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Designing PPP contracts for public charging

Evaluating 10 years of procurement of public charging infrastructure in the Netherlands

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Executive Summary
Ten years of procuring public charging infrastructure in the Netherland is showing continuous development in the realization of Public Private Partnerships (PPP). Ten procurement cases of public charging infrastructure (2009-2018) by municipalities, regions, and provinces are being evaluated on the main aspects of PPPs. These main aspects are government roles and responsibilities, procurement selection, PPP finance, and PPP risks. The increased scale of charging infrastructure in the last ten years has led to reduced costs and improved processes, e.g. efficiency gains in the realization process of charging infrastructure and improved communication towards electric drivers. Governmental agencies tend to steer towards the scale-up of charging infrastructure and thereby to the development of the business case of charging infrastructure.

1 Introduction

The transport sector is responsible for 23% of the total global CO2 emissions [1], and transportation in cities contributes to air quality problems in densely populated cities. According to WHO's most recent survey of 4300+ cities worldwide, only 20% of the urban population surveyed live in areas that comply with WHO air quality guideline levels for PM2.5 [2]. Figure 1 gives an overview of measured concentrations of black carbon in the Netherlands, that is above air quality guideline levels in densely populated cities as well. The pursuit of reduction of CO2 emissions and the goal to improve air quality in cities has led to policy frameworks to promote the uptake of electric passenger vehicles. As a result, since the introduction of policy in the Netherlands, the number of electric passenger vehicles increased to almost 150.000 electric passenger vehicles in February 2019 (both battery electric vehicles and plug-in hybrid electric vehicles) [3].

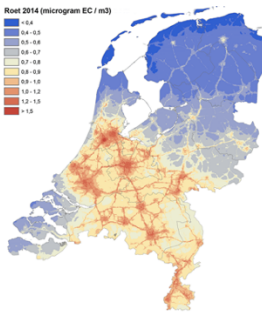

Figure 1: Measured concentrations of black carbon in the Netherlands (BC) [4].

The availability of public charging infrastructure is a prerequisite for the uptake of electric vehicles [5]. In a relatively new market with yet low adoption rate of electric vehicles, it can be difficult to establish a profitable business case for the development and operation of charging infrastructure. Therefore, public charging infrastructure[1] has been procured in different PPP forms for more than 10 years by different municipalities, regions and provinces in the Netherlands. As a result, over 21,000 publicly accessible charging points in the Netherlands were operational in February 2019 [6]. According to the IEA (2018), the Netherlands has the highest charge point (CP) ratio, i.e. the highest share publicly accessible charging outlets per electric car (BEV) for the selected countries (Figure 2). Moreover, the one-off costs for a public charging station decreased by almost 35% in 2017 compared to 2013, and the periodic costs by more than 30% [7].

This paper evaluates the development in the procurement of public charging infrastructure based on the main aspects of PPPs. First, insights into the scale-up of charging infrastructure in the Netherlands is given, based on the technology life cycle framework. Second, ten different cases studies are being compared, ranging from one of the first procurements in 2009 until procurements in 2018 when the public charging infrastructure was already in the growth phase of the technology life cycle. Insights in the development in the procurement of public charging infrastructure may help other countries in their scale-up of charging infrastructure by means of PPPs.

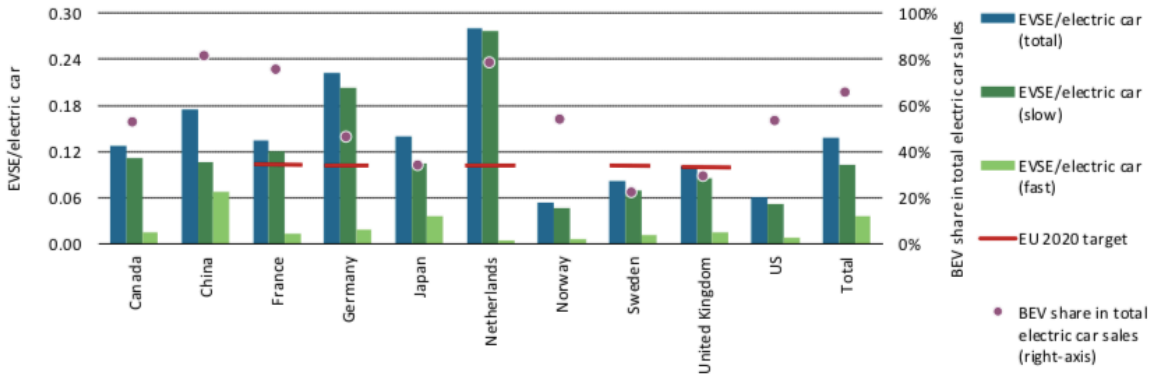

Figure 2: charge point ratio in selected countries [6]

