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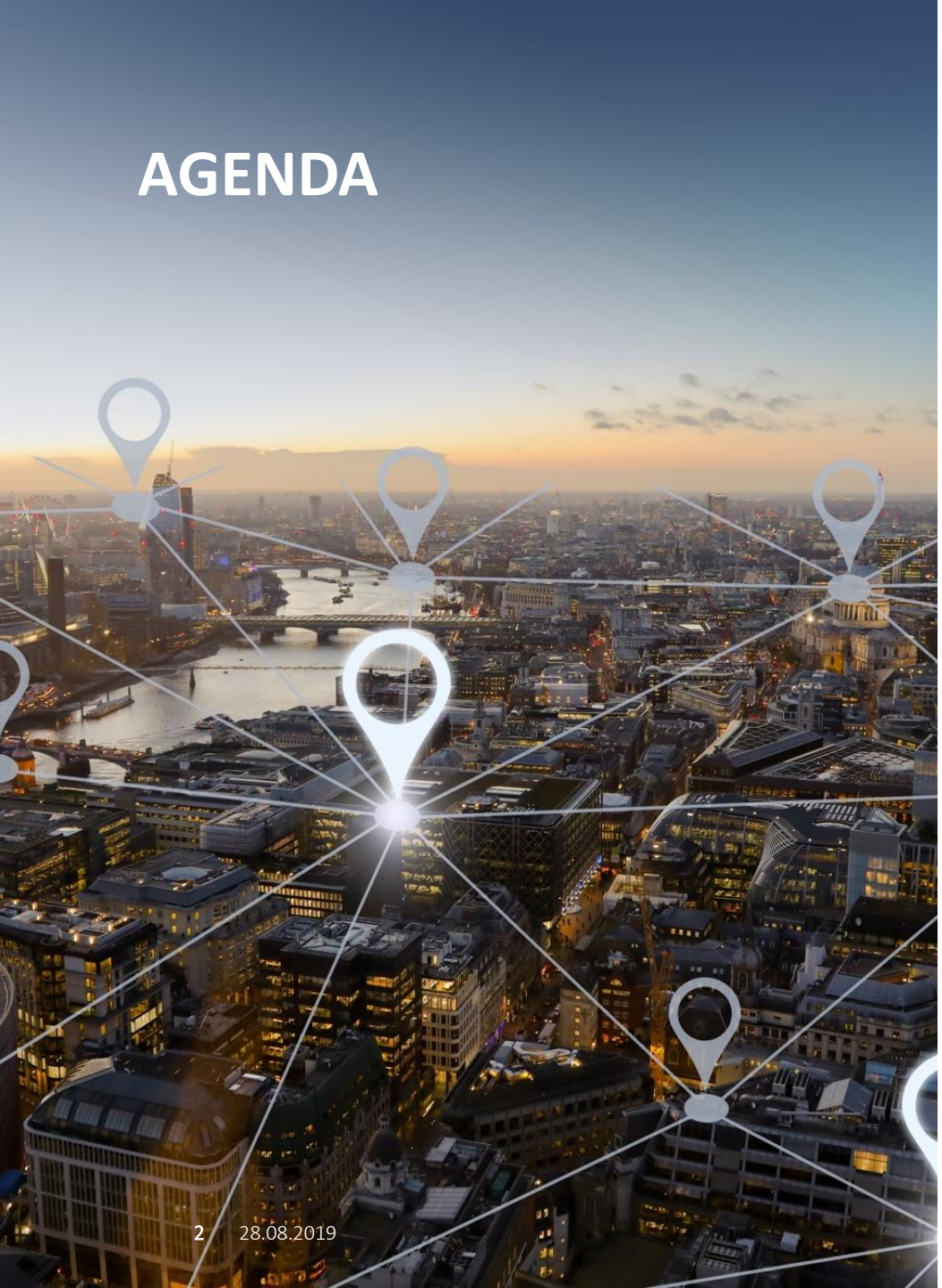
Insights into the Strategic Roll-out and Usage of Public Charging Infrastructure in Germany

