RWE E-Mobility Projects

The energy to lead

Dublin, 18 February 2009

Daimler and RWE launching into the ages of E-Mobility

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In contrast to other new individual transport concepts the “refuelling” infrastructure for electric vehicles (EV) is already in place

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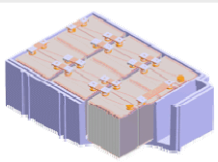
Enablers for sustainable market penetration of EVs/PHEVs are there

DRIVERS FOR E-MOBILITY

TCO and other advantages		Range limitation (might be) solved	
Fuel prices	**CO_2-taxes and framework**	**Li-Ion-batteries**	**Plug-in hybrids**
			
> Fuel prices on record level: 1,54 EUR / l[1)] > Long term forecast: real stable to further rising	> EU: Strict fleet emission targets (2012: <120 g/km) > EU Penalties on CO_2-fleet emission incentivy OEMs to push e-mobility > CO_2-based taxes discussed > Local measures	> Li-Ion-batteries with double energy density compared to NiMH > Ranges sufficient for everyday use > Mass market production expected for 2010	> Range limitation solved by add-on combustion engine (range extender) > Sufficient recharge grid expected

1) 95 Octane, Mineralölwirtschaftsverband Juni 2008

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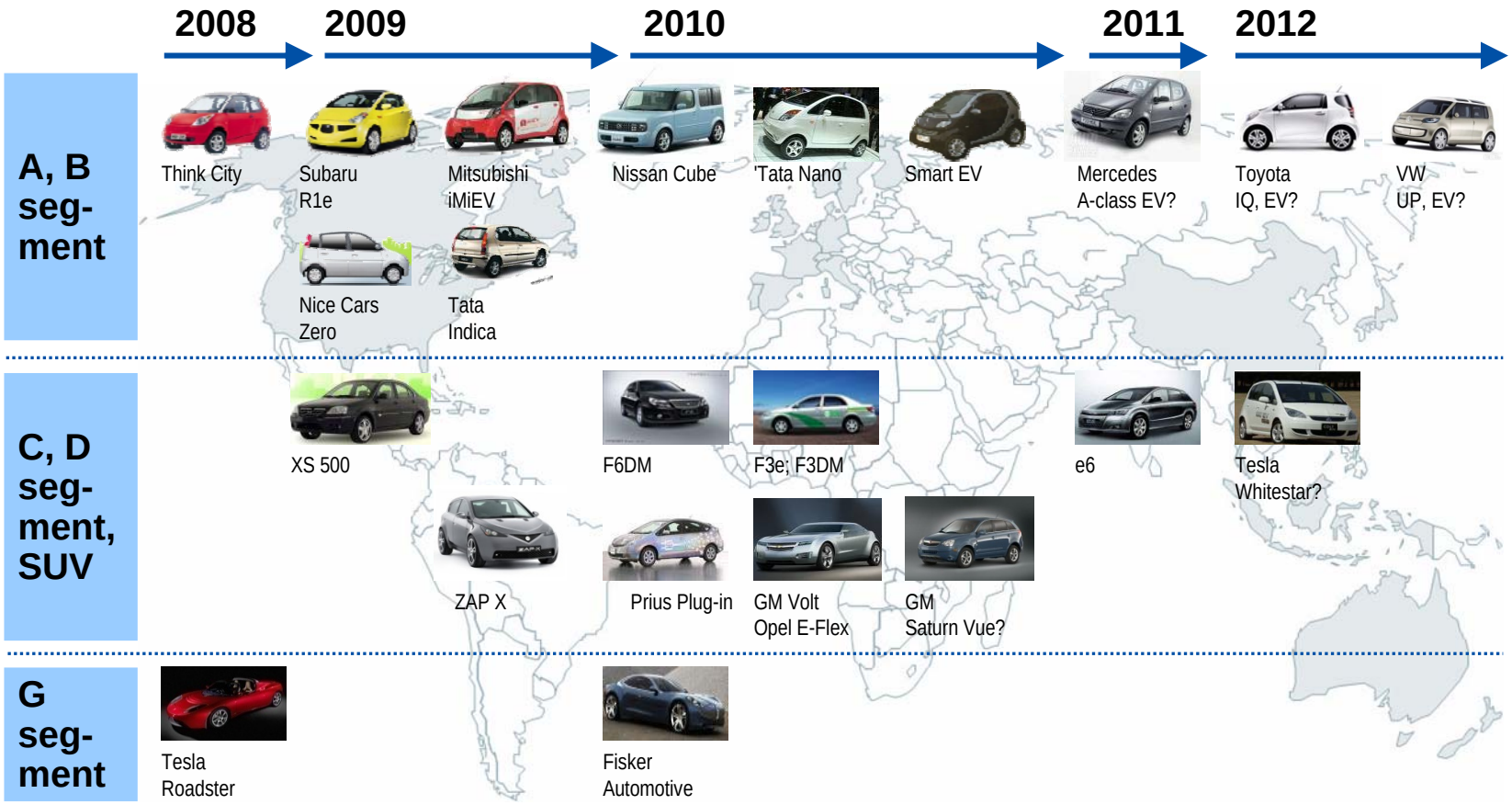
Over 20 EV/PHEV models from leading OEMs and newcomers expected to enter market before 2012