2 Scale-up of charging infrastructure in the Netherlands

New technologies follow a technology life cycle (TLC), divided into four phases, and is linked to the scale-up of the particular technology [8,9]. The TLC starts a *development phase (I)*, in which a new technology is being developed and brought to the market for the first time. Market penetration is still small and the technology is in the early stage of its development. There is still a large uncertainty about user preferences, however users are willing to pay a high price. A lot of new entrants then enter the market in the *take-off phase (II)*. These new entrants introduce many different versions of the technology resulting in technological differentiation and declining costs.

When the amount of experience with the different technological designs increases, the amount of opportunities to improve the technology decrease and a product standard, the dominant design (DD) emerges [9]. In industries with a very diverse buyer demand, it is possible that different DDs can co-exist [10]. The establishment of a DD can occur in two ways [11]: A government body can *de jure* determine the DD. If this is not the case the DD will be the result of a *de facto* market competition between interested parties.

After the dominant design has emerged, and hence technological issues are resolved due to experimentation, a shift towards the *growth phase (III)* takes place [9]. The number of new start-ups in the industry decreases, but incumbents may enter the market. The focus of innovation shifts from technological innovation to process

[1] Public charging infrastructure is typically based on 'normal charging', with a power output of 2-4 kW.

innovation, and economies of scale arise. As a result, the costs of the technology decrease. The industry then evolves into *the maturity phase (IV)* in which the rates of innovation are relatively low and the technology matures [8]. In this phase, competition is mostly price-based, although new niches may arise. The different phases of the TLC are pictured in *Figure 3*.

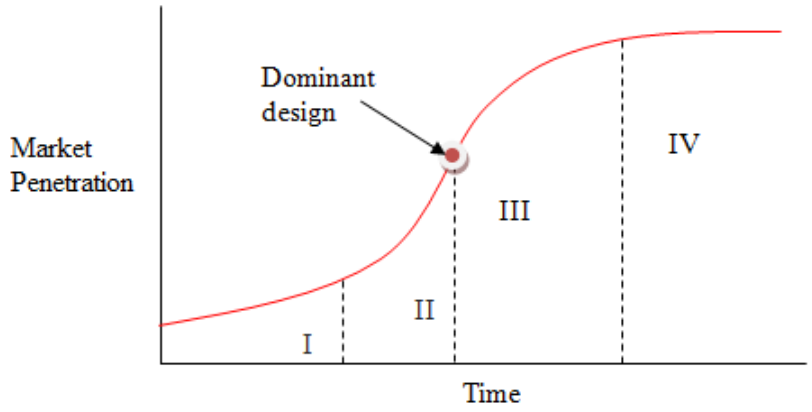

Figure 3: The technology life cycle (based on [8,9,10])

To determine the current phase of charging infrastructure in the Netherlands within the technology life cycle, an overview of the four phases and their indicators is given, as well as an observation on whether these indicators and thus the technology life cycle phase have been met. This overview learns that the Dutch have set on a dominant design regarding the charging infrastructure technology, and the technology is currently scaled-up towards the growth phase. Hence, since 2009, the scale-up of charging infrastructure in the Netherlands has evolved along the development phase and the take-off phase (see Table 1).

Table 1: Technology life cycle of charging infrastructure in the Netherlands

TLC phase	**Indicator**	**Status charging infrastructure the Netherlands**	**Technology observation**
I: Development phase	• Developing technology • Customers willing to pay high price • Small market	✓	Experimenting in the Netherlands started around 2009, for high-end users especially in the capital city. The charging market served the innovators that were willing to pay a high price for driving electric. Few suppliers were available to deliver the charging stations.
II: Take-off phase	• Entry of new suppliers (mainly stat-ups) • Technological differentiation • Start declining costs	✓	After some years of experimenting, more charge point operators (CPOs) arose that competed with each other and the costs started to decline.