Laura Prawatky and Dr. Franziska Lobas-Funck

Accompanying Research for Charging Infrastructure

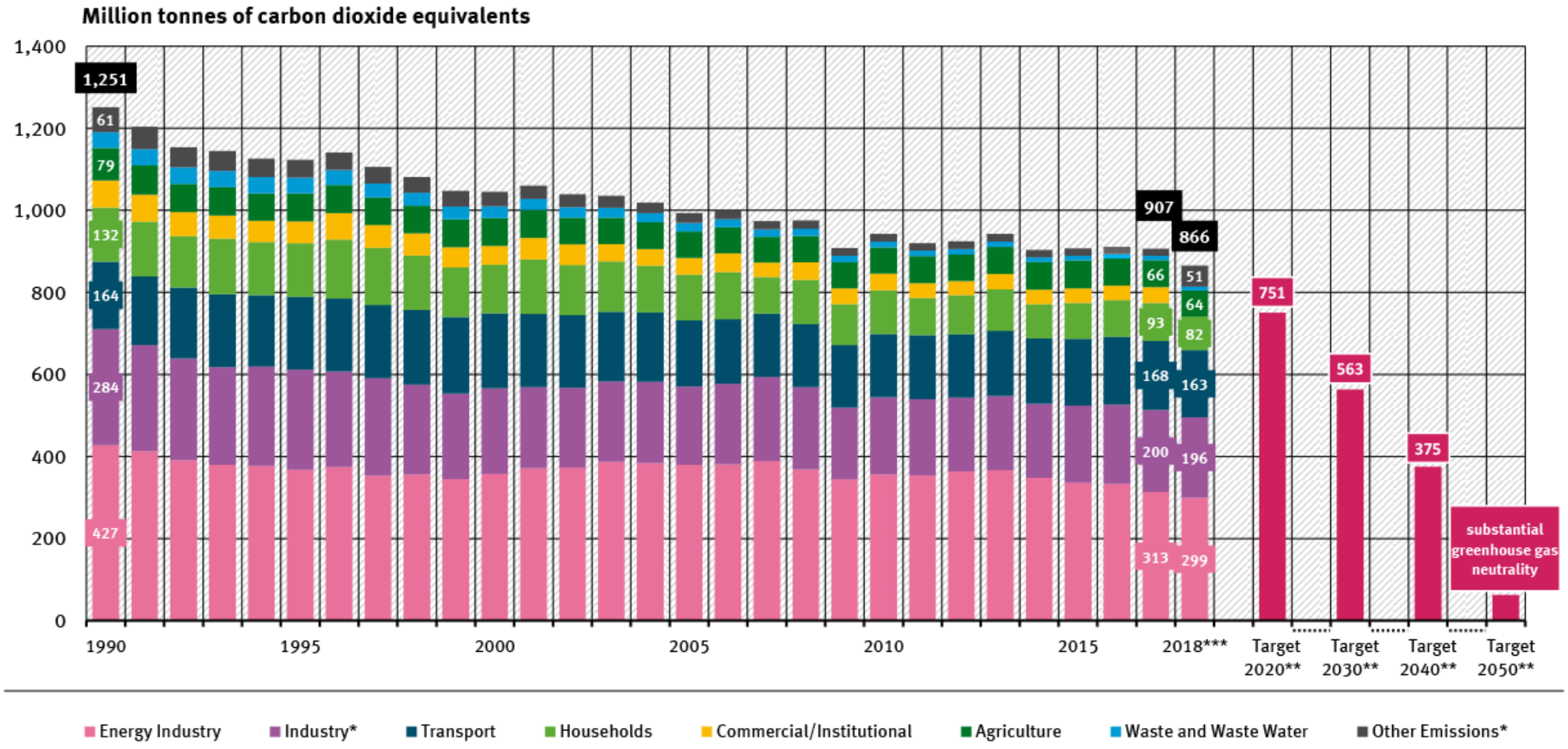
NATIONAL ORGANISATION HYDROGEN AND FUEL CELL TECHNOLOGY

AGENDA



1. Background
2. Research Questions
3. Database and Methodology
4. Results
5. Conclusion and Limitations of Analysis

Emission of greenhouse gases covered by the UN Framework Convention on Climate



Emissions by UN reporting category, without land use, land use change and forestry
* Industry: Energy and process-related emissions from industry (1.A.2 & 2);
Other Emissions: Other combustion (rest of CRF 1.A.4, 1.A.5 military) & fugitive emissions from fuels (1.B)
** Targets 2020 to 2050: Energy Concept of the German Federal Government (2010)
*** Short-term forecast for 2018, emissions from commerce, trade & services contained in Other Emissions

Source: German Environment Agency, National Inventory Reports for the German Greenhouse Gas Inventory 1990 to 2017 (as of 01/2019) and estimate for 2018 from UBA Press Release 09/2019 (corrected)

