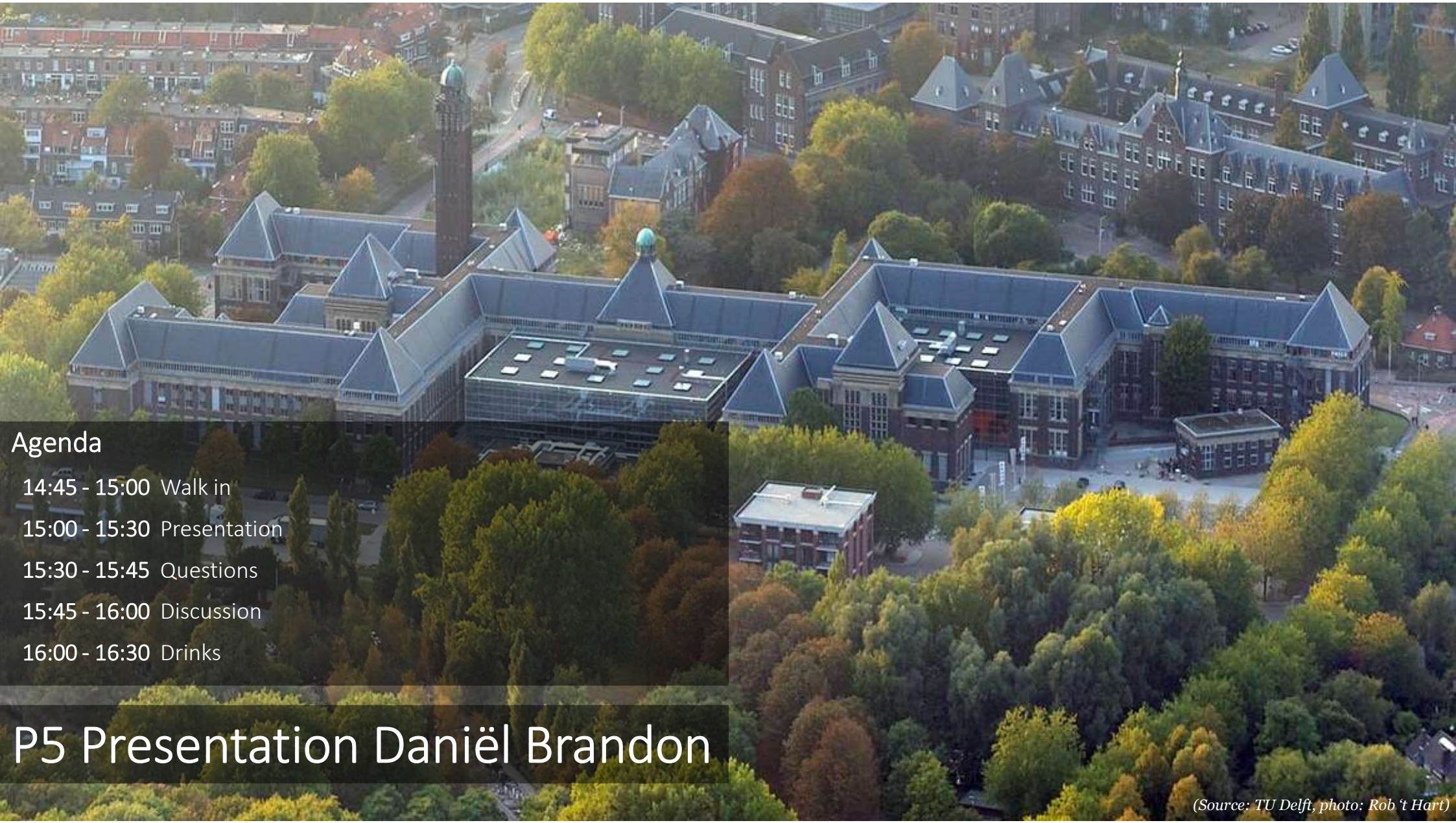


Agenda

14:45 - 15:00 Walk in

15:00 - 15:30 Presentation

15:30 - 15:45 Questions

15:45 - 16:00 Discussion

16:00 - 16:30 Drinks

P5 Presentation Daniël Brandon

(Source: TU Delft, photo: Rob 't Hart)

Upscaling the residential heat provision towards the district scale

Managing geothermal district heating development

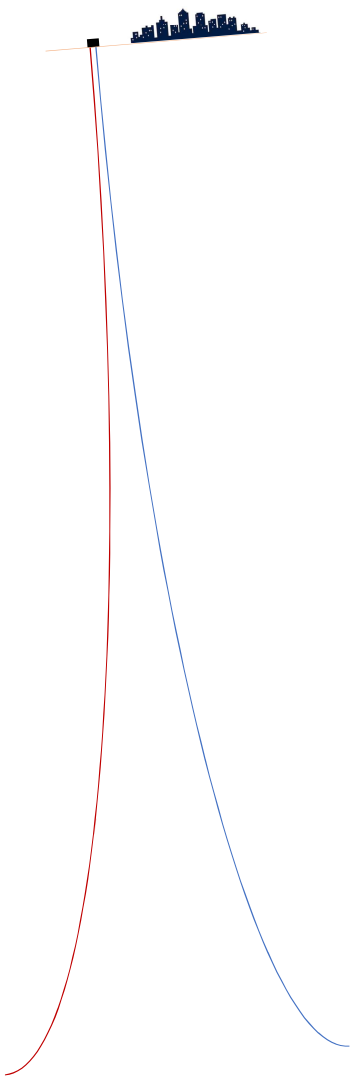
P5

6-11-2019

Daniël C. Brandon

Delft University of Technology

Master of Science in Architecture, Urbanism and Building Sciences track Management in the Built Environment



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- Research gap, problem & aim	6
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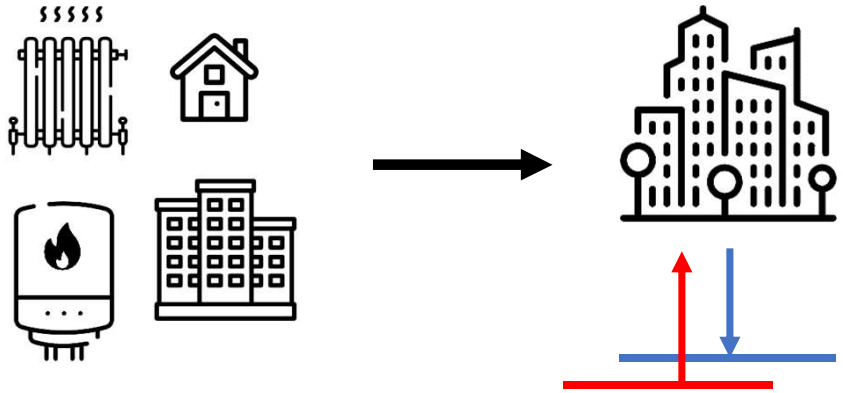
A picture of a geothermal drilling rig (Source: Energieoverheid, 2016)

Introduction

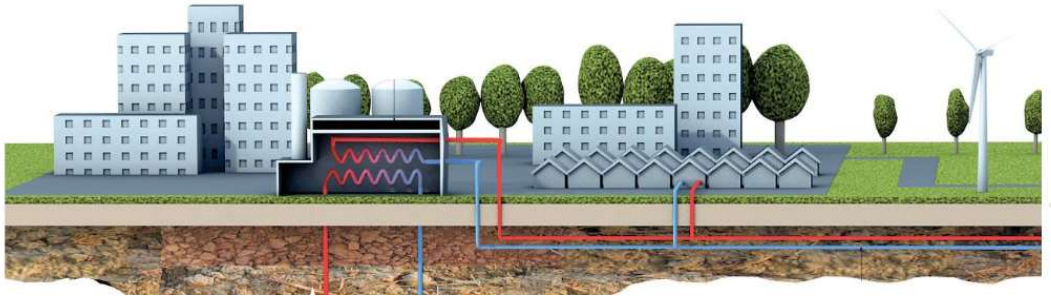
Definitions

Upscaling the <u>residential heat provision</u> towards the <u>district scale</u>

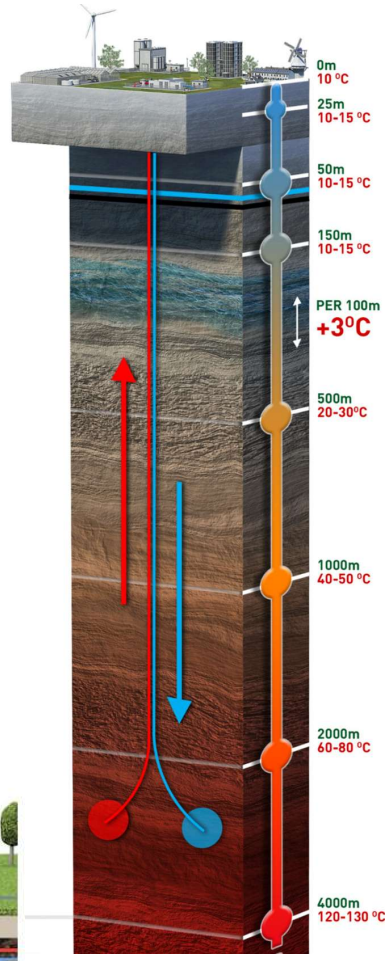
Managing <u>geothermal</u> district <u>heat</u>ing development



Source: flaticon.com



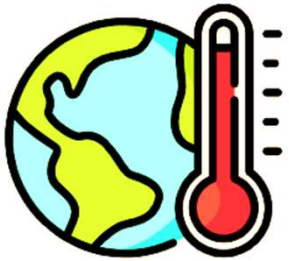
Source: NRC (2019)



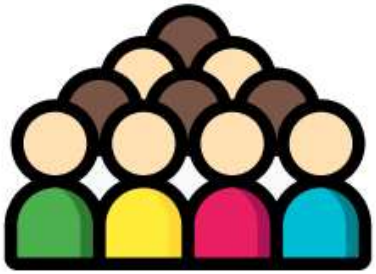
Source: EBN (2018)

Introduction

Trends



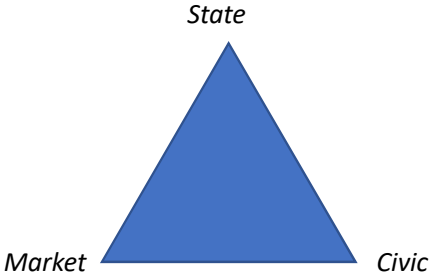
Climate change



Growing population & energy demand

Political pressure

Alternatives for residential heating



Changing roles

Sources: flaticon.com

Introduction

Research problem, aim & question

Research problem and gap

- Important trends that demand for energy strategies and heating alternatives;
- Complexity in networks of various actors, scales and disciplines in urban area development according to Petersen & Heurkens (2018).
- Little literature found on the topic of upscaling the residential heat provision towards the district scale with renewable energy as source where the *existing* built environment and infrastructure is adapted in the Netherlands;

Research aim

- Gain understanding in local approaches and efforts in Geothermal District Heating development (GDHD)

- Clarify, gather and model managerial roles of public, private and civic actors in GDHD;

Main research question

How do public, private and civic actors manage upscaling residential heat-generating facilities to the district scale in the built environment in the Netherlands?

Introduction

Research questions

Main research question

How do public, private and civic actors manage upscaling residential heat-generating facilities to district scale in the built environment in the Netherlands?

Research sub questions

1. What are the managerial roles & dependencies of public, private and civic actors in implementing energy policies, district scale heat-generating facilities and infrastructure in the literature on urban development of built environment in the Netherlands?

2. What are the managerial roles & dependencies of public, private and civic actors in implementing energy policies, district scale heat-generating facilities and infrastructure in the practice of urban development in the built environment in the Netherlands?

3. What managerial roles are effective for upscaling residential heat-generating facilities and infrastructure to a district scale in the Netherlands?

Methodology

Data collection instruments and processing tools

Roles	Aspects	Variables
Managerial	Project management	Initiating, designing, planning, operating
	Process management	Negotiating, decision-making, communicating
	Management tools	Shaping, regulating, stimulating and capacity building
	Management resources	Land, capital, knowledge

Table 1 The managerial roles in urban area development (Source: Heurkens & Hobma, 2014, own edit).