III: Growth phase	• Shift from technological innovation to process innovation • Economies of scale • Incumbents enter the market		Dutch stakeholders have together defined standards regarding the design of a charging station, the socket, interoperability between different operators, etc. These standards are promoted by foundation E-laad[2] and National Knowledge platform Charging infrastructure (NKL)[3]. Governments force charge point operators to comply with these standards, by means of the requirements during procurements. Hence, a dominant design has been established. As a result of the standardization of the technology, in 2013 one municipality already organized a price-based procurement in which quality issues were not rewarded. The municipality expected that few quality-based differences would occur between different charge point operators. This indicates that the dominant design of the technology was indeed set, and that price competition has increased. Since then, the focus of the quality difference between charge point operators has shifted from technological innovation to process innovation, e.g. efficiency gains in the realization process of charging infrastructure and improving the communication towards electric drivers. These process innovations are necessary to allow for the further scale-up of the technology. During this phase, several take-overs have emerged as for example Pitpoint was acquired by Total and Allego was acquired by Meridiem. This indicates that incumbents are interested to enter the market.
IV: Maturity phase	• Price competition • Start-ups create new niches		The competition mainly based on price differences has not started yet, as process innovations are still being developed.

3 PPP research

World wide experience has shown that PPPs can provide a variety of benefits to the government, e.g. alleviating the financial burden on the public sector due to rising infrastructure developments costs, allowing risks to be transferred from the public to the private sector, and increasing the 'value-for money' spend on infrastructure services by providing efficient, lower-cost and reliable services [12]. PPP contract designs are therefore desirable to pursue when facilitating public charging infrastructure. Four main aspects may be distinguished in evaluating PPPs: (1) governments roles and responsibilities, (2) selection of the contractor by using a workable procurement framework and method, (3) a sound financial plan, and (4) risks identification and allocation. These aspects are graphically showed in Figure 4.

[2] https://www.elaad.nl
[3] https://www.nklnederland.nl

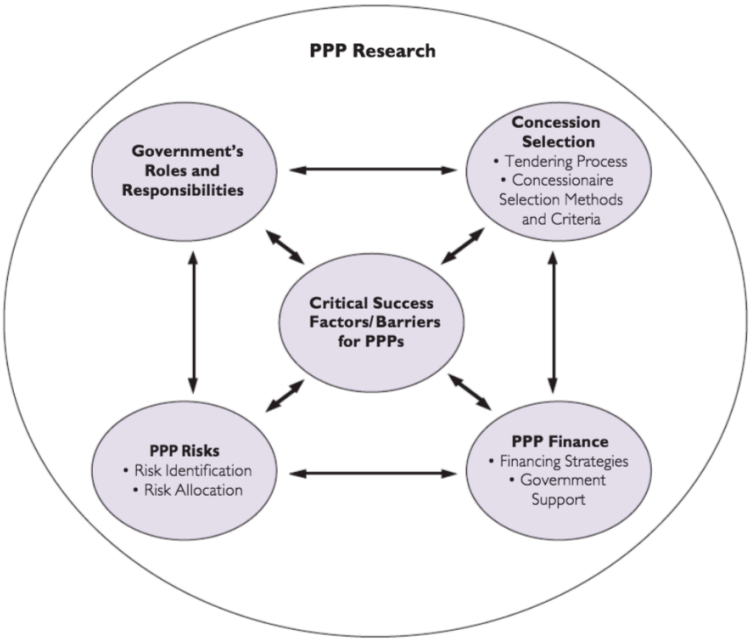

Figure 4: A conceptual classification framework of PPP research [12]

These four aspects are used in this study to evaluate the case studies. These aspects are adapted to fit the purpose of evaluating public charging procurement, and the following dimensions and indicators are defined to evaluate the four aspects (Table 2):

Table 2: operationalization table of procurement aspects (partly based on [13])

Aspect	Dimension	Indicator
Government roles and responsibilities	Contract type	Traditional contract, concession, license model
	Activities of private party	Request portal, installation / management and maintenance / exploitation / energy supply / service provision / removal
Procurement selection	Procurement / tendering strategy	Public procurement, non-public procurement, competitive dialogue, no public procurement procedure
	Procurement type	Price, quality, price/quality, Best Value Procurement
PPP finance	Charging price	Fixed / open / temporarily fixed
	Financial support government	Yes/no, fixed / open
	Contract duration	Build/installation period and operation period in years
	Volume of contract	Municipal / regional volume
PPP risks	Placement planning	Demand driven, databased, proactive placement, strategic placement
	Exclusivity	Yes/no

4 Development PPP procurement in the Netherlands

The development in the procurement of public charging infrastructure based on the main aspects of PPPs is researched by means of case studies. Ten different cases studies have been researched, ranging from one of the first procurements in 2009 until procurements in 2018 when the public charging infrastructure had scaled-up towards the growth phase. An overview of these case studies is showed in Table 3. Data to

determine the indicators as described in Table 2, was found in the procurement documents of the particular cases. This section describes the main findings.