BACKGROUND

Market Incentive Programme Electromobility, Cabinet Resolution of 18 May 2016

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BUYER'S PREMIUM

- Private and commercial customers receive a premium of €4,000 when purchasing a BEV and €3,000 for a PHEV*
- The premium is shared 50/50 between industry and government
- Funding applicable for cars with purchase value below €60,000
- Total budget: €1.2 billion until end of 2020

CHARGING INFRA-STRUCTURE

- Total budget: €300 million for publicly accessible charging infrastructure
- €100 million for slow charging points (max. charge power ≤ 22kW)
- €200 million for fast charging points (max. charge power >22kW)
- Roll-out of 15,000 charging stations

TAX PRIVILEGES

- No taxation on electricity for charging at workplaces
- Extension of motor vehicle tax exemption for electric vehicles from 5 up to 10 years

PUBLIC CAR FLEETS

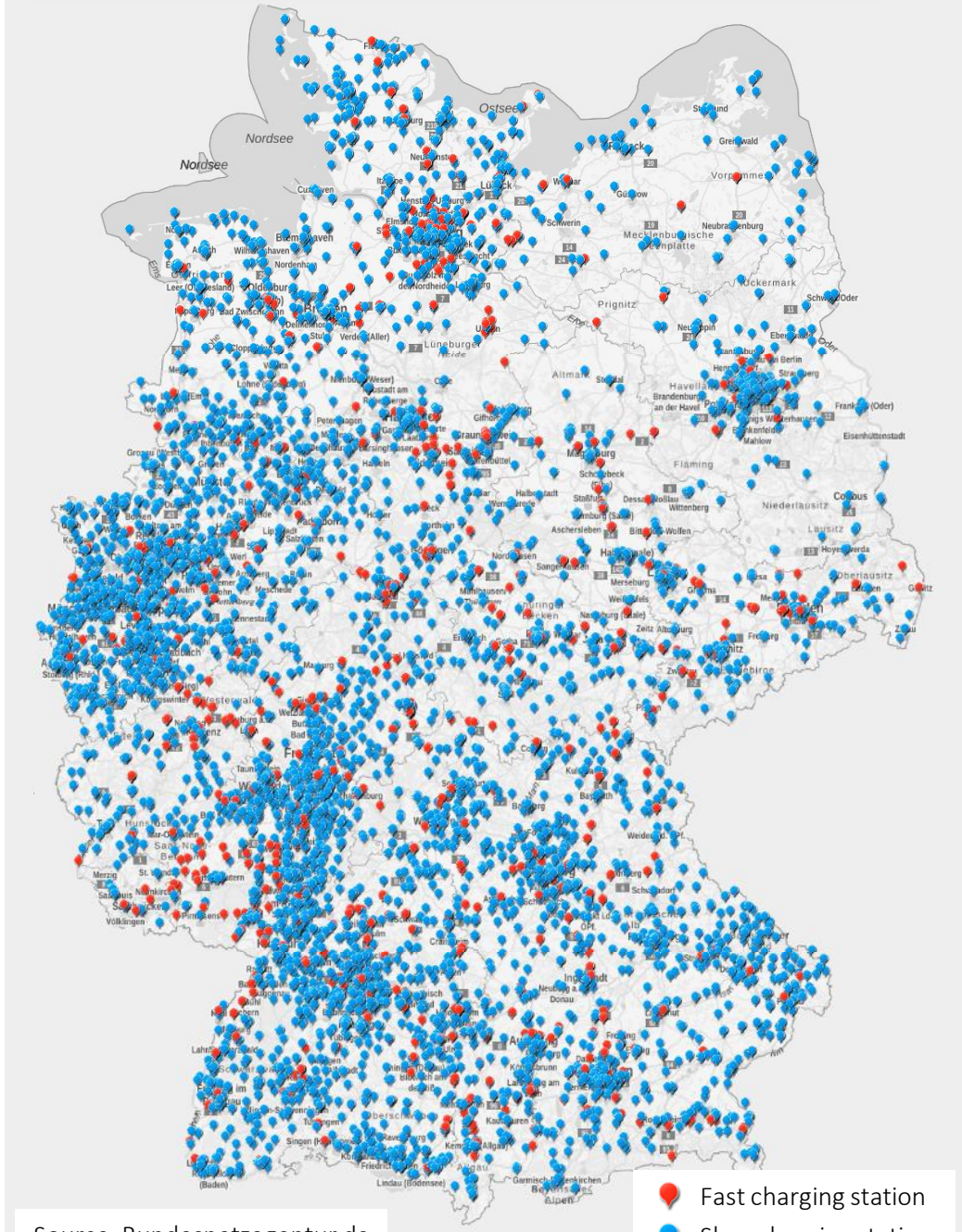
- 20% electric vehicles in the federal government fleet
- Overall investment of €100 million