OVERVIEW OF EV/PHEV GLOBAL OFFERING (ANNOUNCED) – 2008 TO 2012



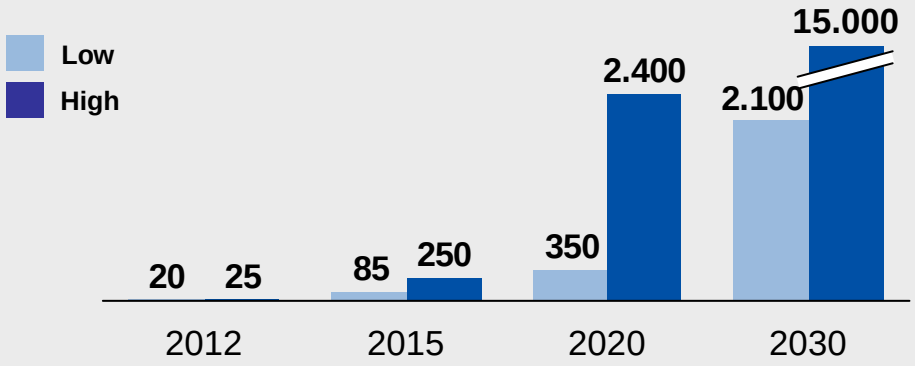
Market scenarios: significant increase from 2015 – in 2020 up to 25% of all new cars could be EV/PHEV

MARKET SCENARIOS EV/PHEV GERMANY; LOW AND HIGH [2012 – 2030]

EV/PHEV of registration of new cars Germany [%]

	2012	2015	2020	2030
Low	<1%	1%	2%	2%
High	1%	4%	23%	23%

Total EV pool Germany ['000]



Total electricity demand [TWh]

	2012	2015	2020	2030
Low	0.02	0.1	0,4	2.8
High	0.04	0.4	3.2	19.0

- State incentives to reach CO2 fleet-targets (penalties for OEMs, CO2-taxes)
- Resulting pricing with positive impact on demand for EV/PHEV
- 2012-target of 120 g/km achievable with optimizing conventional technologies
- 2020-target of 95 g/km requires introduction of EV/PHEV
- Total demand to reach 19 TWh – 3 % of total gross production (637 TWh) in Germany

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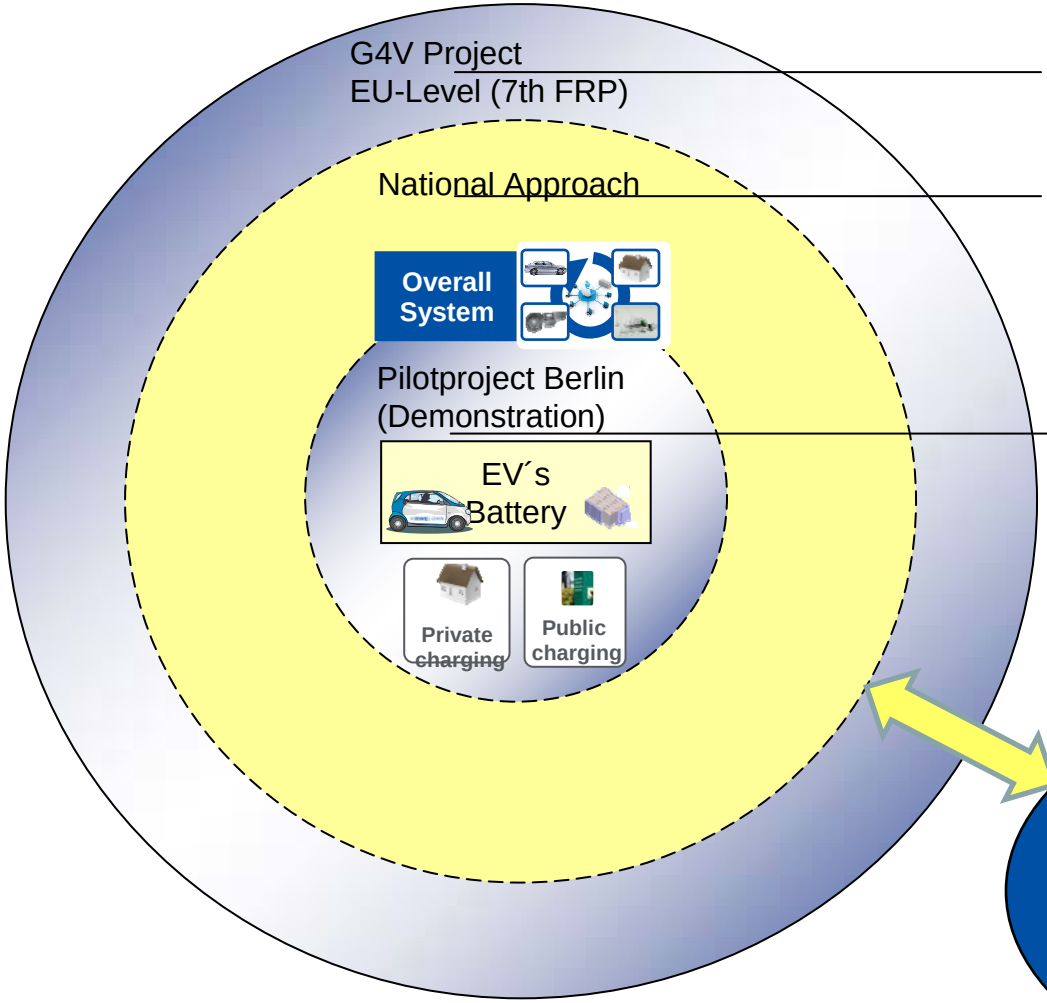
RWE´s E-Mobility activities at a glance