Data collection instruments

1. Literature;
2. Actor analysis (Koppenjan & Klijn, 2004);
3. Case study, revelatory cases (Bryman, 2002; Yin, 2009).

Processing tools

1. Framework of managerial roles (Heurkens & Hobma, 2014);
2. Event-sequence model (Adams & Tiesdell, 2012; p75);
3. Agency model (Adams & Tiesdell, 2012; pp 75-76);
4. Cross-case analytical methods (Yin, 2009);
5. Expert assessment (Bryman, 2012, p.171; Hsu & Sandford, 2007; Jones, 1975);

Methodology

Selection

Category	Source	Selection criteria*				
		1	2	3	4	5
2nd generation Pressurised high-temperature water systems (>100 C)	Industrial waste heat	x	x		x	x
	Biomass		x		x	x
	Combined Heat Plant		x		x	x
	(Ultra) Deep geothermal	x	x		x	
3th generation Pressurised medium-temperature water systems (<100 C)	Industrial waste heat	x	x	x	x	x
	Waste-to-energy		x	x	x	x
	Biomass		x		x	x
	Combined Heat Plant		x		x	x
	Deep geothermal	x	x	x	x	x
4th generation: Low-temperature water systems (~30-70 C)	Low-temperature waste heat (data centers, greenhouses,	x	x	x	x	x
	supermarkets, etc.)	x		x	x	x
	Water (Sewage)					
	Deep and Shallow geothermal	x	x	x	x	x

Table 2 *An overview of alternative energy purposes for heating dwellings and selection criteria (Source: Energy Storage, 2018; Keutel, 2018, Sayegh, Jadwiszczak, Axcell, Niemierka, Bryś & Jouhara, 2018; own edit).*

1=Renewable and climate neutral,
2=Scale and capacity,
3=Urban redevelopment,
4=competitiveness,
5=project phase

x = Indication for when a selection criteria is met.

Methodology

Selection

Ammerlaan

Pijnacker-Nootdorp

Geothermal plant Ammerlaan (Source: Energievastgoed, 2016)

Characteristics

- District Pijnacker-Noord in Pijnacker-Nootdorp
- First floriculture company in the Netherlands with a geothermal heat source

Haagse Aardwarmte Leyweg (HAL)

The Hague

Geothermal plant HAL (source: Energienieuws, 2017)

Characteristics

- District Southwest in The Hague
- First inner-city geothermal plant

Literature phase

Management aspects

Management aspects

How (geothermal district heating) development projects are managed can be viewed from the management aspects money, organisation, time, information and quality (MOTIQ) as mentioned in Bruil et al. (2015, p47).

Management aspect	Relevant topics
Money	lock-in costs, development costs, end-user affordability, heat sale opportunity, competitiveness of alternatives, financial risks, subsidies.
Organisation	Organisation types: line management (top-down hierarchy, with repetitive activities), project management (multidisciplinary and temporary organisation), organisation complexity, organisation fragmentation, degree of actor dependency (joint collaboration).
Time	Project duration, project planning, timing of activities between geothermal district heating development and urban development management, operating time of the geothermal well, time overruns.
Information	Dispersion of specialized information, techniques used to foster learning, information provision to tenants and homeowners, involvement of education, science and technology.
Quality	Geothermal well and location; environmental, health and safety quality; Spatial quality (utility, experience, future value); social values; steering on quality.

Table 3.4.2 Relevant topics extracted from the MOTIQ management aspects (Source: own design, based on literature findings)

Literature phase

Actor role inventory

Public actors

The State and Ministries

Province

Municipality

Private Actors

Developers

Financiers

Communities (energy cooperatives, homeowners associations)

Investors

(Heat) Corporations (Producer, transporter and distributor, storage and supplier)