* if CO_2 emissions < 50 g/km

BACKGROUND

2020 Objectives and Status of Public Charging Infrastructure

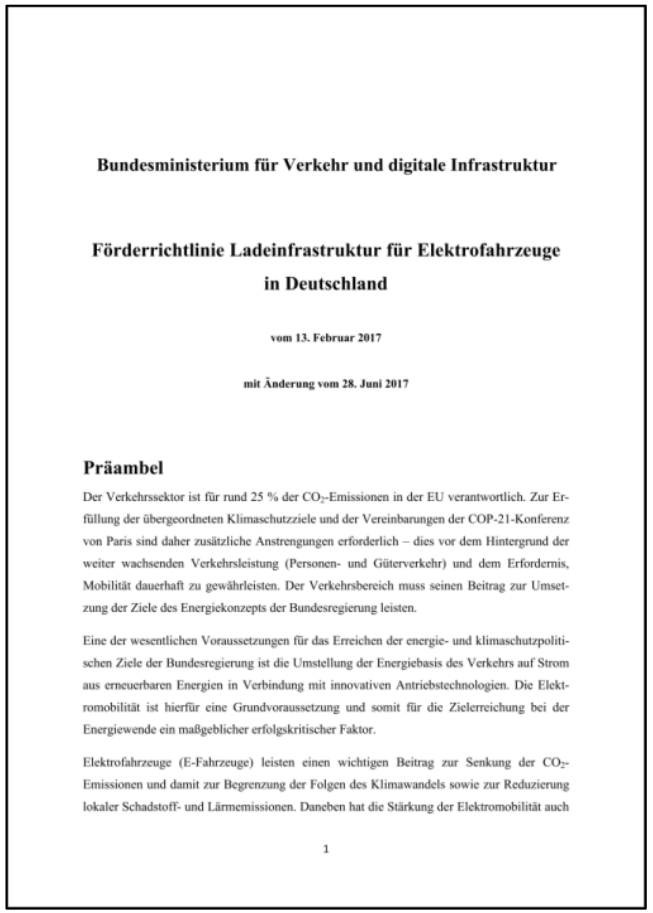
	2020 Objectives		Status
	Coalition Plan of 2018	National Strategic Framework of 2016	August 2019
Slow Charging Points	66,667	~ 20,000	17,200
Fast Charging Points	33,333	~ 10,000	2,100
TOTAL	100,000	~ 30,000	19,300



Source: Bundesnetzagentur.de

BACKGROUND

Federal Funding Programme for Public Charging Infrastructure in Germany



Bundesministerium für Verkehr und digitale Infrastruktur

Förderrichtlinie Ladeinfrastruktur für Elektrofahrzeuge in Deutschland

vom 13. Februar 2017

mit Änderung vom 28. Juni 2017

Präambel

Der Verkehrssektor ist für rund 25 % der CO_2-Emissionen in der EU verantwortlich. Zur Erfüllung der übergeordneten Klimaschutzziele und der Vereinbarungen der COP-21-Konferenz von Paris sind daher zusätzliche Anstrengungen erforderlich – dies vor dem Hintergrund der weiter wachsenden Verkehrsleistung (Personen- und Güterverkehr) und dem Erfordernis, Mobilität dauerhaft zu gewährleisten. Der Verkehrsbereich muss seinen Beitrag zur Umsetzung der Ziele des Energiekonzepts der Bundesregierung leisten.

Eine der wesentlichen Voraussetzungen für das Erreichen der energie- und klimaschutzpolitischen Ziele der Bundesregierung ist die Umstellung der Energiebasis des Verkehrs auf Strom aus erneuerbaren Energien in Verbindung mit innovativen Antriebstechnologien. Die Elektromobilität ist hierfür eine Grundvoraussetzung und somit für die Zielerreichung bei der Energiewende ein maßgeblicher erfolgskritischer Faktor.