The main contract type of the procurement of charging infrastructure in the Netherlands – as the case studies partly reflect – over the last 10 years has been traditional contracts and concessions. The procurement aspects of licenses are very different compared to traditional contracts or concessions, though all license models are very similar and stable over the years. License models include limited requirements for the charge point operator, no exclusivity and no procurement selection. The role of the municipality is limited with regard to choosing the location of a charging station, and the charge point operator installs a charging station when and where the operator identifies a favorable location. The governmental agency does not offer a financial compensation for the installation and operation of that charging station. Hence, the municipality has less influence on building a network of charging infrastructure. As all activities and risks are performed by the charge point operator, the remainder of the results of the development of PPP procurement will focus on the main contract types; traditional contracts and concessions.

Table 3: overview case studies

Case	Geographical scope	Year	Contract type
Amsterdam	Municipality	2009	Concession
Utrecht	Municipality	2011	Traditional contract
Amsterdam	Municipality	2011	Traditional contract
Gelderland	Regional	2014	Concession
Dordrecht	Municipality	2014	License
Den Haag	Municipality	2015	Traditional contract
Arnhem	Municipality	2015	Concession
Rotterdam	Regional	2016	Concession
MRA-E	Regional	2016	Traditional contract
Groningen-Drenthe	Regional	2018	Traditional contract

Government role:
The activities performed by the government tend to change over time:

- The request portal for EV-drivers requesting a public charge station used to be set up and managed by the CPO, while a trend towards publicly owned request portals is identified. Governmental agencies tend to build own request portals, as this smoothens the transition from one CPO to another when a new procurement has been granted and allows for a greater overview of the requests for the governemntal agency.
- The activities related to the installation of charging stations for the CPO tend to expand, as activities previously performed by municipalities such as placing traffic signs tend to shift towards the charge point operator. Activities previously performed by the DSO for the net connection also tend to shift towards the CPO. The CPO is therefore more and more responsible for all necessary activities for the placement of the charging station and charging location.
- Management and maintenance are in all models assigned to the CPO, although governmental agencies increasingly desire to have more (real-time) insights into these issues. Therefore, governmental agencies request to receive the data more often for their own analysis.
- E-mobility service providing (delivered by E-MSPs, E-Mobility Service Providers), including the delivery of often a free subscription for billing services connected to a ‘charge card’ and or an App, were part of the scope of the first traditional contracts and concessions, trying to limit the costs for the electric driver. In most recent contracts, service providing is left out of the scope of the contract leaving this entirely to the market.

Procurement selection
Public procurement procedures have been most common last ten years, which the case studies reflect. There are several exceptions, when a pre-selection was chosen. The procurement type has mostly been based on price as well as quality. There are some exceptions, for example the case study of Gelderland, were the procurement was focused on price only, as standardization of the charging station was set and it was expected that quality issues would not differ much among the applicants. Since then, however, quality was included in procurements again and tends to become more and more important in the procurement selection (the Arnhem case was even a best value procurement). The quality part increasingly focusses on improving the system around the charging station, e.g. by smart charging, ensuring sustainable electricity supply, providing price transparency towards the electric drivers and improvements regarding a time-efficient realization process. Hence, over the years the procurement strategy and procurement type have been steady, and secure a price competition while quality improvement is included as well (in the first years focused on the technology of the charging station, which has shifted to process innovations to improve the system of the charging station during the last years).

PPP finance
Concerning the financing model of PPPs in public charging, multiple changes could be identified over the years and are often related to optimizing the business case for public charging. The most important changes have been:

- The contract duration increased: in the beginning years of charging infrastructure procurement, installation and exploitation periods were integrated. This has shifted towards split periods between installation and exploitation, allowing for an extended exploitation period that results in a more attractive Return On Investment for the CPO.
- The geographical scope of procurements tends to expand over the years towards a regional context in which multiple municipalities cooperate to organize a procurement, up to around 80 municipalities (although municipal scope is also still procured). The increasing geographical scope, will consequently increase the expected amount of procured charging stations which also positively influences the business case.