- Effects of the mass market introduction on the grid
- System Services
- Bi-directionality
- EU-scope

- Development/ Test of Key components
- Systemintegration and – scalability of an Master system
- Business Modelling

- Pilotproject: Demomstration of Master system (Feasibilty/ Lessons Learnt)
- Analyses of customer acceptance
- Derivation of further development needs/ Optimization loop

Deliverable:
System solution Roll-Out/ Bi-directionality

Deliverable:
Specification Control Center (List of Requ.))

Deliverable:
First medium scale realization

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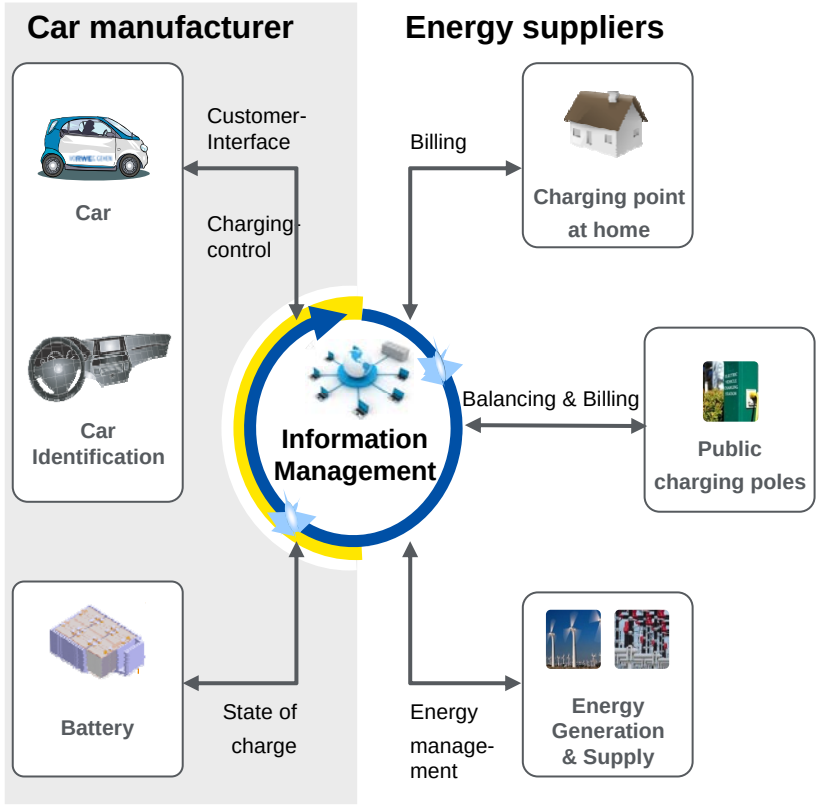
Standardization efforts

EV implication on Electricity Grids

> **A mass market of EVs requires:**

- **Innovative interactions between customer and several stakeholders**
- **A common hardware solution for maximum customer convenience (socket – connector- charging point)**
- **Innovative communication and data handling based on standardized metering protocols**