Elektrofahrzeuge (E-Fahrzeuge) leisten einen wichtigen Beitrag zur Senkung der CO_2-Emissionen und damit zur Begrenzung der Folgen des Klimawandels sowie zur Reduzierung lokaler Schadstoff- und Lärmemissionen. Daneben hat die Stärkung der Elektromobilität auch

1

- Duration: 2017 - 2020
- Objective: promotion of **15,000 charging stations** (~ 30.000 charging points)
- **Investment grants** for hardware, grid connection or enhancement und installation
- Promotion of **publicly accessible** charging points (slow and fast charging points)
- €300 million funding assigned via **calls for applications for funding**
- So far **four calls** (March 2017 / Sept 2017 / Dec 2018/ one currently open)
- **Possible applicants:** natural and legal persons (private investors, municipalities etc.)
- Current status end of July: granted funding for **16,449 charging points** (thereof 2,202 fast charging points)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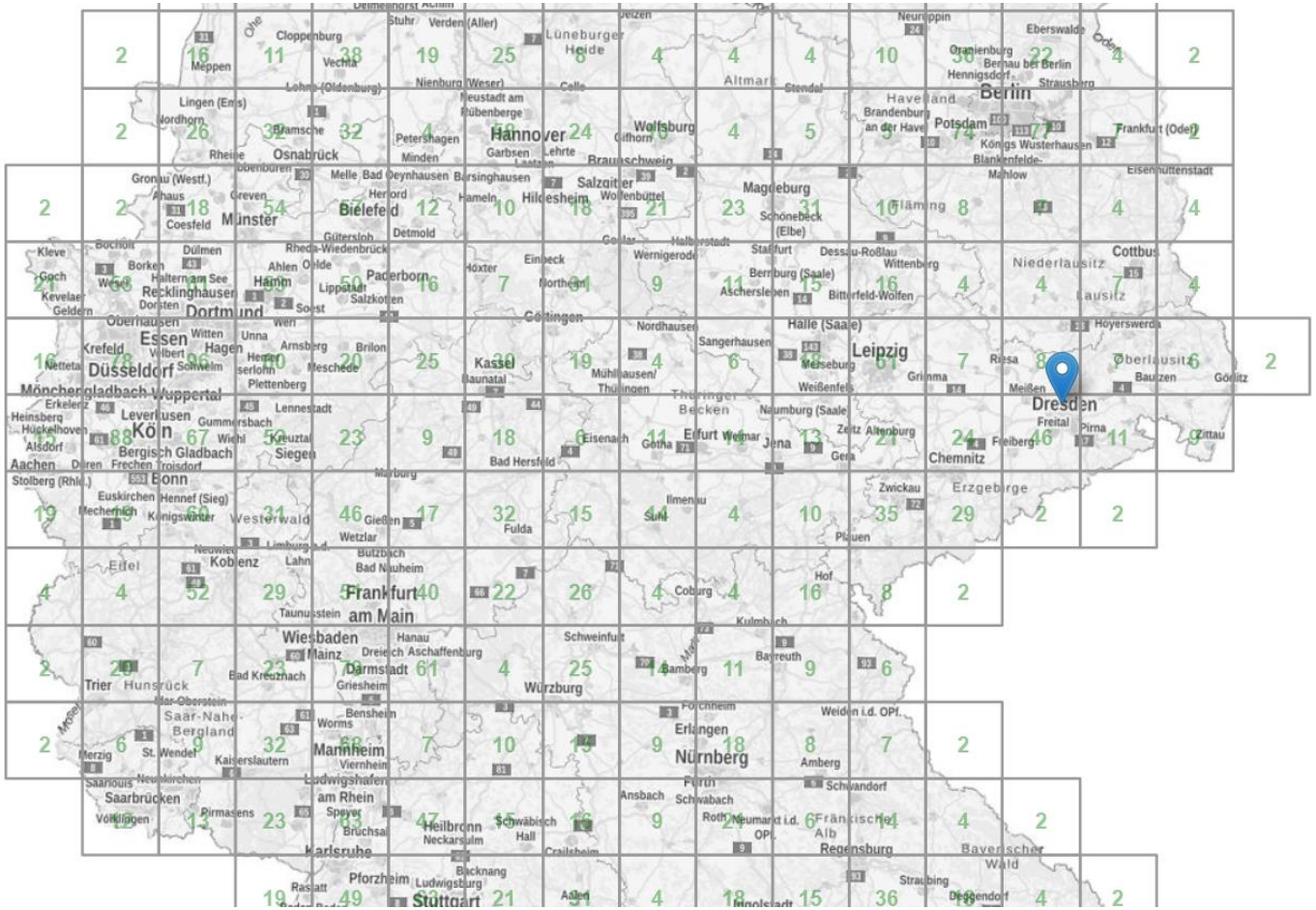
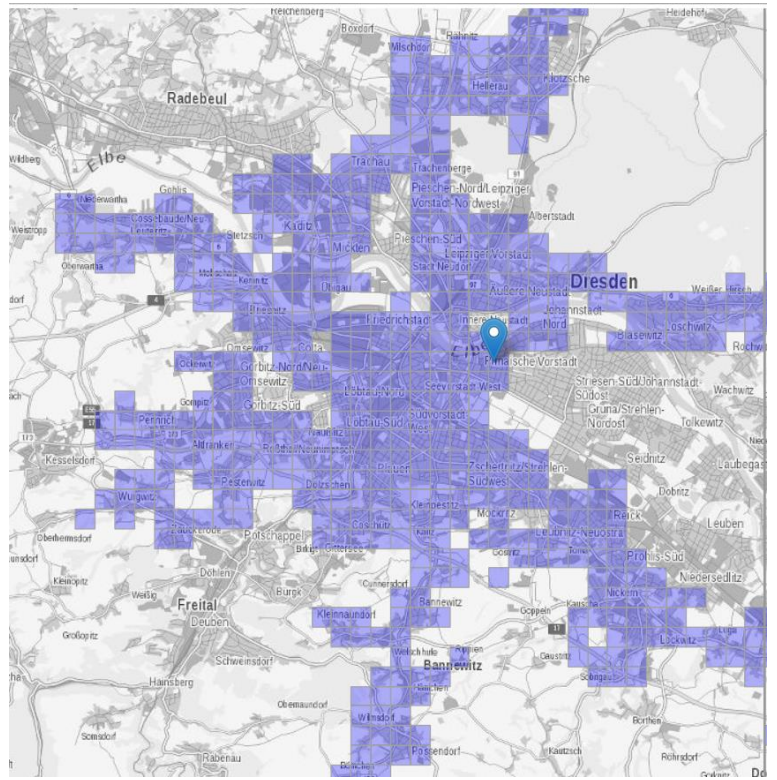
„You can reach any destination.“
+
demand-based and user-friendly
„You don‘t need to wait.“