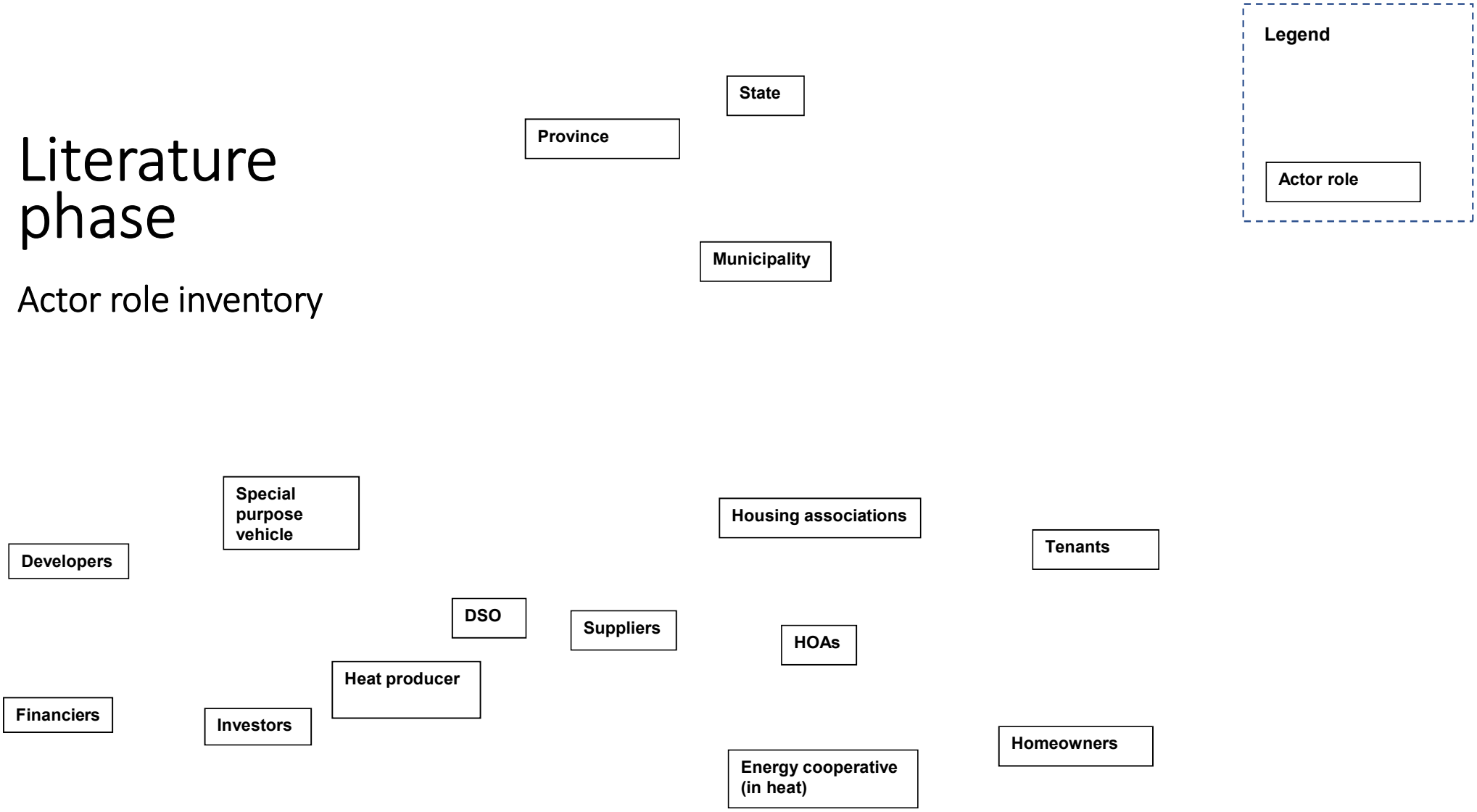
Civic actors

Single homeowners and tenants

Housing Associations

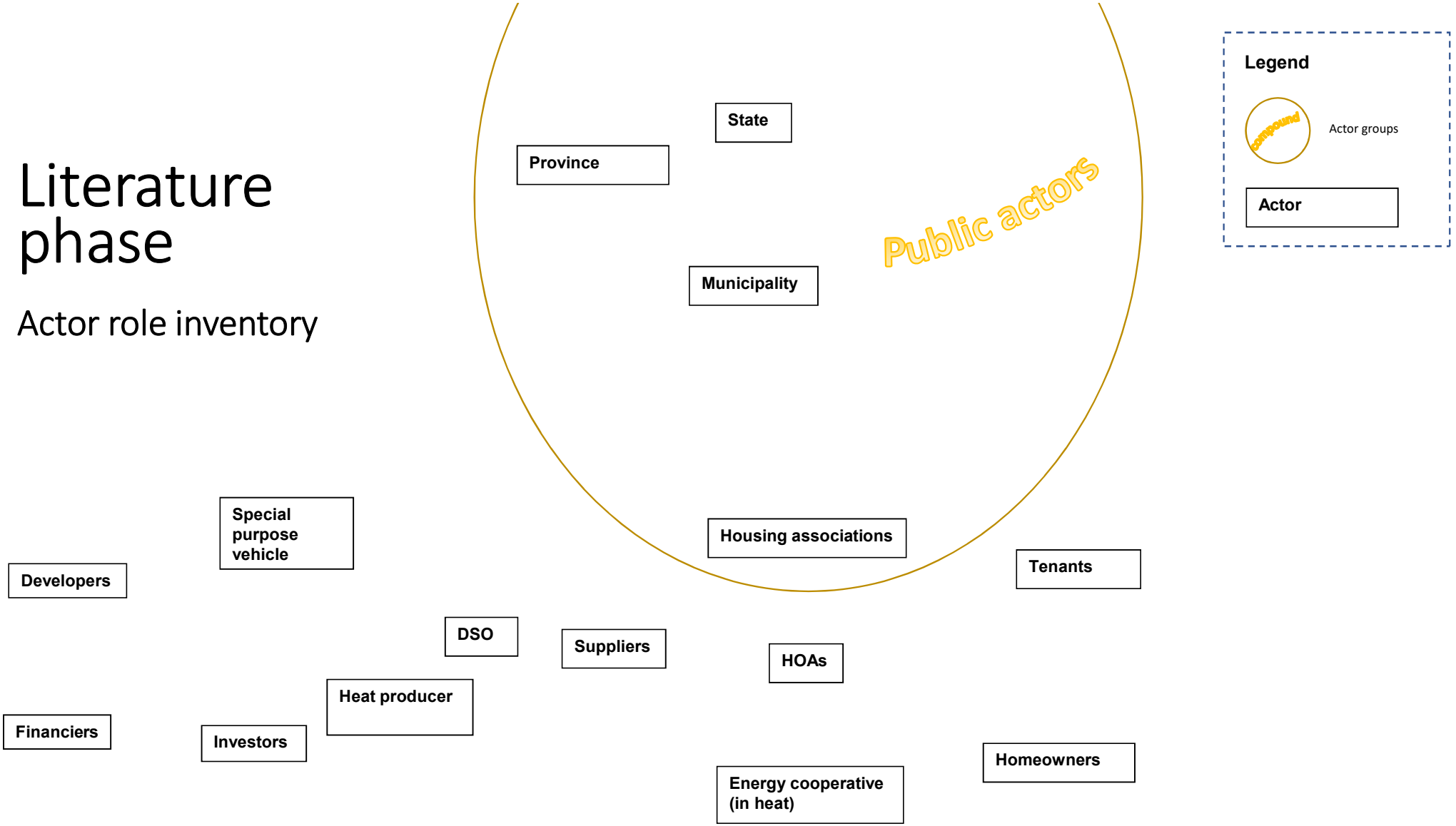
Literature phase

Actor role inventory



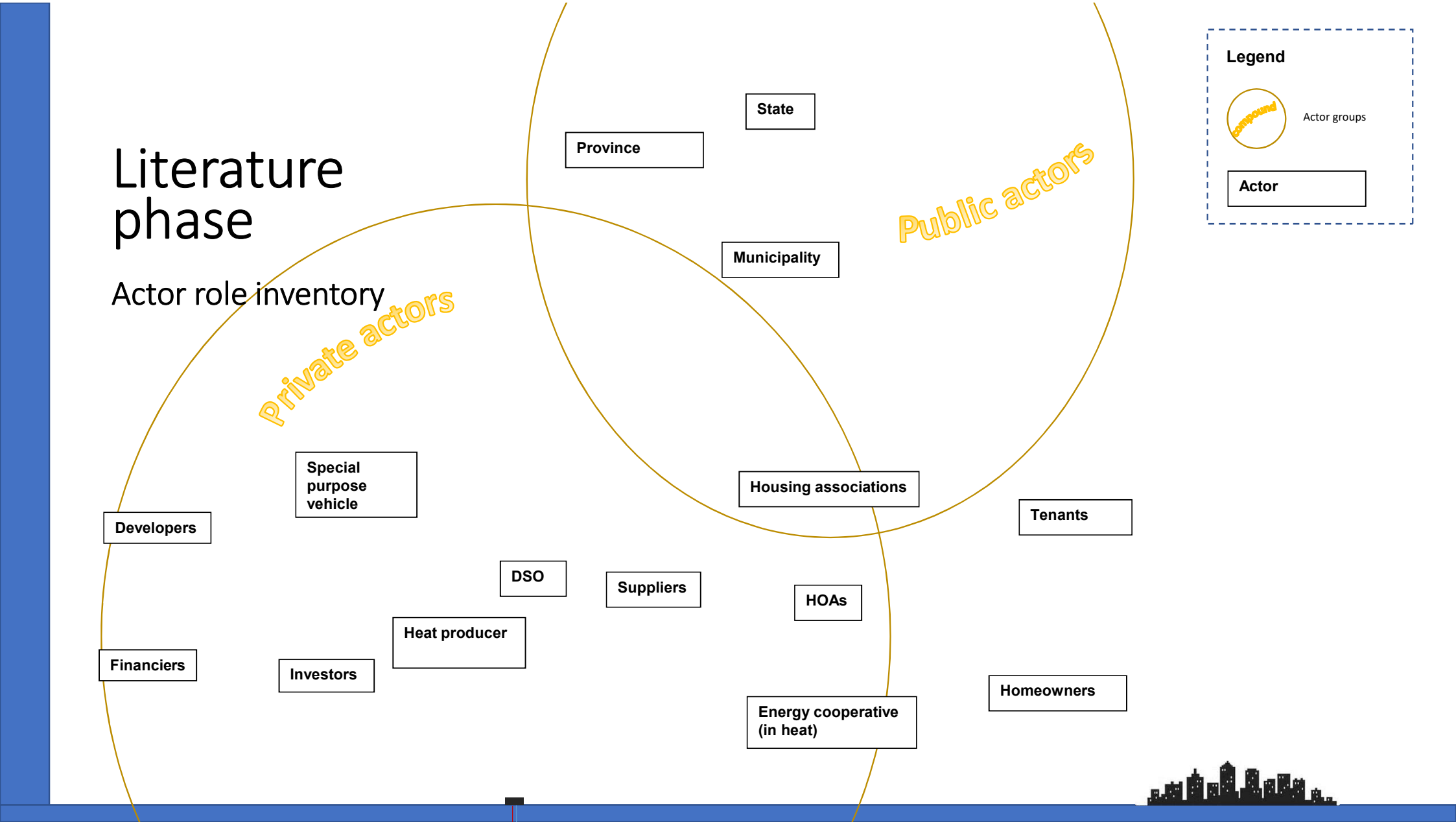
Literature phase

Actor role inventory



Literature phase

Actor role inventory



Literature phase

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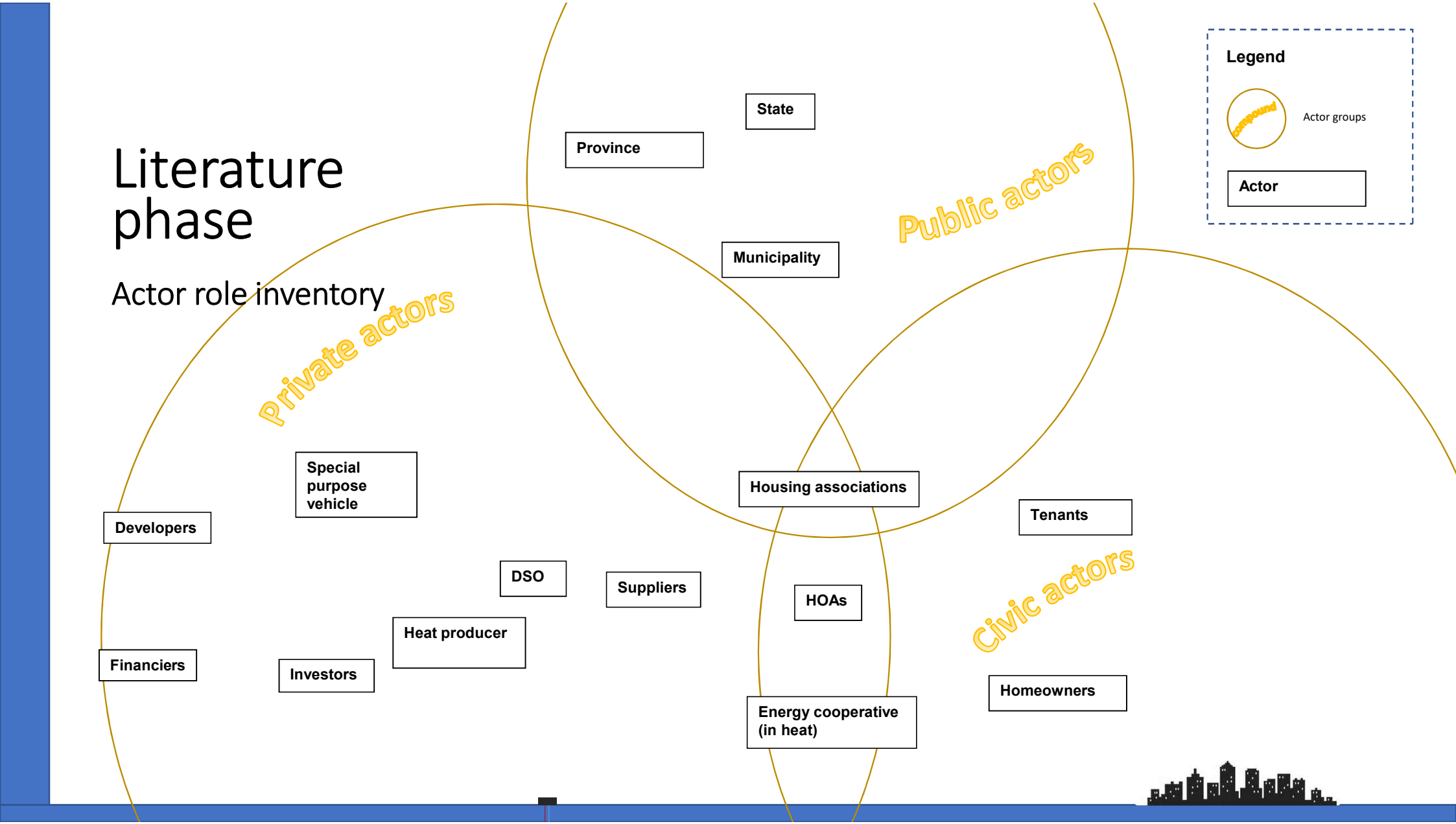
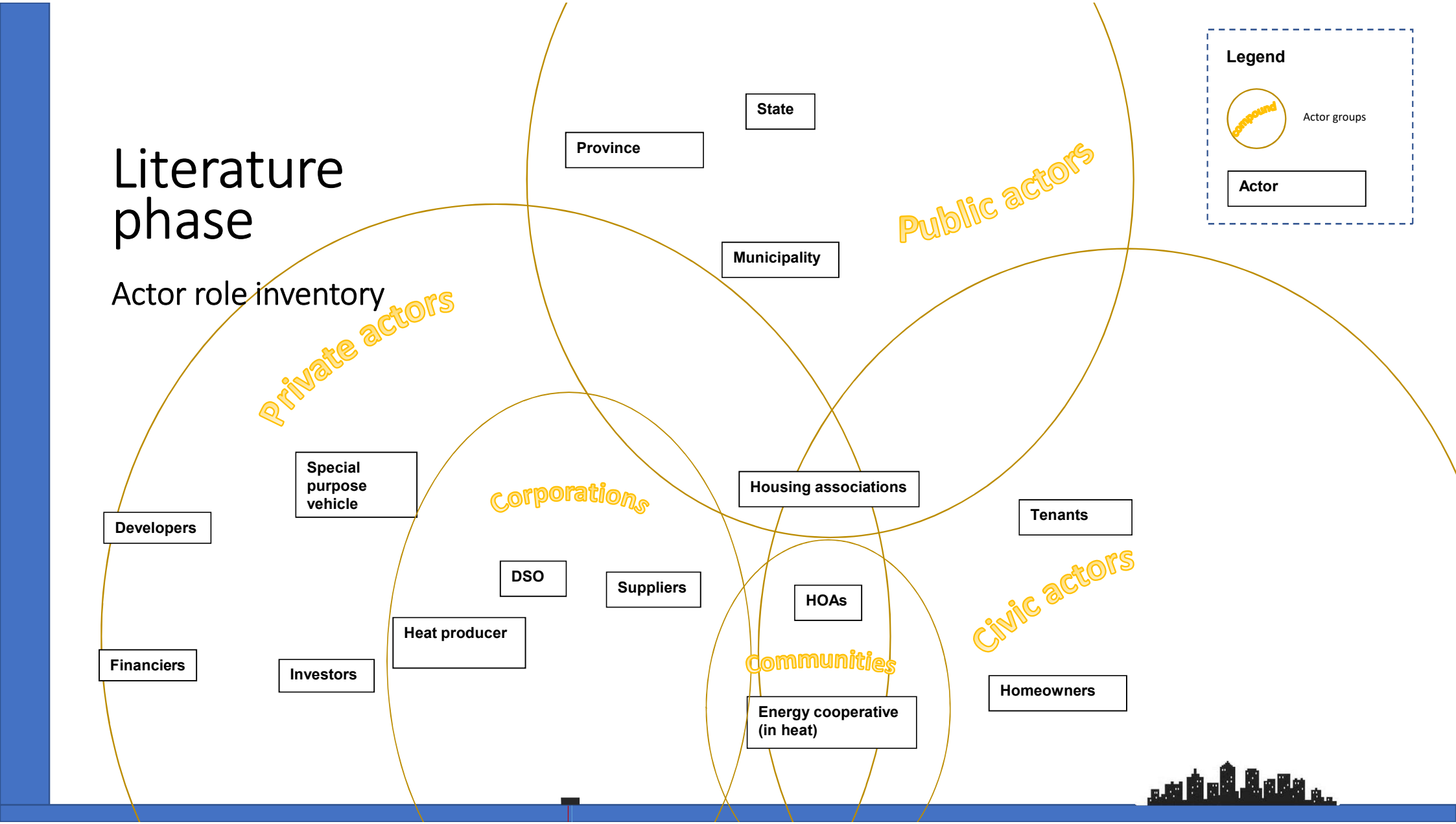


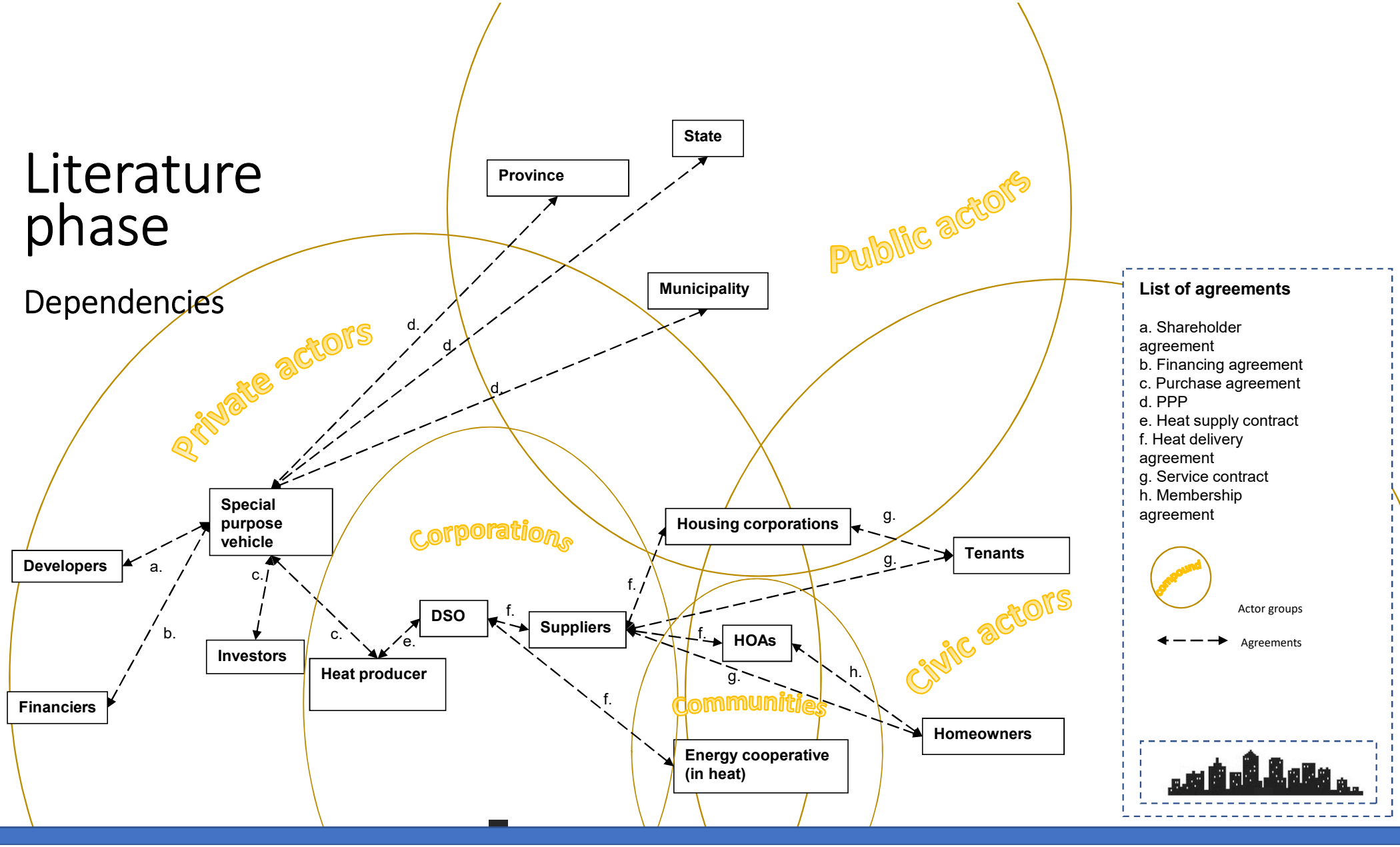
Literature phase

Actor role inventory



Literature phase

Dependencies



Literature phase

Actor role dependencies

Management tools

are at the disposal of public actors

to ‘steer’ on urban development (Adams & Tiesdell, 2012):