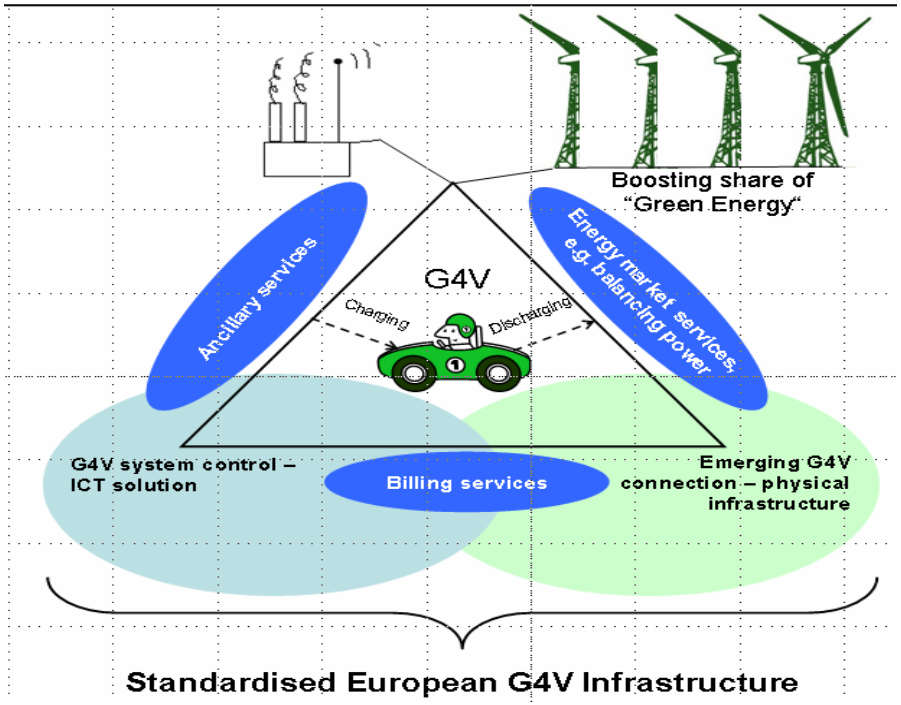
The G4V project aims in respect of the current call are…

> enabling the mass roll out of electric vehicles

> seize the opportunities of the different stakeholder

> minimize the risks for the electricity grids

> ensure customer convienience



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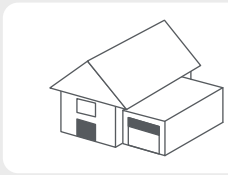
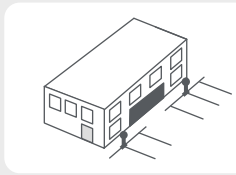
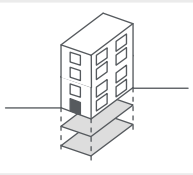
A sufficient recharge grid is a main driver for market penetration of EVs/PHEVs

POTENTIAL LOCATIONS FOR RECHARGING STATIONS

	At home	Public parking	At work	Curb side
Type of location				
	> Own garage or parking space	> Customer parking	> Employee parking	> Curb side
Ownership real estate	> Private	> Private	> Private	> Public (City/ municipality)
Power supply	> Exisiting connection of owner	> Existing connection of facility owner	> Existing connection of facility owner / employer	> New development / connection with the grid

Different scenarios have been developed to simulate effects on grid

SCENARIOS FOR SIMULATION OF GRID IMPACT

Market stage	Innovators	Early adapters	Mainstream market
Market data	> 100.000 EVs > 8.000 km/a > 0,1 kWh/km > ~ 4 kWh/d > 400 MWh/d	> 1.000.000 EVs/PHEVs > 15,000 km/a > 0.15 kWh/km > ~ 7.5 kWh/d > 7,500 MWh/d	> 10,000,000 EVs > 12,000 km/a > 0.25 kWh/km > ~ 10 kWh/d > 100 GWh/d
Power connection	> 4.6kW one phase > 230V 20A > not exposed (V2G-applications)	> 14kW 3 phase > 0.4kV 20A	> 44 kW 3 phase > 0.4kV 63A
Effects	**Neglectable impact on grid and generation**	**Small impact on grid and generation**	**Significant impact on grid and generation**