BACKGROUND

Strategic Roll-out of Public Infrastructure in Germany using the “Standort-TOOL”





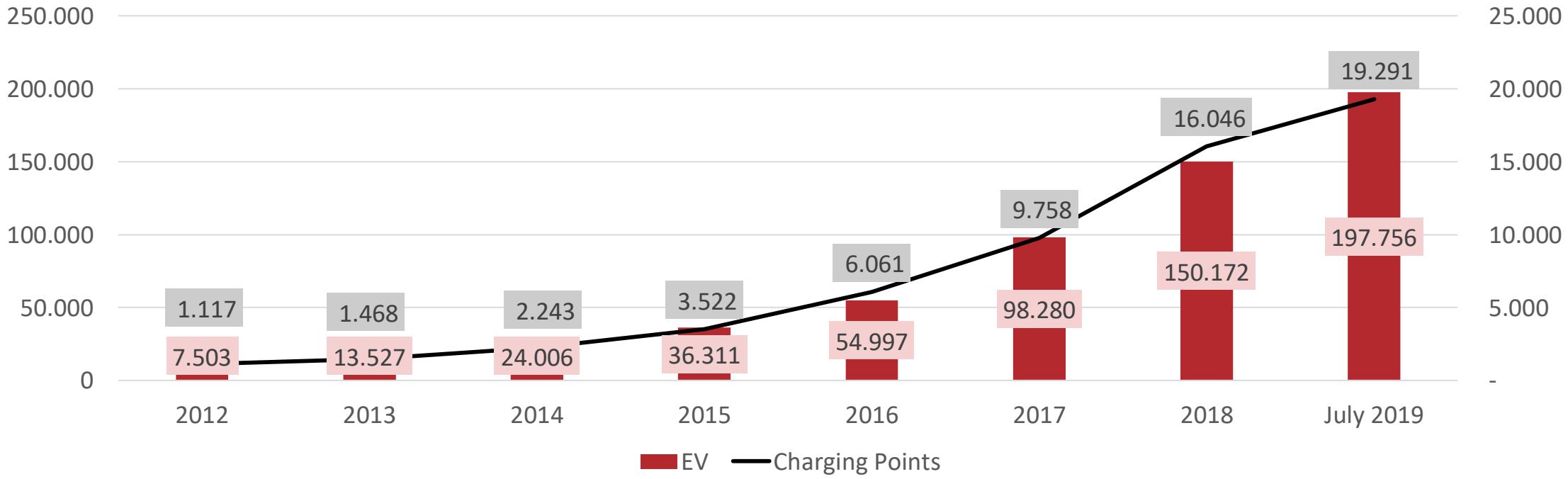
blue area: high potential

➢ higher funding rate

BACKGROUND

Development of Charging Infrastructure and Electromobility in Germany

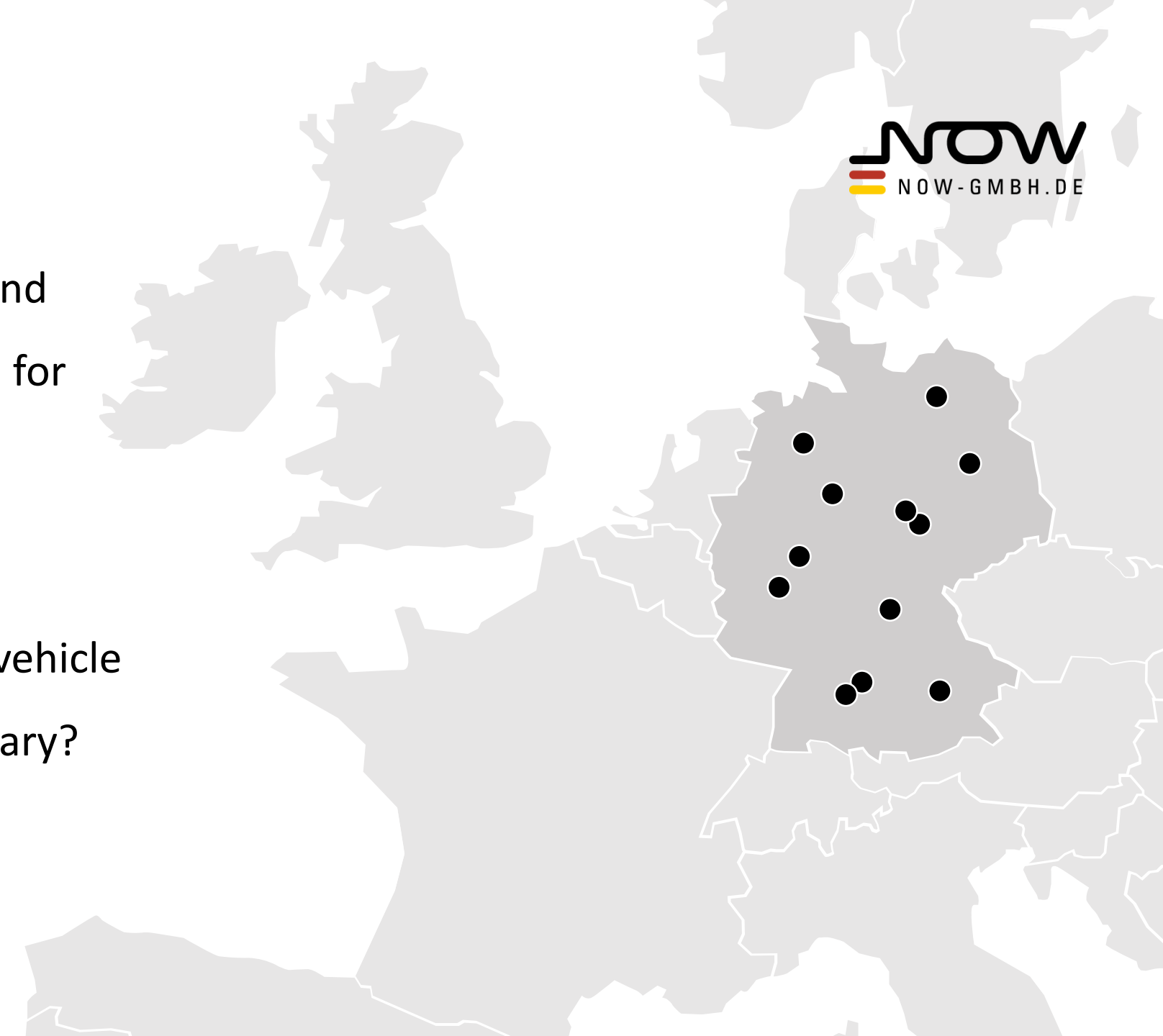
- Electric Vehicles (EV) = Battery Electric Vehicles (BEV) + Plug-In Hybrid Electric Vehicles (PHEV)
- 2.7% of newly registered passenger vehicles are eletric (in June 2019)
- 0.4% of passenger vehicle stock is elctric (status July 2019)



Sources: Federal Network Agency (Bundesnetzagentur), German Federal Motor Transport Authority (Kraftfahrt-Bundesamt)

RESEARCH QUESTIONS

- What utilization levels and end consumer prices are needed for charging stations to become economically viable?
- Is the promotion of electric vehicle charging stations still necessary?