1. Shaping: The publications of plans, strategies and visions

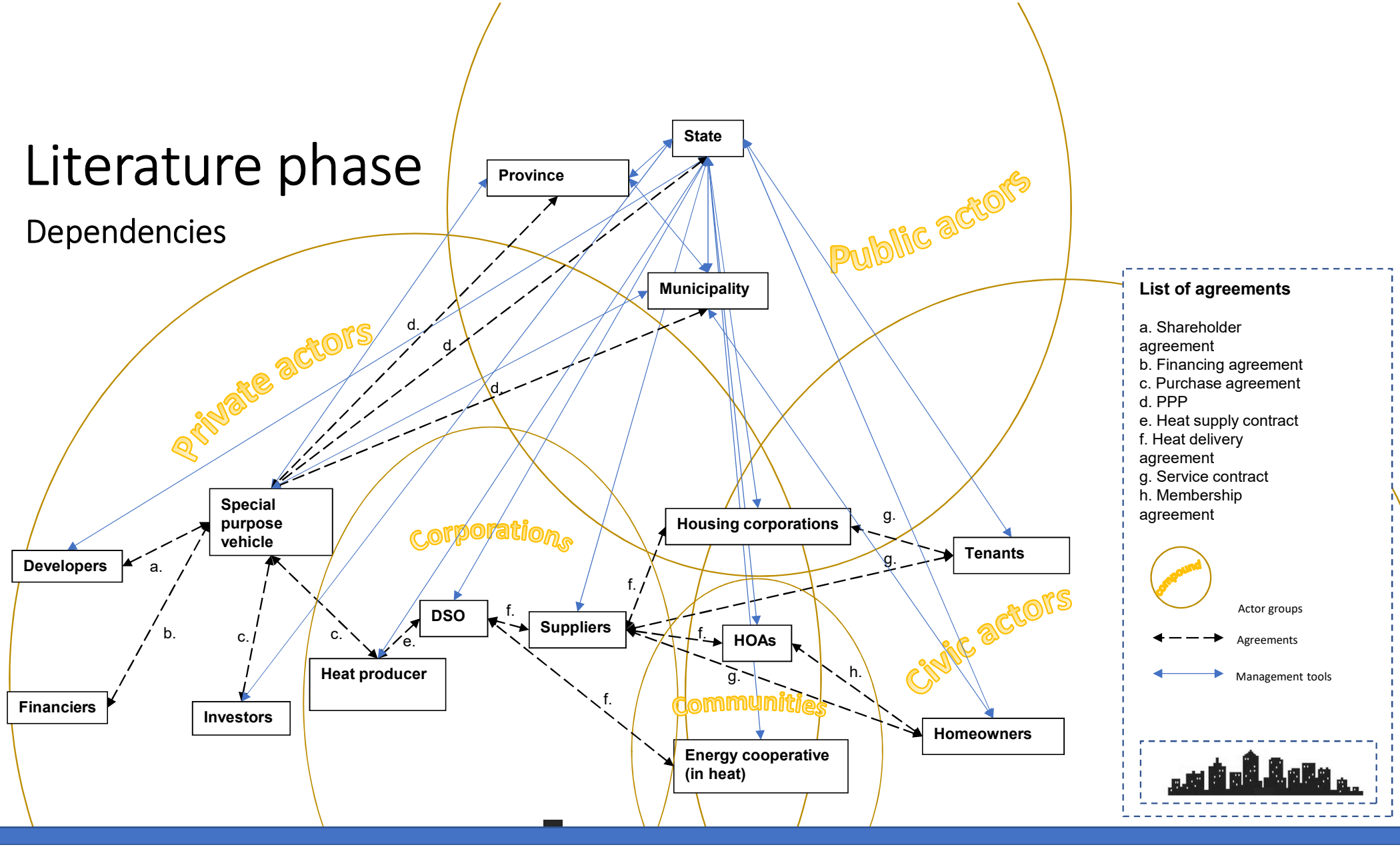
2. Regulating: Regulations such as the Spatial Planning Act, The Building Decree, Heat Act (Consumer protection), environmental law, sustainable policy.

3. Stimulating market behaviour: Stimulating the development by land acquisition, grants (subsidies) and loan guarantees

4. Building capacity: The improvement of actor relationships by providing arenas for interaction and networking […], Heurkens (2012; p87)

Literature phase

Dependencies



Literature phase

Sub conclusion

Research sub question:

What are the managerial roles & dependencies of public, private and civic actors in implementing energy policies, district scale heat-generating facilities and infrastructure in the literature on urban development of built environment in the Netherlands?

Findings from literature

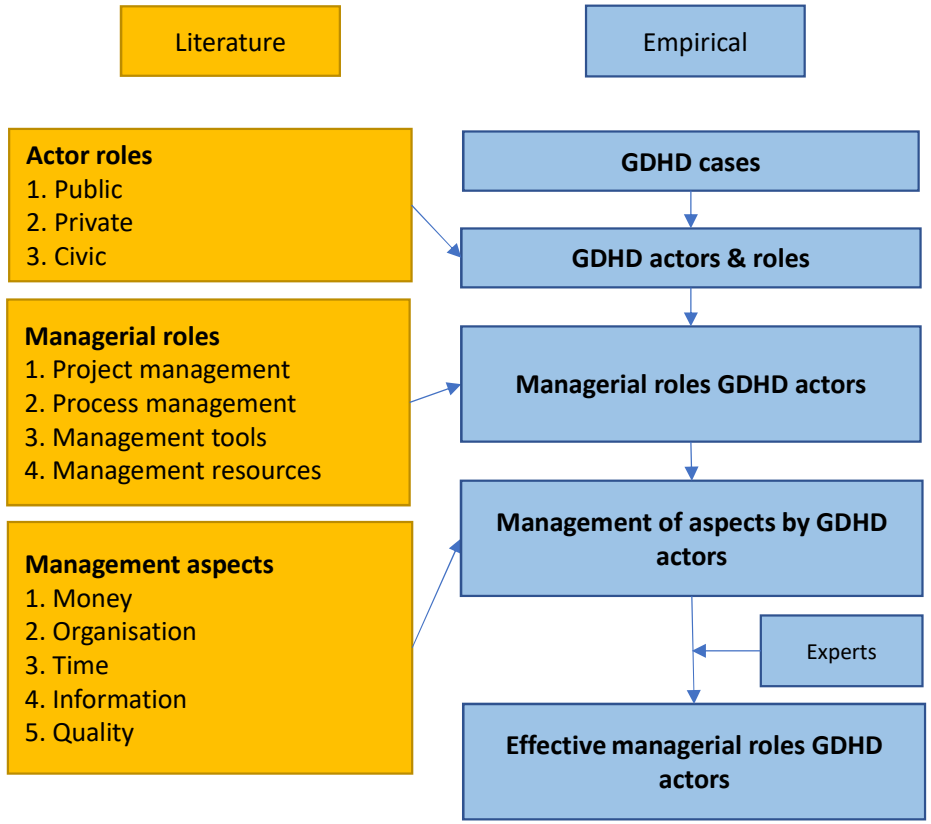
- Implementation of energy policies from different governmental levels (supra-national, national, regional, local);
- Public actor 'steering' on development through management tools (regulating, shaping, stimulating and capacity building);
- Implementation of heat-generating facilities and infrastructure requires joint efforts from all the three actor groups (public, private and civic);

Conclusion on method

- Not case specific: all possible roles and no consistent role division for the actors involved;
- Analysis of revelatory cases: literature gap on geothermal district heating development.

Methodology

Conceptual model



Empirical phase

Haagse Aardwarmte Leyweg

(Photo sources: Haagseaardwarmte.nl)

Empirical phase

Haagse Aardwarmte Leyweg

Map of The Hague

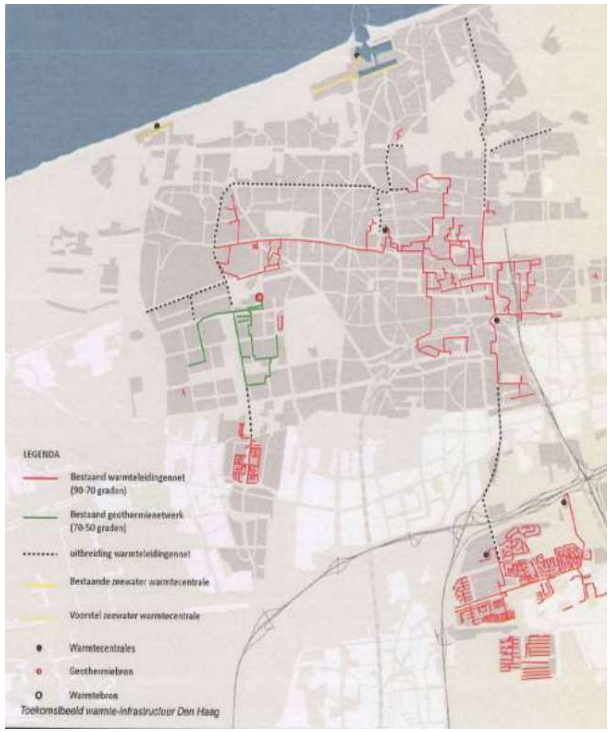


Figure 4.2.1 The existing heat infrastructure in The Hague (Source: Den Haag, 2014, p18)

Actor inventory: event-sequence table

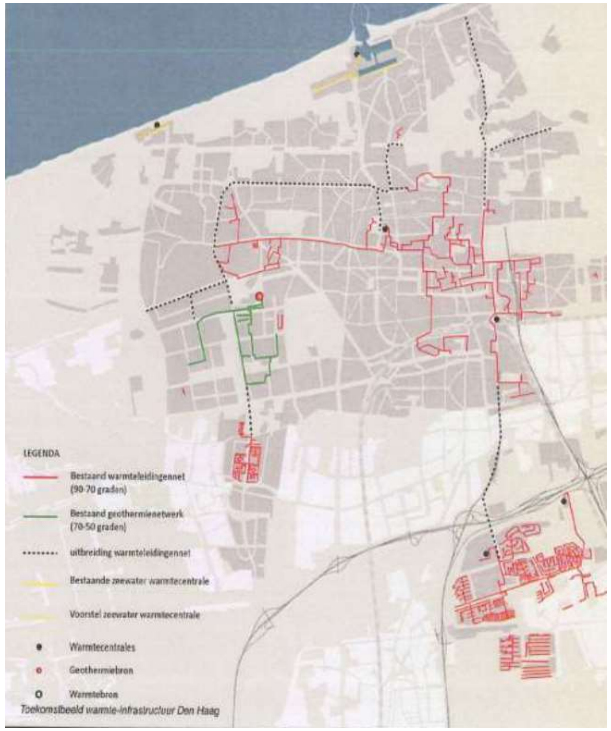
	Name	Main tasks	Time	Involved actors
1	Start-up of ADH	Development of the ADH organisation	2007	Municipality of the Hague, the housing associations Vestia, Haagwonen, Staedion and the energy corporations Eneco and E.on Benelux
2	Development of infrastructure	Development of heat infrastructure for 4000 dwellings	2009-2015	ADH and partners (Eneco: infrastructure, consultants)
3	Development of the well and infrastructure	Drilling the geothermal well, development of buildings and geothermal system components.	March – Nov 2010	ADH and development partners WPMI: well construction, Stebru Bouw: civil works heat plant, Cofely: installation components, consultants)
4	Bankruptcy	Bankruptcy declaration	August 27th, 2013	Municipality of the Hague, the housing associations Vestia, Haagwonen, Staedion and the energy corporations Eneco and E.on Benelux (ADH)
5	Delivery of heat	Heat delivery from the gas turbine	2012-now	Eneco, Uniper, end-users
6	Project relaunch	Redevelopment of the ADH project	September 2015	Municipality of The Hague, Energiefonds Den Haag (ED).
7	Takeover	Well acquisition	2016	Official receiver (curator) of ADH, HAL
8	Planning	Licencing, engineering and cleaning wells	December 2018 – August 2019	HAL, PEP, Hydreco Geomec
9	Realisation	Construction to connect to the grid, supervision and monitoring	August 2018 – January 2020	Hydreco Geomec
10	Operation	Start up and operation of the geothermal well	Feb 2020 (Planned)	Hydreco Geomec, Eneco

Table 4.2 An overview of the steps that were taken in HAL project (Sources: B. van Dun, personal communication, march 26, 2019; Gemeente Den Haag, 2016a&2016b; Aardwarmte Den Haag, 2011; Schoof, 2011).