As a result of the increasing optimization of the business case of public charging, the amount of public financial compensation has changed. In the beginning, periodic compensation for management and maintenance of charging stations was offered as well as up-front compensation for the installation of charging stations. More recently – as the exploitation of charging stations is more profitable – the amount of up-front compensation for is lower (or not necessary anymore) and periodic compensation is not offered any more.

PPP risks
The placement planning of charging infrastructure has evolved over the years. In the beginning, the placement tended to be strategic and the governmental agency decided on desirable locations. Over the years, this shifted towards demand driven placement, i.e. habitants or workers within a municipality may request for an expansion of the public charging infrastructure. This type of placement offers the advantage for the charge point operator that there will be a secure demand of electric drivers for the charging stations, positively influencing the business case. In recent years, a demand driven approach tends to be combined with strategic placement, to ensure the development of a charging network that covers the whole municipality. Strategic locations are often locations where no habitants or workers request for a charging station, but where demand for charging infrastructure may be present or expected, such as at sport clubs or shopping malls. The selection of these strategic locations tends to be more and more based on a data driven forecast of the charging demand within the municipality.

5 Conclusion
Since the introduction of policy to promote electric vehicles in the Netherlands, the number of electric passenger vehicles increased to almost 150.000 electric passenger vehicles in February 2019. The availability of public charging infrastructure is a prerequisite for the uptake of electric vehicles and public charging infrastructure has therefore been procured in different PPP forms for more than 10 years by

different municipalities, regions and provinces in the Netherlands. As a result, over 21,000 publicly accessible charging points in the Netherlands were operational in February 2019.

The charging infrastructure market has evolved with the increasing number of charging stations towards the growth phase. Standardization of the charging stations is defined, in form of the design of a charging station, the socket, interoperability between different operators, etc. Governments force charge point operators to comply with these standards, by means of the requirements during procurements. Since then, the focus shifted from improving the charging stations, to improving the system around the standardized charging stations to allow for further scale-up, e.g. efficiency gains in the realization process, IT systems and communication towards the electric driver to offer price transparency.

Governmental agencies tend to contribute to the scale-up of charging infrastructure and to the improvement of the business case of public charging by means of their procurement. The increased contract duration and increased volume of procured charging stations both positively improve the the business case for the charge point operator, and therefore periodic public compensation is abundant and public up-front compensation is rapidly decreasing. During the procurement selection, applicants are requested to subsribe with the amount of upfront compensation needed, and as this in converging among applicants, more emphasis is given to quality issues during the procurement selection. These quality issues often relate to improving the system around the charging station.

In recent years, governments tend to combine a demand driven with strategic placement. Moreover, governmental agencies tend to enable themselves with more data (e.g. real-time insights in management and maintenance of charging stations), that can be used for a data driven placement strategy. The expansion to strategic placement and data driven placement startegies allows for the development of a charging network that covers the whole municipality. Figure 5 gives an overview of the main trends, i.e. exceptions have occurred, over the last ten years public charging procurement.

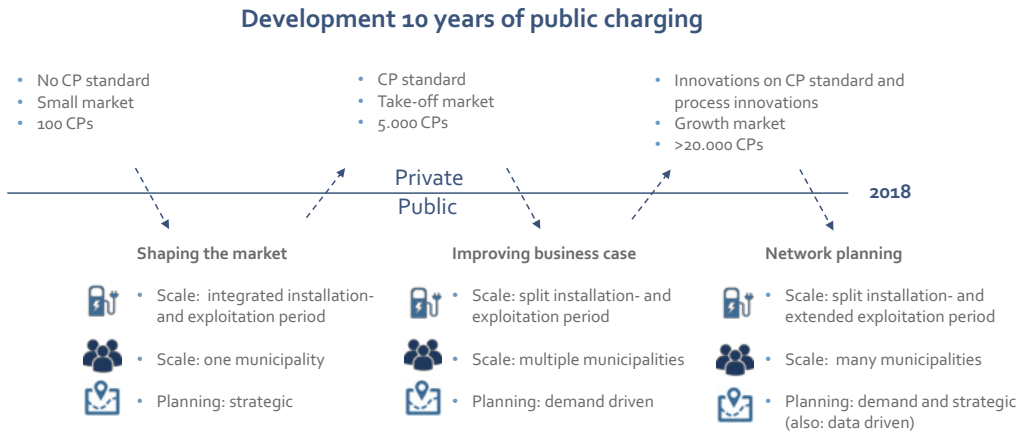

Figure 5: overview development 10 years of public charging stations

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