 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 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 it needs to be emphasized that as we work with ideal type situations, the reality will be about hybrid forms, and some of which may be positioned closest 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 mode, in which the particular one public or one private lead actor can indeed operate as project entrepreneurs: setting the stage, having an important say, but not irrespective of other stakeholders interests and opinions.
Secondly, in positions 3. and 4. we may indeed wonder what orchestration is to be expected, and who can take a lead position as project entrepreneur. Basically it can be said that the institutional setting does express dominance of a particular interest, public or private, which does provide some guidance in negotiations, if only that private and public actors know that the lead position lies with actors of another persuasion. Further, the setting does clarify that, in absence of counter indications, all stakeholders are in it together and that it is clear that either public or private actors should take the lead position – not expecting this from actors from other persuasions, but possibly being criticized by those in case of inaction – and that they should not wait for others (within their own public or public persuasion) to settle the setting for decision-making and take the lead. Having said this, with positions 1. and 2., we need to keep in mind 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 grid or infrastructure as envisaged at the operation level, but that does not take away from the chance that at 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, so in fact they may be left with an impasse, statically (as inaction) or dynamically (by continuous changing of ambitions), through mere undecidedness, competitive considerations and/or anti-commons. This may give rise to an orchestration intervention at constitutional level that changes our default assumption of an absence of top-down orchestration – the world of heat grid/infrastructure being left to the mere interplay between stakeholders as stakeholders see fit.

Before we move to the constitutional level, the below table 3 presents the collective choice overview, built upon Table 2, which was about the operational (level) overview.

| **Table 3 - Types of Collective Choice Governance Orchestration in Heat Grids** | | | | |
|---|---|---|---|---|
| **Regulatory ➔** <br> **🡻Technical** | | **Regulatory nature of the grid regime** | | |
| | | **Public** | **Hybrid forms** | **Private** |
| | **Low to modest** | **1. Obligate in the general interest (*unilateral*** | **Hybrid** | **2. Obligate in dominant private interest** |

| | | | | |
|---|---|---|---|---|
| **Technical complexity of the grid functionality** | | ***decision*)** | **regimes and/or functies.** | **(*unilateral exchange*)** |
| | **Hybrid forms** | **….** | **……** | **…..** |
| | **Modest to high** | **3. Attuning general interests (*multi-actor/public cooperation*)** | **Hybrid governance & orchestration** | **4. Afstemmen van private belangen (*multi-actor / private negotiation*)** |

- The *constitutional choice situation* is that of establishing (or changing or terminating) a regime of positions and rules that allows collective choice in the making of (certain types of) heat grids at the afore collective choice level. As said, our default assumption is one of absence of instructions from this level, so 'on the ground' dominance, primarily at operational level, will determine the collective choice setting. We already saw that especially in type 3. and 4. situations this approach may provide some guidance, but stakeholders may still face a wicked deadlock, calling for a constitutional level intervention. We should add to this that in type 1. and 2. situations, there may be concerns at constitutional level about macro-effectiveness and efficiency of the preferred operational preferences and consequential collective choice pattern, as well as on the legitimacy and lawfulness of these (especially related to single actor legal and/or economic dominance), that could give rise to interventions which pre-structure the collective choice arena. At constitutional level, certain ideal type grids or infrastructures could be formally/legally banned or restricted while others could be favoured; directly (e.g. no private monopoly over supply and distribution) or indirectly (e.g. reliability requirements excluding the possibility of having only one supplier) – causing a reframing of operational ambitions, but also a resetting of collective choice rules. Constitutional choice could also declare dominance of some party within a type 3. or 4. Situation, such as by a public task provision (in type 3. – which could trigger political and perhaps legal accountability) or a targeted subsidy-arrangement (in type 4 – which would pull in public power, through appointing a particular office with the power to subsidize) – or by otherwise channelling behaviour by obligations and/or facilitation, thereby influencing the governance mode and lead positions in orchestration of collective choice decision-making.

## 6. Institutional environment

The possibility of constitutional interventions, to correct failure at operational and/or collective choice levels (to secure effective, efficient, legitimate and lawful heat grids or infrastructures) is typically one which takes a general and abstract legislative form (for all cases, by anyone involved, to set-up and operate grids and infrastructures.

Typically this is what we see when markets fail (because of dominance or lack thereof – the latter sometimes for the understandable reason of high sunk costs) and governments seek to remedy such failure – but equally public cooperation failure could call for a remedy instigated at constitutional level – such as by declaring or creating dominance to so invoke a particular type of orchestration.

This brings us back to the example of the Dutch Heat Act. In the above we stated that presently this Act does not prescribe a public or a public regime, not does it insist on a high or low level of technical