Empirical phase

Haagse Aardwarmte Leyweg

Map of The Hague



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Empirical phase

Haagse Aardwarmte Leyweg

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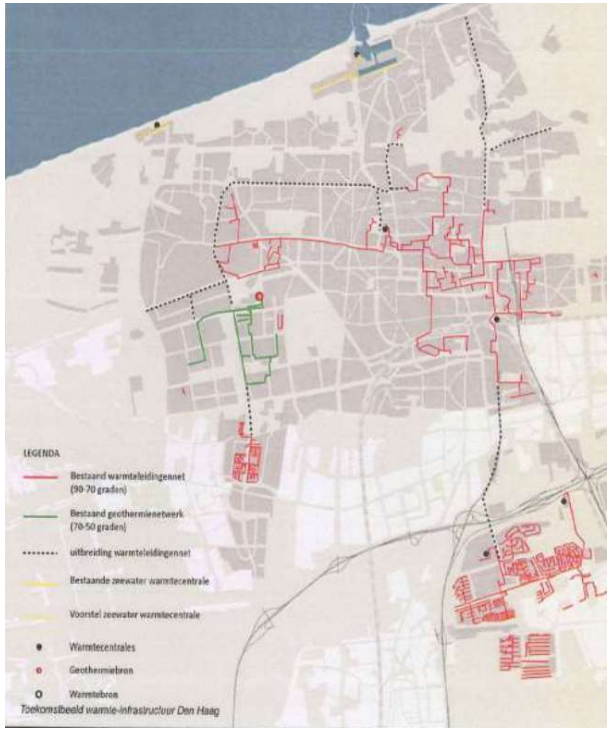

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Empirical phase

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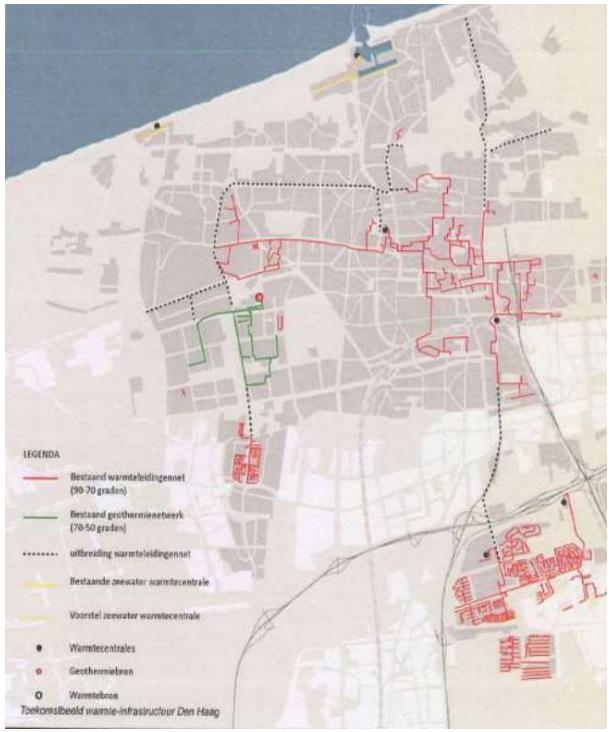

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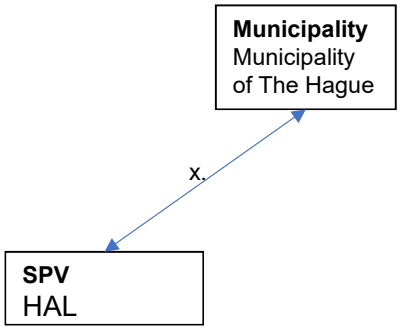
Empirical phase

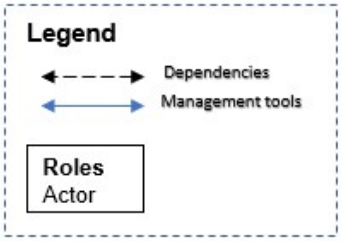
Haagse Aardwarmte Leyweg

Actor dependencies



Management tools
w. Regulatory: Environmental permit assessment (w1), Extraction licencing (w2);
x. Shaping: Heat plan & intentional development plans;
y. Capacity building: networking (y1) and information provision (y2);
z. Stimulating: Development subsidy (z1),Capital-raising (z2), producing subsidy (z3);

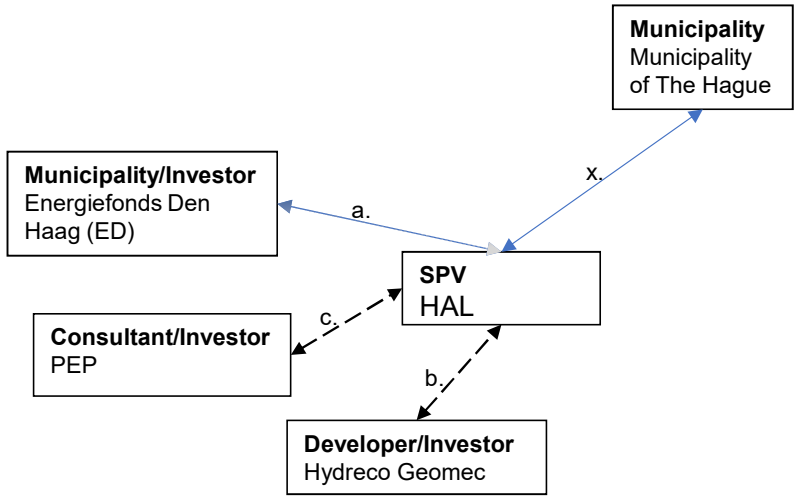
Agreements
a. Shareholder agreement
b. Shareholder and service agreement;
c. Consultancy and shareholder agreement;
d. Financing agreement;
f. Consultancy;
h. Heat delivery contract
j. Building contract;
l-n. Heat supply agreement
o. heat supply agreement



Empirical phase

Haagse Aardwarmte Leyweg

Actor dependencies



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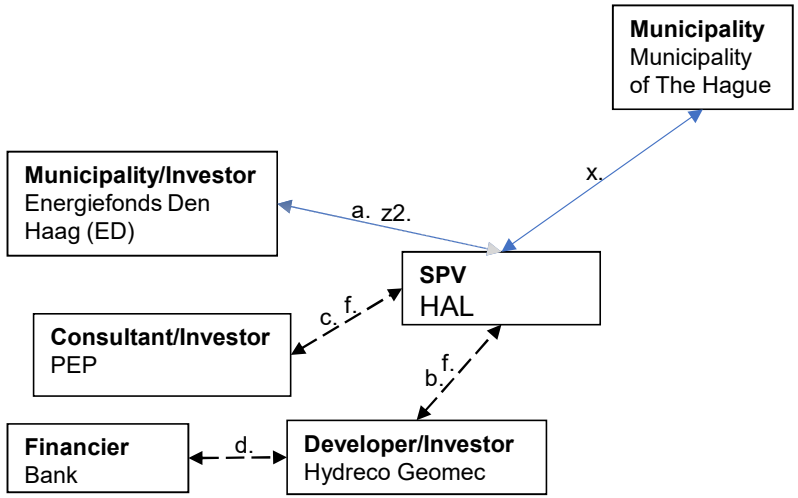
Legend
Dependencies
Management tools
Roles
Actor

Empirical phase

Haagse Aardwarmte Leyweg

Actor dependencies



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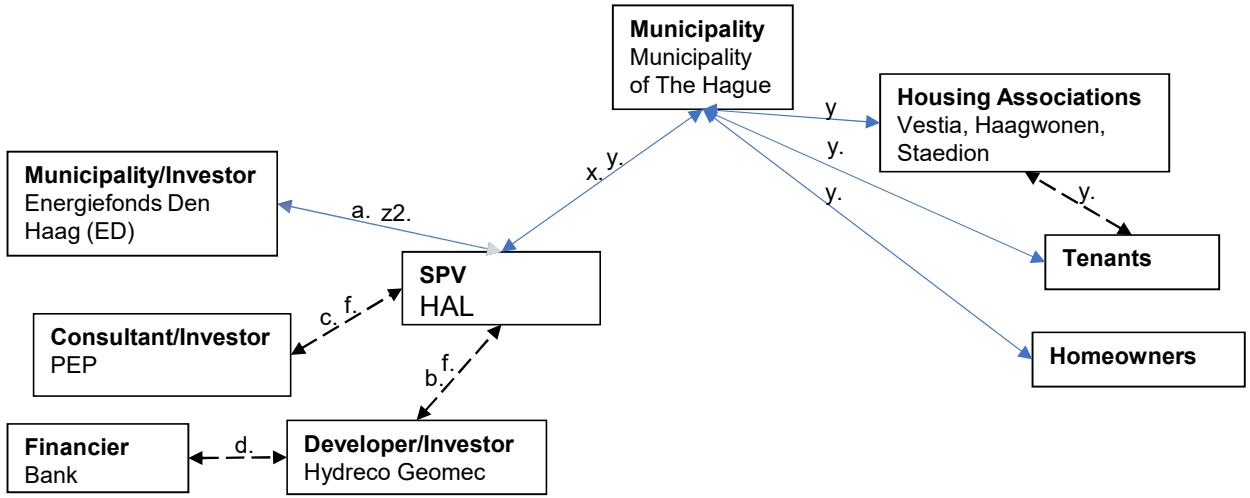
Legend
Dependencies
Management tools
Roles
Actor

Empirical phase

Haagse Aardwarmte Leyweg

Actor dependencies



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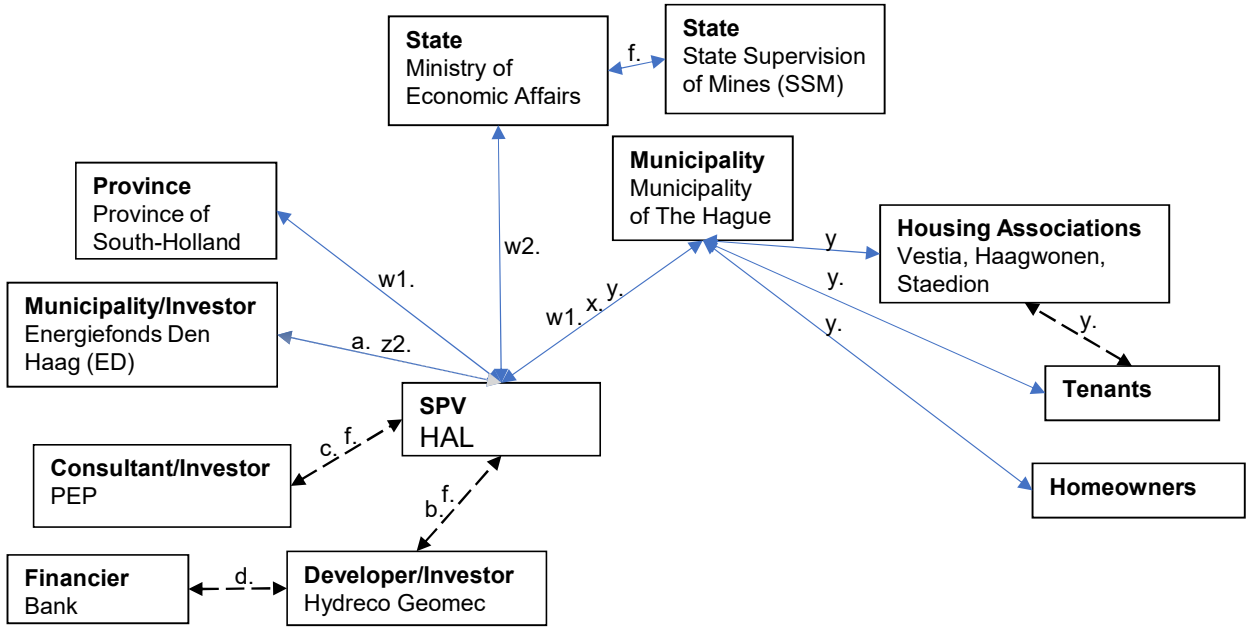