DATABASE AND METHODOLOGY

Evaluation of Economic Viability

- Discounted Cash Flow Analysis
- Economic viable if Net Present Value > 0
- Discounting factor calculated as return on equity, based on Capital Asset Pricing Model (CAPM)

Variable	Formula	Notation	
Net Present Value (NPV)	$NPV = I - \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t}$	I	Investment = Capital expenditures (CAPEX)
		n	Useful life in years
		CF_t	Cash flow per year
		r	Discounting factor
Discounting Factor (r_{CAMP})	$r_{CAMP} = r_f + (r_M - r_f)\beta$	r_f	Risk free interest rate
		r_M	Market return
		β	Company-specific risk factor
Cash Flow (CF)	$CF_t = Total\ Revenue_t - OPEX_t$	$OPEX_t$	Operational expenses per year

DATABASE AND METHODOLOGY

Online Platform for Monitoring of Federal Funding Programme OBELIS

- Location
- Technical Features
- Grid Connection
- Operation, Costs, Pricing
- Utilisation

website: https://obelis.now-gmbh.de

DATABASE AND METHODOLOGY

Input Parameters

Parameter	Used Value	Based on
Useful life in years	15	Estimation, missing category in fixed-asset depreciation table (AfA)
Discounting factor (r_{CAPM})	4.6 %	r_f = 0.46 % (ten-year government bond) r_M = 6.3 % (annual return of the DAX) β* = 0.7 (peer group beta factor of German stock-listed utilities)
Electricity purchase price	21.56 ct/kWh	Ø electricity price of commercial customers in 2018 Source: Federal Network Agency (Bundesnetzagentur) and Federal Cartel Office (Bundeskartelamt), Monitoring Report 2018
CAPEX	depends on type of charging point	Data from proof of expenses of federal funding programme
OPEX*, end consumer price, utilization	depends on type of charging point	Data from half-year reports 2/2018 transmitted via OBELIS

*excluding personnel expenses

DATABASE AND METHODOLOGY

Evaluation for Slow Charging Points

- Data selection: 1,471 charging stations with 2 slow charging points
- Slow charging points ≤ 22 kW

CAPEX

- Only charging stations connected to low-voltage grid
- Ø CAPEX = 11,100 EUR

OPEX and Utilization

- Ø OPEX = 770 EUR/year
- Ø Utilization = 6 kWh/day (n = 67,170 charging sessions)

End consumer price

- Most common price = 39 ct/kWh

DATABASE AND METHODOLOGY

Evaluation for Fast Charging Points

- Data selection: 172 charging stations with 2 fast charging points
- Fast charging points > 22 kW

CAPEX

- Only charging stations connected to low-voltage grid
- Ø CAPEX = 47,700 EUR

OPEX and Utilization

- Ø OPEX = 1,600 EUR/year
- Ø Utilization = 22 kWh/day (n = 44,417 charging sessions)

End consumer price

- Most common price = 49 ct/kWh

ANALYSIS AND RESULTS

Charging stations with slow charging points	Empirical value	Break-Even at (with funding)		Break-Even at (without funding)	
Utilization	6 kWh/day	22 kWh/day	↗ 267%	28 kWh/day	↗ 367%
End consumer price	39 ct/kWh	85 ct/kWh	↗ 118%	1,04 EUR/kWh	↗ 167%

Charging stations with fast charging points	Empirical value	Break-Even at (with funding)		Break-Even at (without funding)	
Utilization	22 kWh/day	43 kWh/day	↗ 95%	60 kWh/day	↗ 173%
End consumer price	49 ct/kWh	75 ct/kWh	↗ 53%	97 EUR/kWh	↗ 98%

CONCLUSION AND LIMITATIONS OF ANALYSIS

- Funding for public charging infrastructure still needed at current levels of utilization and consumer prices
- Break-Even reachable at realistic levels of utilization

LIMITATIONS OF ANALYSIS:

- Revenue stream assumes that charging point operator (CPO) = E-mobility provider (EMP) for all users of the charging stations (no levy payments between CPO and EMP)
- Personnel expenses are not considered within OPEX
- Master data in OBELIS is based on self-reported specifications from investment grant recipients (e.g. charging capacity of charging point)
- Operating data in OBELIS is based on data export of IT-backend of charging stations with possible software errors

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FUEL CELL TECHNOLOGY

FASANENSTRAßE 5
10623 BERLIN
GERMANY

Laura Prawatky
Programme Manager
Accompanying Research for Charging Infrastructure
E-mail: laura.prawatky@now-gmbh.de