complexity as regards grid or infrastructure functionality. Perhaps we should now 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 grids), but there are safeguards concerning maximum nationwide tariffs (set by the Dutch office of fair trade & consumer protection – the ACM), the use of contracting powers (the right to shut off, compensation for service interruptions, and regulations concerning monitoring & measuring and conflict resolution. In case of large scale grids or infrastructures, of more than 10 users and producing more heat than 10.000 Gigajoule/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 can be regarded as an instance of a particular type of legal institution; that of a regulated market, being a hybrid institutional environment placed between the ideal type environments of 'public hierarchy' and that of 'competitive markets'. Building upon work done by Klok & Van Heffen (2000) and Ruiter (2004), Heldeweg & Lammers (2014) have explained how such legal institutions connect with the image of interconnected action situations at various institutional level (as in Ostrom's '*IAD-Framework*'). Legal institutions are prescriptive regimes of rules about behaviour patterns such as contracts, property, eminent domain, public authority, and legal persons, which in reality present themselves as if they are facts that project opportunities and constraints to human activities and interactions. Institutional environments, such as public hierarchies (of municipalities, provinces, states, and supranational entities such as the EU), competitive markets (of foodstuffs, holidays, or public services) and civil networks (ranging from churches to trade unions and from neighbourhood watch organizations to international NGOs) may also be regarded as legal institutions. The *describe* behaviour patterns that may exist in practice and *prescribe* how these can be instantiated, changed and terminated, and what rules apply while they exist. Thus they add a normative dimension to patterns of collective choice and/or operational action situations. This is exactly what the Dutch Heat Act is doing with respect to heat grids and infrastructures, both at operational level (e.g. though permit requirements) and at collective choice level (e.g. decision-making on permits, but also constraints on contracting). The latter possibility could clearly impact on the freedom of stakeholders to self-determine the (ideal type) form of orchestration in governance of decision-making that is to lead to new or improved heat grids and infrastructures – but hopefully, upon occasion, also on their inability to break out of a deadlock. In doing so the Heat Act can project and prescribe a particular mode of governance orchestration. Ideal-typically (a.) public interest and 'voice' driven command & control, following public hierarchy, (b.) private interest and 'exit' driven exchange in competitive markets, and (c.) collective/common interest and loyalty driven cooperation in civil networks (Heldeweg & Sanders, 2013). Note that civil networks are not seen here as hybrids between 'government' and 'market', but as a pure mode, with its own distinct characteristics (Thompson, Frances, Levaĉić & Mitchell, 1991). Thus one can envisage bi- and trichotomies as hybrids between two or all three pure institutional environments, with fitting hybrid forms of regulation, including of collective choice orchestration. Regulated markets are an example of a hybrid between competitive market and public hierarchy, with government (hierarchically) setting particular boundaries at constitutional level, for contracting at collective choice level. So far we did not mention the possibility of community/NGO initiatives towards establishing heat grids, but of course it is, at least theoretically, possible that they are in fact the private stakeholders, and so one could also image regulated networks as a hybrid arrangement, for instance in the form of government providing the means and one of more NGOs being the project entrepreneurs.

What we did see is that the Dutch Heat Act does present a regulated market, constraining contracting (which mainly concerns the operational situation of a grid or 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 & 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 paper, 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 (Warmte Visie; 2015) of the Dutch Ministry of Economic Affairs it becomes clear that the central Dutch government is considering specific interventions towards a more distinct positioning of certain stakeholders, to further effective orchestration within the regulated heat market – i.e. taking constitutional level decisions to change the institutional environment in which collective choices are to be made towards establishing heat grids and 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.* (2015, 18)[2]

In 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 grid and (thus) allowing a local 'future proof' deliberation on choosing between gas and heat grids.
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 grid will be established and if, in case of new resident housing, there will be an obligation to connect to a heat grid.* (2015, 19)[3]

And 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 grids 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 grid, 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 grid. 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."* (2015, 21)[4]

It is interesting to see that a greater complexity of the grid functionality is propagated in combination with a greater public responsibility in orchestrating. This begs the question whether this is a first step towards a stronger public regime, i.e. greater hierarchy. In any case, we see a movement in the direction of collective choice type 3, within the hybrid area of the triangle 2-3-4 (of Table 3), 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 grid operator manages the heat grid or 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).* (2015, 21-22)[5]

Clearly 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 grids and infrastructures even further in the direction of a public-hierarchical (type 1) direction – away from private self-regulation – making orchestration a more forceful instrument (but possibly no less complex).
Meanwhile there are indications that the Minister is also considering a less compulsive 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."* (2015, 23)[6]

These citations demonstrate that the Dutch national government is looking for a more prominent mode of orchestration which brings, within a regulated market, a stronger public dominance as regards taking initiatives towards establishing heat grids and infrastructures. The question remains if the Heat Vision will lead to a change in the Heat Act that will streamline orchestration and if this will leave (much) room for a pallet of operational level-driven stakeholder orchestration.

**7. Finally: movements in governance of heat grids and infrastructures**

The project for a 'north branch' of the heat grid of Arnhem ('Noordtak warmtenet Arnhem') is an example of how the province of Gelderland is active in supporting the energy transition. 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. From the viewpoint of the typology of operational settings of grids and infrastructures, one may explain such deadlock and consider options for reducing complexity and find a way forward.

Additional research is needed to more systematically assess whether there are patterns in preferences concerning governance of heat grids and infrastructures and how they impact the success rate of establishing such grids and infrastructures. This research should also look into how, aside from the bottom-up process of operational 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 grids and infrastructures.

This article presents a first step in providing a model that can be helpful both in analysing heat grid projects (and deadlocks), but also to ultimately provide guideline for the design or improvement of decision-making processes.

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[1] This operationalization is taken from: Montfort, van C. (2009), Besturen van het onbekende. Goed bestuur bij publiek-private arrangementen. Den Haag: Boom Lemma.

[2] Author's 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."

[3] Author's 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"

[4] Author's 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."

[5] Author's 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)."

[6] Author'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 ondermeer de te ontwikkelen warmteplannen en restwarmteprojecten."