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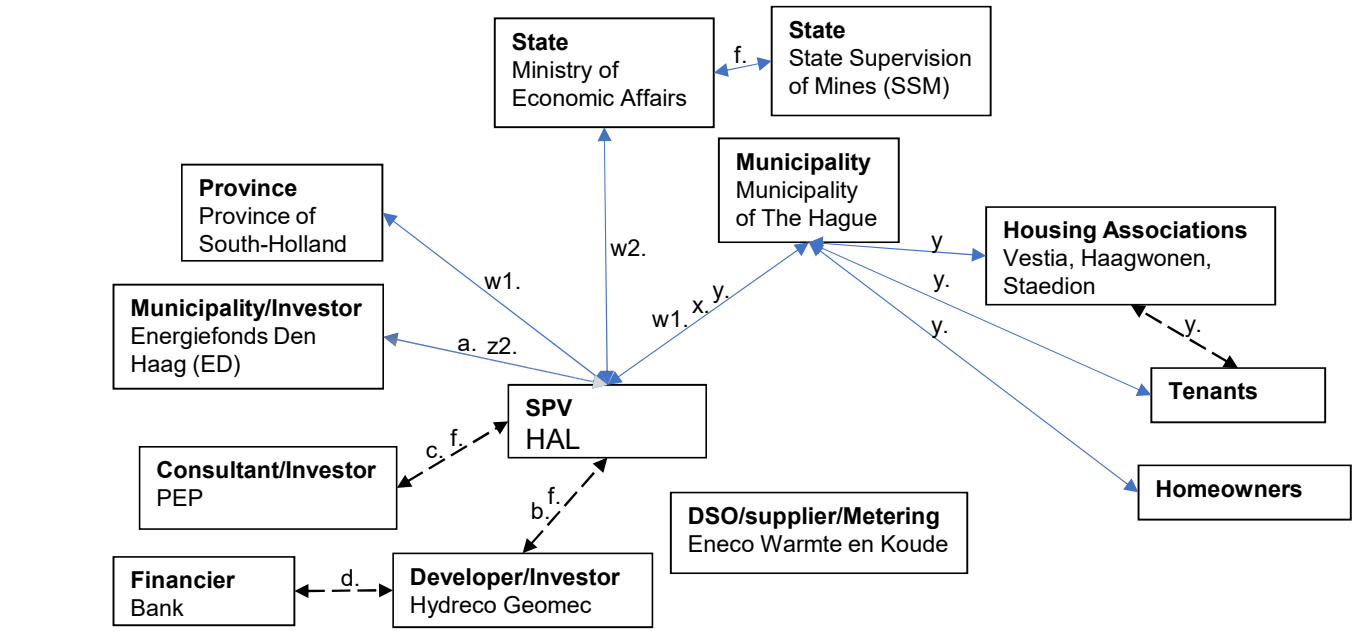

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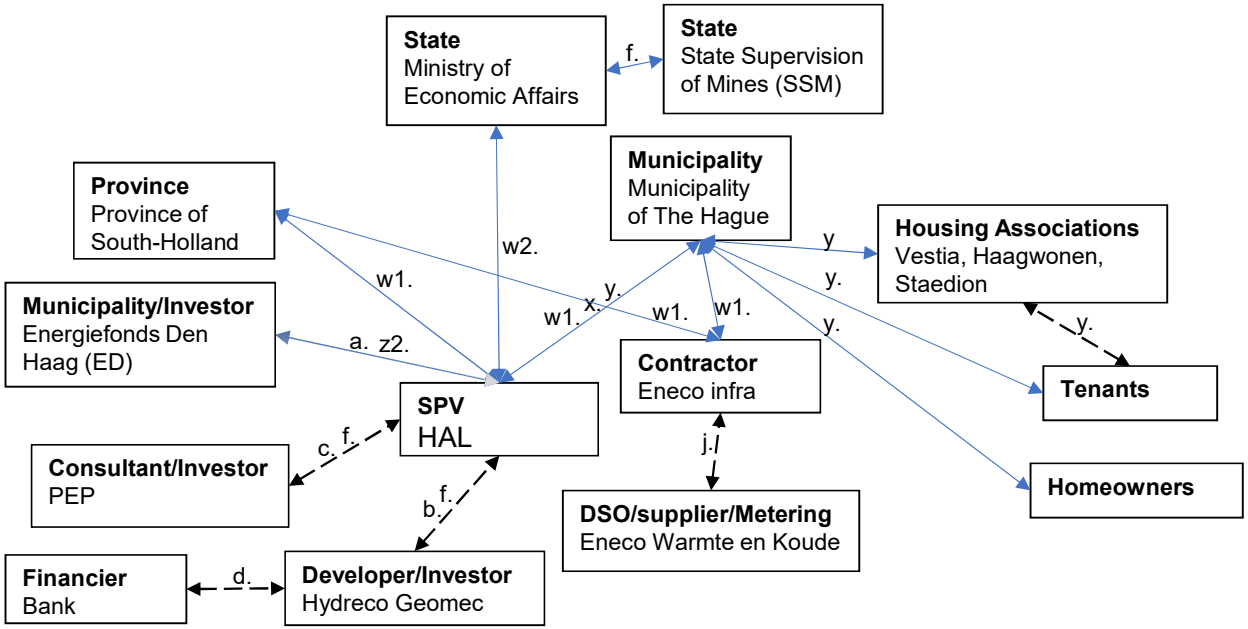

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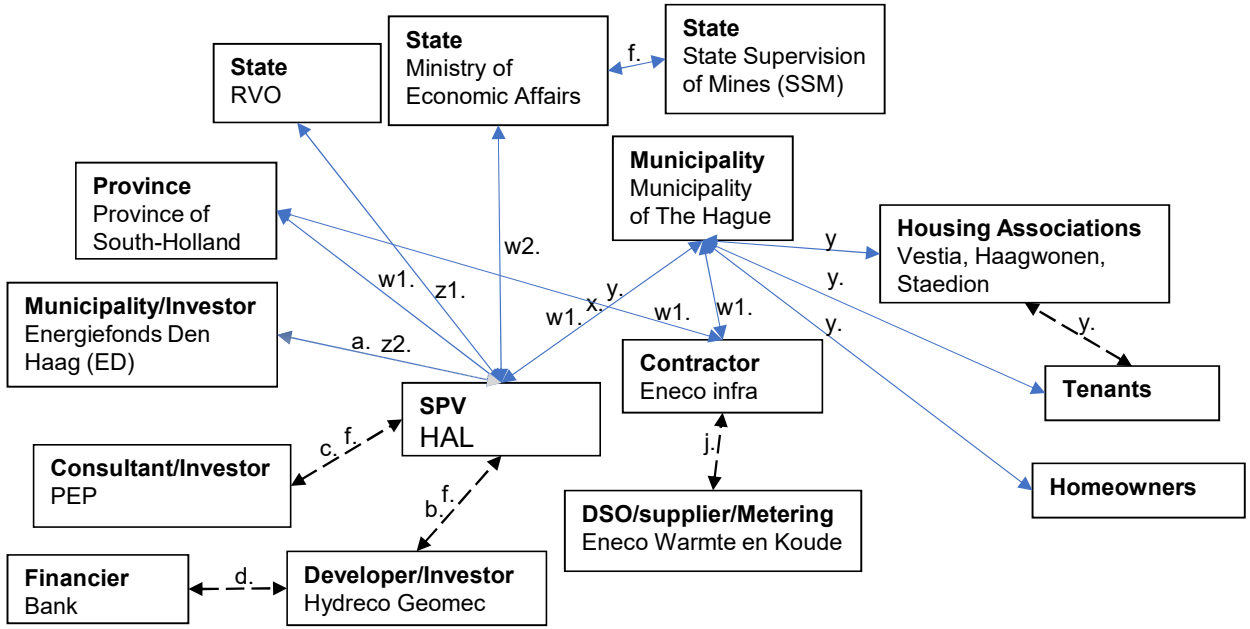

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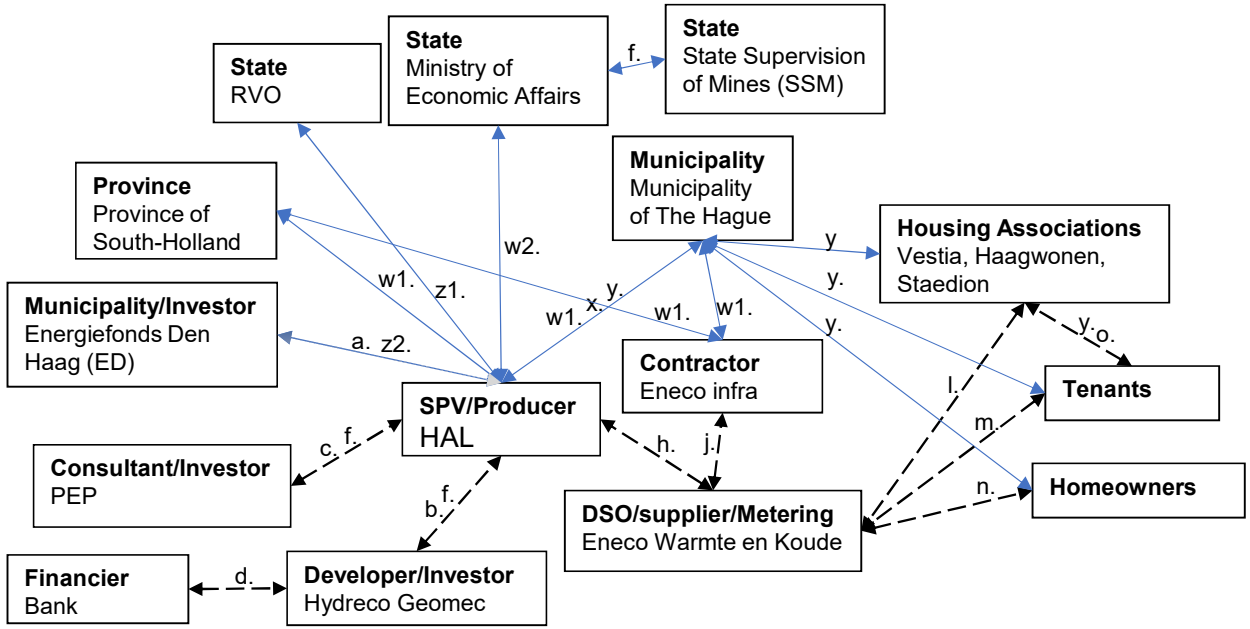

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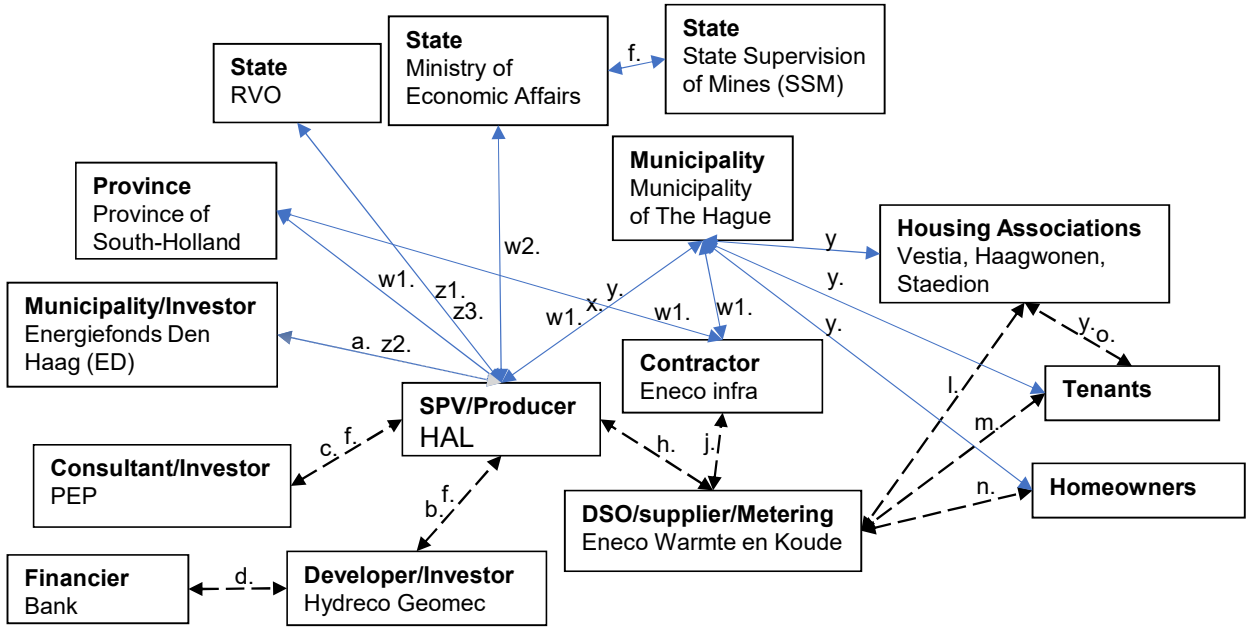