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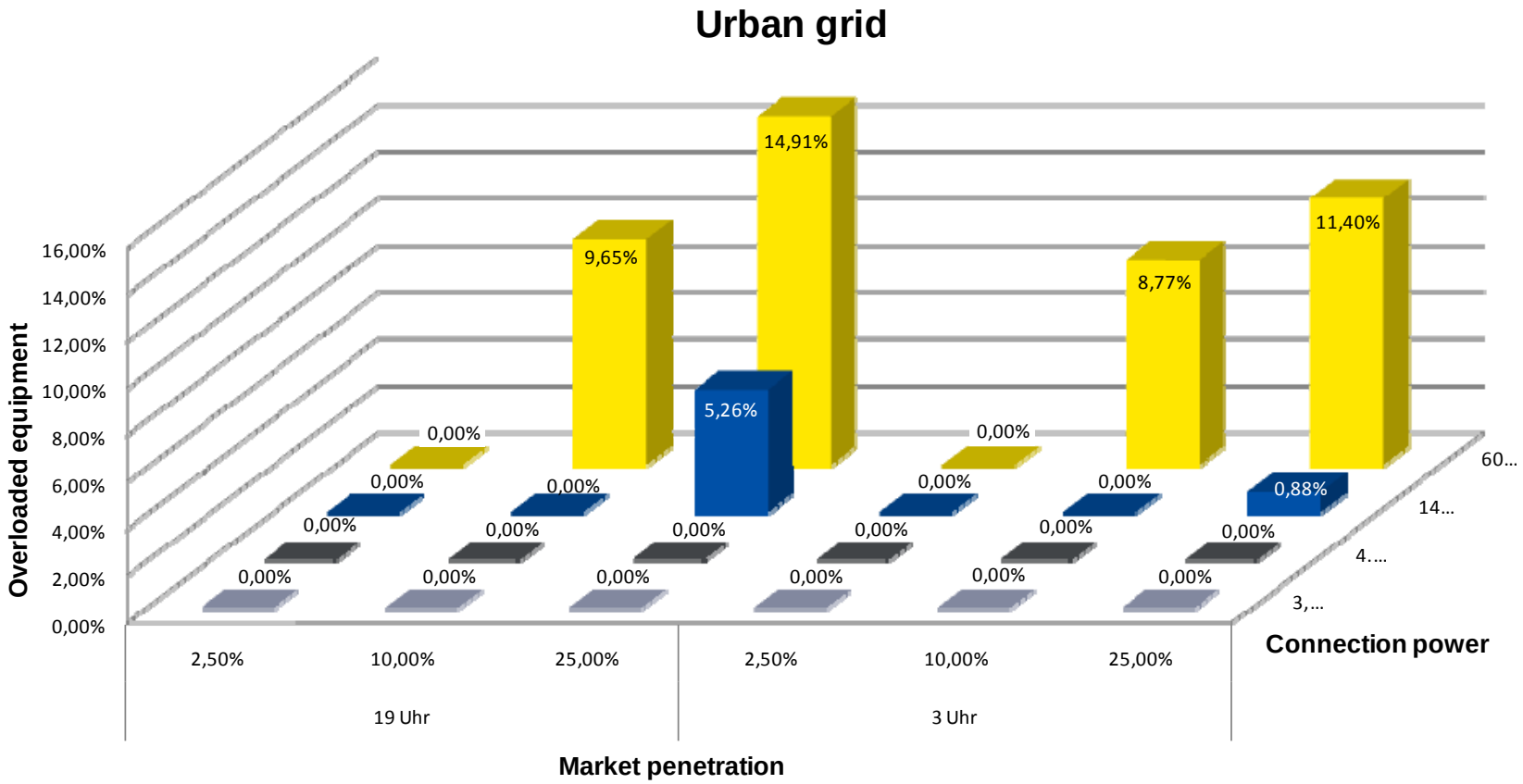
Limited effect on urban grid with reasonable connection power

SIMULATION OF GRID IMPACT FOR URBAN GRID



Source: Grid study Fraunhofer / RWTH Aachen

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E-Mobility Target is the development and demonstration of the „Master System“ which can handle the moving mobile customers

Targets of the RWE E-Mobility projects

	Vehicle Interface	Intelli-gent Re-charger	Safe Data network	Controlled Electricty Grid	Control Center	Added Value Services	Master system
R&D	> Interface Vehcile – Recharg eing pole	> intelli-gente Recharg ing pole	> Test of Data-network for Commu nication	> Usage of E-Mobility function ality of Smart Grid	> Centrali zed Intellige nce for E-Mobility	> Creation of the baseme nt for V2G and G4V	> Creation of a list of require-ments for a Master system

	Technical Test in Mülheim a.d.R.	Pilot and Demonstration in Berlin
Technical Test and Demon-stration	> Technical Test of technical/physical Developments in Mülheim with a small circle of customers with EVs (3-5 EV)	> Funcionality test of the Master System in Berlin > Large scale demonstration with broad numbers of E-Vehicles and Customer > Development of customer solutions via the real test bed

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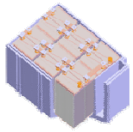
Huge existing demand on technical development in Infrastructure for EV is adressed in the E-Mobility projects

Battery	EV / PHEVs	Vehicle Interface / Recharging Pole	Safe Data-/ Electricity Network	Control Center	Added value services	Master System
						
> Li-Ion-Battery with Energy density 2x opposite to NiMH > Useful Range capacity > Massmarket capability in 2010 possible	> Problems in driving ranges will be solved with Hybrid concepts (ICE/Range Extender)	> Massmarket maturity of Commu-nicationssolu tions are not available > No intelligent Recharging concept existing	> Derzeit vernetzte Lade- / Daten- und Strominfra-struktur nicht verfügbar > Hoher F&E Aufwand für Entwicklung Smart Grid für E-Mobilität notwendig	> Centarlized Intelligenz for a mass market introduction nescessary r > Great R&D-efforts are needed	> Technical requirements for realization of V2G / G4V-concepts isn´t there in the moment	> Holistic Management of a broad infrastructure for E-Mobiliy isn´t exist in the moment > Great R&D efforts are needed
Focus of existing Initatives		**Technology focus of RWE E-Mobility project**				