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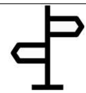
Cross-case analysis

Project	 Ammerlaan-TGI	 Haagse Aardwarmte Leyweg (HAL)	 Similarities	 Differences
Money	- The *development costs* of the geothermal well came out higher due to unexpected cost for extraction plan amplification demanded by the State Supervision on the Mines (SSM). - There was a high certainty about the *heat sale opportunity* since Ammerlaan would use the it for its own greenhouses. A benchmark showed that the development costs outweighed the costs for natural gas for heating. - The expansion to the apartment buildings of Rondom Wonen, school, sport complex and adjacent greenhouses meant more *heat sales and subsidies* for Ammerlaan. Although the *development costs* for the development of the geothermal well were sunk, Ammerlaan had to consider the extra investment costs belonging to laying down heating infrastructure. - The State body RVO introduced the SDE subsidy for sustainable energy production in 2008 (Beterduurzaam, 2019) and introduced the Market introduction for energy innovations subsidy in 2011 (RVO, 2011). Both were used by Ammerlaan for the development of the geothermal well. - The *development costs* for the housing association were too high and would not fit in the budget of the housing association. The budget allocation of the of the Stadsgewest Haaglanden subsidy and an EFRO-subsidy was made possible by the Municipal Council of Pijnacker-Nootdorp **(4.1.2)**. If the two *subsidies* did not cover 100% of the *development costs*, the apartments of the housing association would not have been not connected to the geothermal district heating. - The *financial risk* of the development was spread over the involved actors. The developer of the geothermal well **(4.1.1)** was bearing the development risks as stated in the turn-key agreement. The *financial risk* that was accompanied with infrastructure development for the expansion were for Ammerlaan, who had to ascertain that the development costs could be covered with future cashflow. - In order to keep *end-user affordability* the State has decided to set maximum heat tariffs which also applied to the Ammerlaan project. However no connection costs were charged by Ammerlaan to keep the heat offer attractive. - The heat that was offered by Ammerlaan is from a source where zero CO2 is emitted. Ammerlaan as user, the Municipality and the housing association found geothermal energy a *competitive alternative* to the collective heat-generating facility.	- The *development costs* of the geothermal well and infrastructure were expected to be € 45 Mln.with a long payback period (Schoof, 2011), but the organisation of ADH prospected insufficient future cashflow. - The *heat sale opportunity* was jeopardized due the credit crunch that resulted in an insufficient heat demand to cover the development costs, which led to the bankruptcy of ADH. The redevelopment of the well took place when there were there was more certainty about the connected households. - The *redevelopment costs* of the geothermal well could be covered when HAL took over the organisation. There was a sufficient *heat sale opportunity* for the organisation of HAL since Eneco was willing to buy the heat business to business. - In the HAL organisation the Municipality used private law instruments **(4.2.2)**: Energy fund The Hague (ED) became shareholder in the organisation. In this way ED could provide interest-bearing capital for development through a revolving energy fund, which is considered a stimulus tool. - The Ministry of the Interior covers the unprofitable top margin of the residential adjustments in the area of Bouwlust-Vrederust by a state grant that is made possible through the budget allocation for the pilot project 'natural gas-free neighbourhoods' (Gemeente Den Haag, 2019; p5) - State body RVO introduced the SDE *subsidy* for sustainable energy production in 2008 (Beterduurzaam, 2019). The *SDE+* subsidy that the project of HAL was eligible for created more financial certainty of future cashflows. - The *financial risks* are spread across the HAL organisation, where multiple shareholders such as PEP, ED and Hydreco Geomec invested money. In comparison with the ADH project the *financial risk* is expected to be smaller since there is a larger sale opportunity to dwellings that were connected in the time between and more existing dwellings that are being connected to the district heating network in the near future. - In order to keep *end-user affordability* the State has decided to set maximum heat tariffs which also applied to the Eneco in the HAL project. HAL itself sells b2b and therefore the sale price should be competitive with the prices that other heat producers offer. - ADH had built a bad reputation for geothermal energy because of its bankruptcy. Therefore it was hard to be *competitive* in terms of reliability. In terms of CO2 emission, the geothermal well is preferred over the gas turbines (Den Haag, 2018). - Due to the bankruptcy of ADH the dwellings that were connected to the grid receive heat from the Uniper gas turbine until the geothermal well is operational. Because geothermal energy without a heat buffer is only capable of fulfilling the base load **(3.2.2.e)**, the gas turbine stays operational to cover the peak load. Therefore the *lock-in costs* and revenue losses for Uniper for the shift to geothermal energy are mitigated.	- The development costs of the geothermal well are considered high and there is a long payback period. - State body RVO subsidised the production of geothermal energy in both developments with the SDE and later developed SDE+ subsidy. - The local governments in both cases are involved in covering development costs with stimulus instruments, although the origin, type and utility of the tools are different. - In terms of GHG emission, geothermal energy as source in district heating is a *competitive alternative* in comparison with natural gas. - The *end-user affordability* is equal due to the maximum heat tariffs that are set by the State, however the connection costs variate.	- Ammerlaan had a high certainty about heat use and future heat sale opportunity due to the expected capacity of the geothermal well. The ADH organisation failed to secure the heat sale opportunity due to the dwelling development variable, while the organisation of HAL stepped in when there was a prospect of sufficient heat sale opportunity. - In the development of HAL capital is transferred to an SPV which holds the risks, cash flows etc. that are disconnected from the financiers' own activities in contrast to the development of Ammerlaan in which all the risks were connected to the horticultural company as developer/investor. - The stimulus tool used by the Municipality of the Hague is a revolving energy fund, that could only be used through private law instruments: becoming shareholder in the SPV and provide interest-bearing capital. - The stimulus tool used by the Municipality of Pijnacker-Nootdorp concerned budget allocation of two former subsidies that where not utilised. - Since Ammerlaan is a horticultural company, the organisation was eligible for a Market introduction for energy innovations subsidy, while HAL received state grants from the pilot 'natural gas-free neighbourhoods'.
Organisation	- Negotiations for expansion of the geothermal grid took place between housing association Rondom Wonen, the Municipality and Ammerlaan. - In geothermal district heating development of Ammerlaan, the public actor organisation is arranged such that there are *repetitive activities* concerning licencing safety, construction and environmental issues **(3.2.1)**. The first developer the geothermal well is also recognised as a *line organisation* since its core business is constructing geothermal wells, for which repetitive activities are executed. - Generally there is a strong *top-down hierarchy* were the Province and Municipalities carry out many tasks in commission and according to the rules of the higher government. However, when it concerns geothermal district heating development by the horticultural sector, the Municipality of Pijnacker-Nootdorp chose to carry out a facilitating role, while a director role is applied for residential, commercial and Municipal real estate (Pijnacker-Nootdorp, 2016a). Private actor *top-down hierarchy* is recognised due to the private secotr realisation where the local public actor was only involved the initiative phase: the development was in accordance with the Municipal environmental structure vision for heat **(4.1.2)**. Although the availability of the supply that matched the demand of the housing association, the development is considered less demand-driven by locally rooted civic actors because Ammerlaan had an oversupply of heat that was generated by the geothermal well. - The Ammerlaan project organisation of the expansion to the dwellings as presented in the actor dependency analysis **(4.1.2)** can be considered a project management organisation: the organisation involved (specialised) actors from multiple disciplines (engineering, real estate, planning, environmental law etc.) and exists temporary. - The organisational environment of the Ammerlaan development can be considered sector *fragmented* where multidisciplinary actors decide about the project outcome. Ammerlaan fulfilled multiple roles (e.g. developer, operator and distributor) that are normally divided among other actors, so chain integration management is recognised were Ammerlaan was less *dependent* on intermediate actors. The decision to connect to the geothermal grid was up to the housing association and not *dependent* on the tenants **(4.1.2)**, which made it easier due to the involvement of less decision makers that could influence the development.	- Also in the geothermal district heating development of HAL, the public actor organisation is arranged such that there are *repetitive activities* concerning licencing safety, construction and environmental issues **(3.2.1)**. In the HAL development project, Hydreco Geomec was contracted to perform management activities **(4.2.2)**. As a geothermal operator that operates multiple geothermal wells, Hydreco Geomec can be considered a line management organisation that performs *repetitive activities*. - Generally there is a strong *top-down hierarchy* were the Province and Municipalities carry out many tasks in commission and according to the rules of the higher government. The Municipal council of the Hague takes a leading role in developing district heating since 1975 (Den Haag, 2013; p16). The development by the former ADH organisation and the current HAL organisation is a typical example of public-private partnership where the municipality is actively involved in the realisation **(3.3)**. - Due to the involvement of the Municipality, an area-based approach is followed to match the prospected supply with the demand is determined by the Municipality (Gemeente Den Haag, 2019). The development can be considered supply-driven by public and private actors, because the heat demand of civic actors was already fulfilled with other means before the alternative geothermal was proposed **(4.2.2)**. - For the development project management activities in the planning and realisation phase are performed in a *temporary* setting (e.g. engineering, installation realisation). In the operational phase repetitive maintenance activities (e.g. ESP replacement) and heat production are carried out from the HAL organisation **(4.2.2)** and can be considered process management activities. - The organisational environment of the HAL development project is considered *complex* since there is a large role fragmentation, chain segregation and decision making decentralisation **(3.4.2)** among the actors in the heat supply: the producer, distributor, supplier and multiple end-users are separate actors. - Stakeholders in the neighbourhoods and building blocks are gathered and involved to execute plans neighbourhoods in the district Bouwlust/Vrederust (Gemeente Den Haag, 2019). Involved stakeholder group consist of Haag Wonen, Vestia, Staedion (housing associations), Stedin (gas and electricity grid), Eneco (geothermal grid), HAL and also Homeowner associations (Gemeente Den Haag, 2019).	- In both cases the regime is partly similar: The state and ministries and Province of South Holland. Therefore the regional plans of both development organisations are on the same page. - The line in the organisation are the actors that have a specialisation to perform a role in the organisation. - The development organisations have a top-down hierarchy that is supply-driven where in Ammerlaan the development is a private realisation. - Also in the HAL organisation a *top-down hierarchy* is recognised: from the initiative phase until the operation phase the local government is involved.	- An important difference in regime is the Municipal ambition: Pijnacker-Nootdorp wants to be energy neutral in 2050 (Pijnacker-Nootdorp, 2016b) and The Hague wants to be energy neutral in 2030 (Den Haag, 2019). - The Municipality of Pijnacker-Nootdorp carried out a facilitating role while the Municipality of The Hague carried out a directory role. - Although the organisation of geothermal district heating development is considered *fragmented*, the organisation of Ammerlaan is considered less fragmented due to integration management of Ammerlaan and less decision makers that influence development on the demand side. On the supply side Ammerlaan also fulfilled multiple roles, while in the HAL project there was a larger role fragmentation and decision making decentralisation in the heat supply chain. In the HAL organisation there were relatively more varying ownership types recognised.
Time	- The Ammerlaan project started in 2009 so the *project duration* approximately 10 years. The initiative and planning the development of the first phase took one year, the realisation took two years (due amplification) and *well operation time* 7 years. Planning the expansion to the housing association took 3 years (2012-2015), realisation of infrastructure half a year and the housing association received geothermal heat for 3 out of 7 years if the well operating time. - In 2009 the Municipality of Pijnacker-Nootdorp made policy plans for a heat transition (Gemeente Pijnacker-Nootdorp, 2009a). - Plans of Ammerlaan to become a climate neutral horticultural company: there was a target set to change the 2,5mln. m³ gas use per year for geothermal energy (Ammerlaan, 2010). Also plans were made by Ammerlaan together with the Municipality to connect the Municipal real estate (school and sportcomplex) in 2010 **(4.1.2)**. - Students of Delft University create a planning for the realisation of geothermal well in 2007 (TU Delft, 2007) - Regarding *timing* the housing association planned to improve the insulation of the dwellings and combined the redevelopment with the connection to the geothermal district network. - So far no information is found on planned maintenance or soil excavation works by the Municipality of Pijnacker-Nootdorp that coincided with the soil excavation works Ammerlaan. Tough the Water Authority in place determined in which time frame excavation work could take place, taking into account the soil conditions over the year. - The only *time overrun* found is the amplification that was necessary for safety reasons. Time overrun is well managed because the risks of time overrun is covered by Ammerlaan by providing heat through a backup heat-generating facility.	- Before HAL started the redevelopment of the geothermal well, ADH initiated the project in 2007 so the *project duration* is 13 years. The planning phase took two years and in 2009 the first infrastructure was developed. In 2010 the geothermal well was realised in 8 months. In 2013 insufficient infrastructure was realised to provide future cashflow and the geothermal well was closed. In 2015 the project was relaunched and in 2016 the geothermal well organisation was taken over by HAL. - The first initiative started with backcasting studies in 2013 of The Municipality which led to plans to become climate neutral by 2040 (Den Haag, 2013; p2; Den Haag, 2018). Until august 2017 different strategic and binding plans for the city are drafted (Energy vision, Sustainability vision, Housing vision, council proposal sustainable heat). - In the coalition period 2018-2020 a concrete decision was made to make 25000-30000 dwellings more sustainable (by shutting down gas connections) in ten districts in The Hague, where the district Den Haag Zuidwest is part of (Gemeente Den Haag, 2018). - A district specific inventory for preferred alternatives for heat is made and visualised through an Energy map (Den Haag, 2018). In the district Bouwlust/Vrederust it showed which dwellings to connect to geothermal grid (Gemeente Den Haag, 2019). After mapping, an execution plan with a planning for dwelling and building block adjustments in the different neighbourhoods in the district Bouwlust/Vrederust were made to connect to geothermal grid of the HAL project (Gemeente Den haag, 2019). - The timing of the district heating development is aligned such that the outdated gas piping could be replaced during the same soil excavation works (Gemeente Den Haag, 2018). - For the redevelopment of the geothermal well Hydreco Geomec presents their operational planning (HAL, 2019). In the HAL organisation the planning (engineering, licencing, cleaning wells) phase lasted approximately 9 months until august 2019. After that the realisation of the installation and connection to the grid will take 7 months and the geothermal well is expected to be operational from January 2020.	- The planning and realisation of a geothermal well takes less time (11–36 months) in comparison with the possible planning and realisation time of district heating networks (6- 72 months). Also the time spend on the planning and realisation of the dwelling adjustments (from 36 months) is considered long. - The infrastructure development and geothermal well development was executed at the same time in the projects. - The housing associations in both cases were looking for ways to make their building portfolio more sustainable. Since the area of Den Haag Zuidwest was already qualified for urban restructuring the geothermal district heating development could coincide with the sustainability aims. - In both projects a backup system was in place to generate heat while the geothermal well was not operational. This is also needed for fulfilling the peak demand.	- In the Ammerlaan case there were no urban area developments such as excavation works etc. planned by the municipality at the time infrastructure was going to be laid down, while in the HAL case the realisation of the geothermal district heating network is aligned with the planned Municipal urban area developments and infrastructure works (e.g. outdated gas piping). - Due to the bankruptcy of ADH, the already connected dwelling had no other heat source so there was decided to feed the grid with a backup system, while in the Ammerlaan case the geothermal well was already operating when a connection to dwellings was made. - Time overrun of the infrastructure development and insufficient sales of heat in the ADH organisation led to cost overrun and bankruptcy of the organisation.
Information	- The Ammerlaan project was one of the first geothermal projects in the Netherlands and the *specialised information* regarding engineering was dispersed among the well developer and students of TU Delft. There were assumptions about the subsurface conditions, production capacity **(4.1.2)**. At the time amplification was needed well engineering consultants were called in because knowledge was not present at that time - The tenants were *informed* late about the plans of geothermal district heating and it came as a surprise. This was done when it was certain that the geothermal well could be developed. Although no consensus with tenants was obliged, the residential adjustments require tenant cooperation. Lessons learned are the early involvement of tenants (A. Swank, personal communication, march 26, 2019) - The *information provision* to residents was managed by the housing association and Ammerlaan. Through residential information evenings, information letters, press reports, Q&A forms and folders the residents were informed about Ammerlaan, the geothermal technique, safety, sustainability ambitions, grid route, residential adjustments, comfort, uncertainties, costs, planning, progress and project delivery (Rondom wonen, 2015). These documents are publicly accessible on the website of the housing association and residents (tenants and homeowners) were provided with contact information for additional (technical) information, complaints or damages concerning the geothermal district heating development.	- The specialised information is shared among the experts in geothermal well development in order to have certainty about the subsurface conditions, production capacity and techniques used **(4.2.2)**. - During the development of ADH, information concerning geothermal energy and the project was shared during residential meeting evenings (Schoof, 2011). - When HAL restarted the development in 2016, they had the intentional plans to involve local residents, other stakeholders, companies and the neighbourhood council for cooperation (HAL, 2016). - The *information provision* to residents was managed by the different involved housing associations, Municipality of The Hague and HAL. Through residential information evenings, information letters, press reports, Q&A forms on the website the residents were informed about the organisations behind HAL, the geothermal technique, safety, sustainability ambitions, residential adjustments, uncertainties, planning, progress and project delivery (HAL, 2019). These documents are publicly accessible on the website of the housing association and residents (tenants and homeowners) were provided with contact information for additional (technical) information, complaints or damages concerning the geothermal district heating development. In 2017 there also was a visit to the geothermal well plant (HAL, 2017) - The directory role that the Municipality of the Hague is performing, a lot of *information* concerning costs, planning etc. is shared in Municipal Documents that are publicly available. The Municipality of The Hague has been directory in making their building stock more sustainable since there	- In both cases much effort is made to provide information to the neighbourhood and residents that are going to be connected. - The geothermal well of Ammerlaan and the geothermal well of ADH were drilled in the same year. - In the time the well was drilled the available information about production capacity was uncertain and formed a risk for the geothermal district heating feasibility.	- The residents in the Ammerlaan case were informed late by the housing association: when there was a certainty that the realisation of the dwelling adjustments could be financed. - In the ADH organisation the residents were already involved in the planning phase of the development.
Quality	- The geothermal well of Ammerlaan is *located* in an agricultural/horticultural area that is not in the vicinity of sensitive functions (e.g. dwellings). - The public actors, predominantly the State Supervision on the Mines (SSM), were actively involved in the *environmental quality* assessment concerning the health and safety of the geothermal well **(4.1.2)**. - Ammerlaan and the housing association steered on the *spatial quality aspects*: there was thought about end-user comfort and factors that can be experienced as disturbing (e.g. soil excavation) were mitigated by information provision beforehand and financial compensation for the dwelling adjustment was awarded to residents (Rondom wonen, 2015). - Although future value and sustainability are part of *spatial quality*, these are also *social values* that were present at the time of development. The replacement of the collective natural gas fed heat-generating facility by geothermal district heating was an alternative that met the social values of decarbonisation caused by the various trends **(1.1)**.	- The geothermal well of Haagse Aardwarmte Leyweg is *located* in an urban area with sensitive functions (e.g. dwellings, hospital). - In the geothermal district heating development of ADH, a document concerning the desired installation quality (Eneco, 2011) is shared among the stakeholders of ADH. - The plant where the geothermal installations are in is located in an urban area so certain *spatial qualities* are steered on. An architect was contracted to shape the appearance of the building (Visser, 2013) to steer on the experience value variables (e.g. clarity, visibility, recognisability, aesthetics). However, some may find the building ugly and strange (Hoogland, 2018), which indicates that *spatial quality* is subjective. - Concerning the *spatial quality*, the area of The Hague Zuidwest district is pointed as district for restructuring (Den Haag, 2007), which indicates that the spatial quality is below the desired level. - The Hague as public actor, considered district heating to be an important solution for CO2 emission from the 90's (Den Haag, 2013; p17), which is an indication for certain social values. - The large willingness of multiple stakeholder types to cooperate in the project shows that the development is in line with the *social values*.	- The decarbonisation trend is witnessed by and happening to the same society. Therefore the social values are in line, although some actors could find alternative solutions to gas (e.g. all electric) more fit than geothermal district heating.	- Due to the directory role of the Municipality of The Hague they are much involved in working to the desired quality, although the Ministry also had an important role in the qualification for restructuring. - In the Ammerlaan project, Ammerlaan and the housing association worked hard to foster *spatial quality*, while the Municipality of Pijnacker-Nootdorp held a facilitating role. - The location type of the geothermal well is different, which may demand for different *spatial qualities*.