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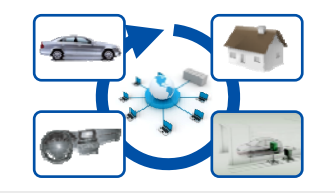
In the large scale Project E-Mobility Berlin the Master system will be developed and the Maturity of the technical solutions for a massenmarket prepared

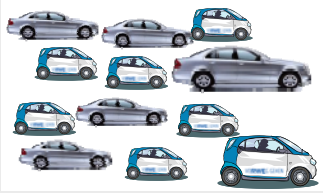
Stage I (2009) Stage II (2010/2011)

Development Master System



> Development of an **integrated Master System** – Key components:
  - **Elektric Vehicle**, incl. Battery-technology
  - **Recharging Infrastructure**, incl. Nessescary Communication technology
  - **Electricity Supply**, incl. Generation mix and Integration of Vehicle-to-grid functionalities
> Clear **Orientation on Customer Solutions**
  - Mobility offers
  - Integration of local B2B partner

Technical Trial Mülheim a.d.Ruhr and Demonstration in Berlin



> **Functionality Test of the scalability of the Control Center** – handling of greater numbers E-Vehicles and Customers
> **Customer solutions** in a real **Environment**
  - Examination of **Customer behaviour & acceptance**
  - Sufficient numbers and „supply“ area **to define the optimal Recharging Infrasstructure**
  - Waht are the **attractive Locations** for **Recharging poles**
> In Summ > **100 E-Fahrzeuge** of the brand **smart / Mercedes-Benz** and in the first instance **ca. 500 Recharging points provided by RWE**
> In a pre phase all **technical trials** in Mülheim

Demon-stration

> **Large-scale Demon-stration in Gemany** to accelerate the **mass market introducti on**
> **Projects** with further **Partners**

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Beside the technical developments some other obstacles has to be solved – dedicated parking space:

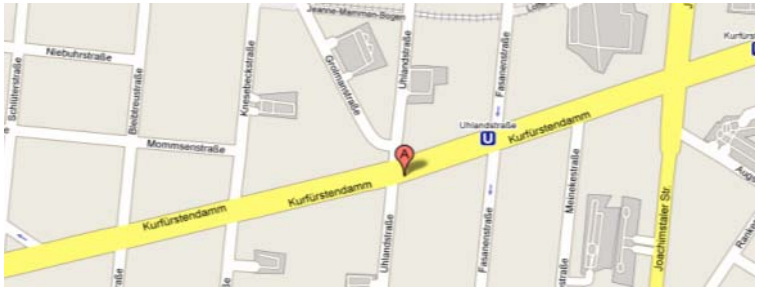
Detailing of the Location

> In front of shops (Douglas) und Cinema „Paris“
> First two parking lots side by side on the mid street area
> West of Uhlandstraße

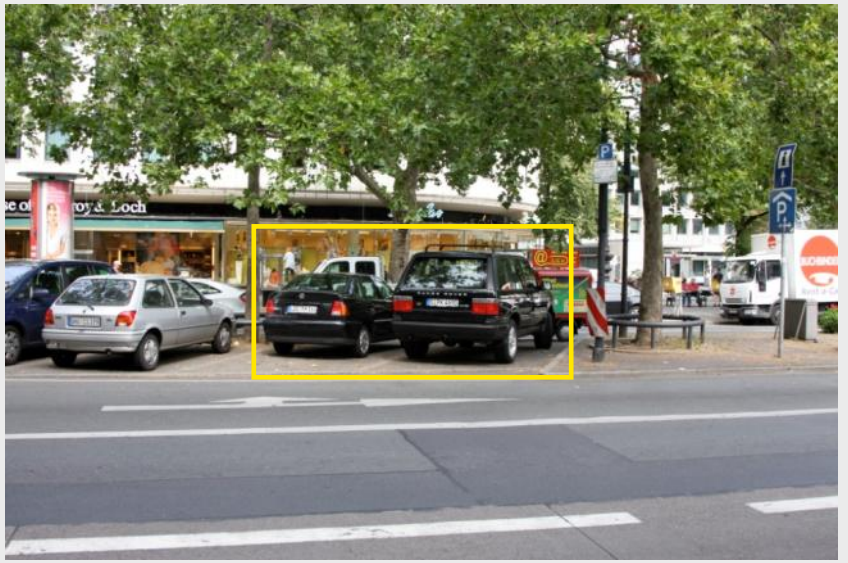
Kriterien für Standortwahl

> Passer-by frequency: **niedrig** ——●—— **hoch**
> Attractiveness of Shops: **niedrig** ——●—— **hoch**
> Estm. parking time [min]: ☐ **<30** ☑ **30-60** ☐ **>60**
> Further Advantages: High visbility from both Street sides

Section of City map



View



Parking informations

Managing time: 09:00 – 22:00 (Zone 7)
Free of charge: 22:00 – 09:00

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Standardisation is needed to enable the EV user to re-charge at any charging station without different connectors

Hardware

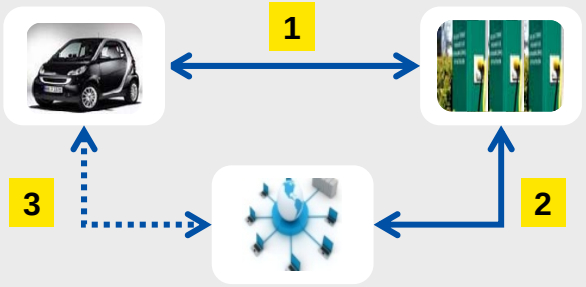
Cable/ connection

> On the basis of the load needed

Mechanical protection

Communication

Communication protocols



1 TCP/IP (e.g. Powerline)

2 Communication via TCP/IP in the grid (e.g. DSL via concentrator) or wireless communication TCP/IP (e.g.. GSM)

3 Optional: wireless communication TCP/IP (e.g. GSM)

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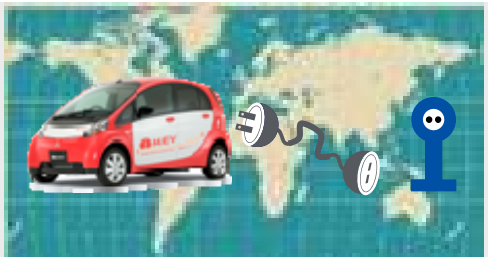
Standardization benefits customers, utilities and OEMs

Benefits from standardization

For customers



- **High convenience**
  - **One single solution worldwide**
  - **No adapters** or different cables needed
- **Faster** electric vehicle **run-up/market success**
- **No retrofit costs** for adopting to new charging systems

For Utilities/OEMs

- **Cost benefits**
  - **No sunk costs** for proprietary interim solutions
  - **Shared** development and standardization **costs**
  - **Economies of scale**

An OEM/Utility standardization initiative was started end of 2008 to accelerate and improve standards definition

Audi
essent
OPEL
EnBW
endesa
FIAT GROUP
EDF
Ford
e·on
PSA PEUGEOT CITROËN
RENAULT
VATTENFALL
MITSUBISHI MOTORS
edp
NISSAN
TOYOTA
RWE
Enel
VOLVO

OEM/Utility standardization initiative will ensure a common technical approach

REASONS FOR IMPLEMENTING THE OEM/UTILITY STANDARDIZATION INITIATIVE

OEM/Utility standardization initiative process

Benefits of OEM/Utility standardization initiative

- **One single position** to speed up the standardization process
- **One common standard** already **for the first generation infrastructure/ vehicles**
- **Clear development roadmap**

Let us work together to construct the pathway which makes the mass market introduction of E-Mobility possible !!!

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More time to talk ? More questions ?

> Backup

Electric mobility enables efficient integration of RES

Network integration is decisive for business model:

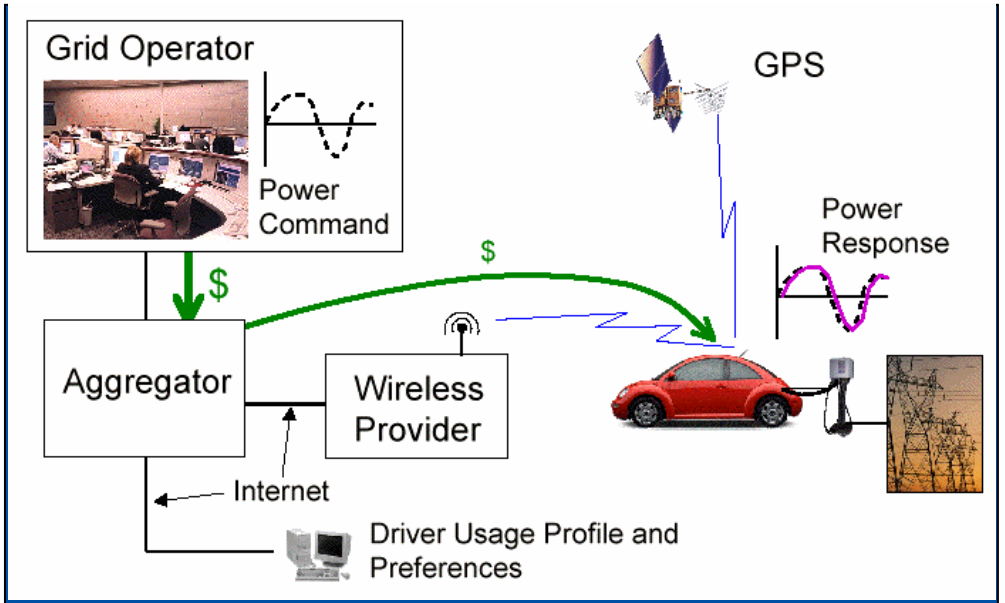
“Vehicle to Grid” (V2G) requires “Grid for Vehicle” (G4V)