Empirical phase

Cross-case analysis

Main similarities

- High up-front development costs and long payback period;
- Partly similar regime: The State and Ministries and Province of South Holland;
- Production subsidy (SDE) by RVO, Development subsidy covering development costs;
- Geothermal well development take less time than the district heating network although the development was coinciding;
- Extensive information provision to neighbourhood and residents.

Main differences

- Certainty of the (potential use or) sale of heat;
- Organisation fragmentation and integration of roles among actors;
- Directory or facilitatory role of the Municipality;

Empirical phase

Sub conclusion

Research sub question:

What are the managerial roles & dependencies of public, private and civic actors in implementing energy policies, district scale heat-generating facilities and infrastructure in the practice of urban development in the built environment in the Netherlands?

Sub conclusion on empirical study

- Large public actor involvement, where in each governmental level certain management tools are considered.

- There is a large role segregation among the actors, pointing out that there is no GDHD agency that has all the in-house capabilities of developing a geothermal well, district heating infrastructure and residential adjustments together.

Empirical phase

Expert assessment

Aim

- Verification of the findings from literature and case study;
- Determination of effective roles.

Involved actors

- Policy advisors from the Municipality of the Hague and Province of South Holland, geothermal developers and operators, housing associations researchers from TU Delft and urban area development managers.

Statements

Management aspect	Statement
Money	*The sales of heat to private and civic actors is insufficient to cover the development costs: without the availability of subsidies and grants, the development of geothermal district heating will not happen.*
Organisation	*An area-based approach that is steered by public actors (top-down) is more effective in upscaling geothermal district heating than civic actor (homeowners & tenants) initiatives (bottom-up).*
Time	*A. The connection of dwellings to geothermal district heating can only happen before the end user's current heat-generating facilities are past due and municipal soil excavation works are planned.* *B. Before the start of geothermal well and infrastructure development legally binding agreements with the end-users regarding dwelling adjustments and grid connections are necessary.*
Information	*The provision of development information (planned and ongoing) and civic participation through capacity building tools leads to more acceptance, cooperation and fosters adoption by civic actors.*
Quality	*Meeting the environmental quality standards will only lead to geothermal district heating development if the desired spatial quality and social values are met.*

Table 5.1 Statements for the Delphi study based on literature and empirical findings.

Empirical phase

Sub conclusion

Research sub question:

What managerial roles are effective for upscaling residential heat-generating facilities and infrastructure to a district scale in the Netherlands?

Conclusion

- The role of public actors: stimulus and regulatory tools to evoke competitive advantage and foster maturation of the sector;
- Organisationally public, private and civic actors are strongly dependent;
- For time planning the is an important local governant role in coordinating, optimising development and acquiring support together with private actors;
- Roles of public and private actors for providing information through capacity building;
- Important role of public, private and civic actors to align the desired environmental quality.

Conclusion

Research main question:

How do public, private and civic actors manage upscaling residential heat-generating facilities to district scale in the built environment in the Netherlands?

Conclusion

- Public, private and civic actors manage upscaling residential heat-generating facilities to district scale in the built environment in the Netherlands by forming a strategic plans, making deliberate decisions and executing several processes;
- Strategic plans are formed through shaping tools (e.g. heat plans), but need additional stimulus, appropriate regulation and capacity building to be implemented;
- The execution of processes requires planning, coordination and collaboration of the involved actors.
- Consensus by public, private and civic actors is reached through intensive communication, negotiation about the built environment. Our built environment.

Discussion

Limitations of the research

1. The research is limited to two cases with certain actors involved, in the Province of South Holland and excluded other cities' solutions for reducing GHG;
2. Dutch practices, excluding international cases;
3. Cases are development projects initiated ten years ago.

Recommendations for practice

1. The use of management tools by public actors;
2. Conducting subsurface surveys and exploration near dense urban areas;
3. Anticipate to the CO_2 tax by looking for geothermal development;
4. Look at technological innovations to foster feasibility

Recommendations for further research

1. Study the actor organisation and GDHD of (international) cases;
2. Comparable studies on countries that have a mature geothermal sector (e.g. USA, Germany, Iceland);
3. Investigate deeper: beyond general dependencies;

Reflection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Thank you for your attention.

Questions?