Use of “plug-in” capable vehicles as distributed mass storage systems for providing system services

+ Error tolerant
+ Regionally controllable
+ Cost effective due to double use
+ Additional energy sales

Bottlenecks:

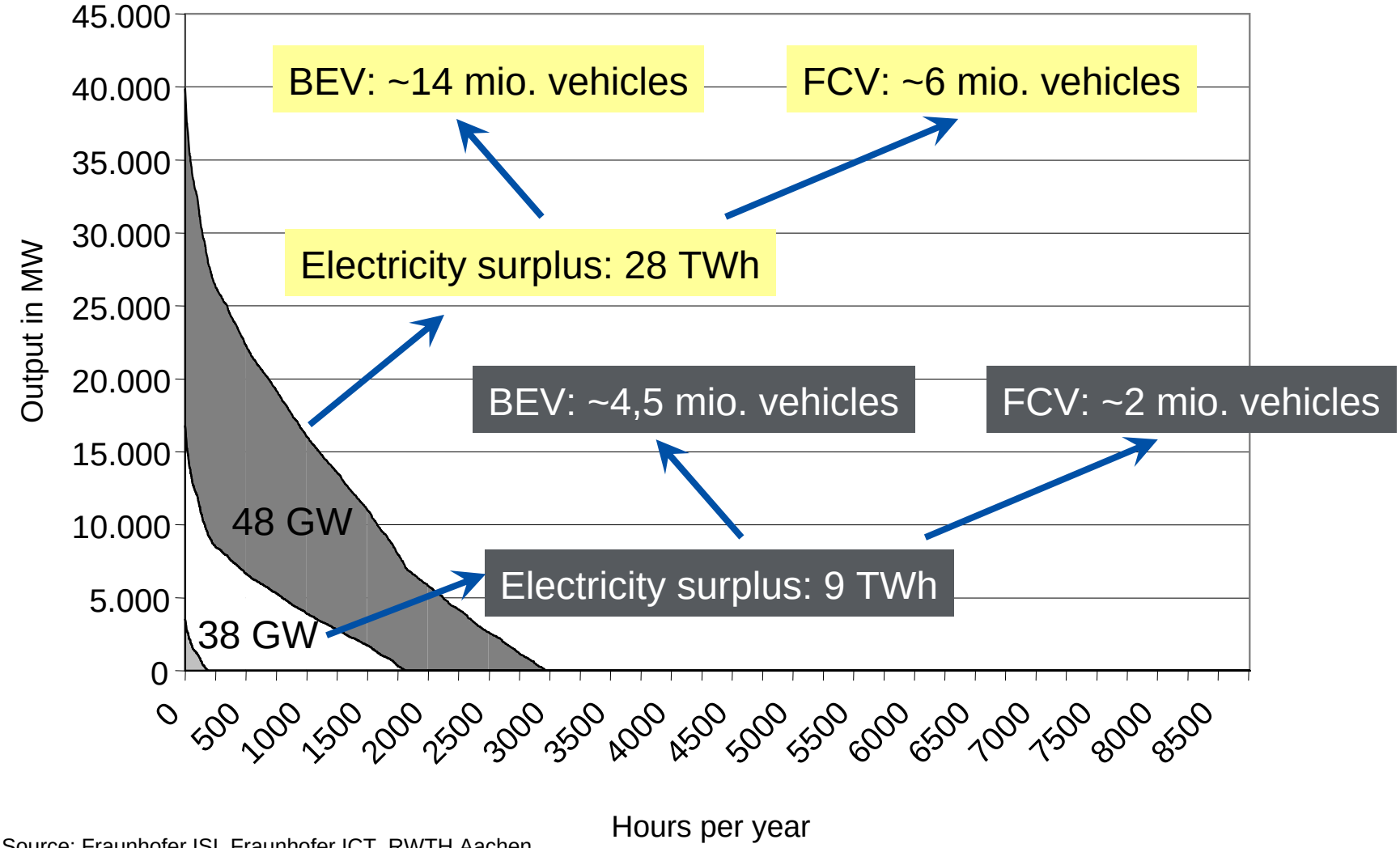
- Battery storage (techn.)
- Grid connection (economic)
- Poss. greater loads in the low voltage sector in the low tension grid



Just 660,000 vehicles would be able to provide more balancing power (for approx. 1h) than all of the German pumped-storage hydroelectricity plants combined.

Source: Fraunhofer ISI, Fraunhofer ICT, RWTH Aachen

Electric mobility enables efficient integration of RES - a high potential to absorb electricity surplus



Source: Fraunhofer ISI, Fraunhofer ICT, RWTH Aachen

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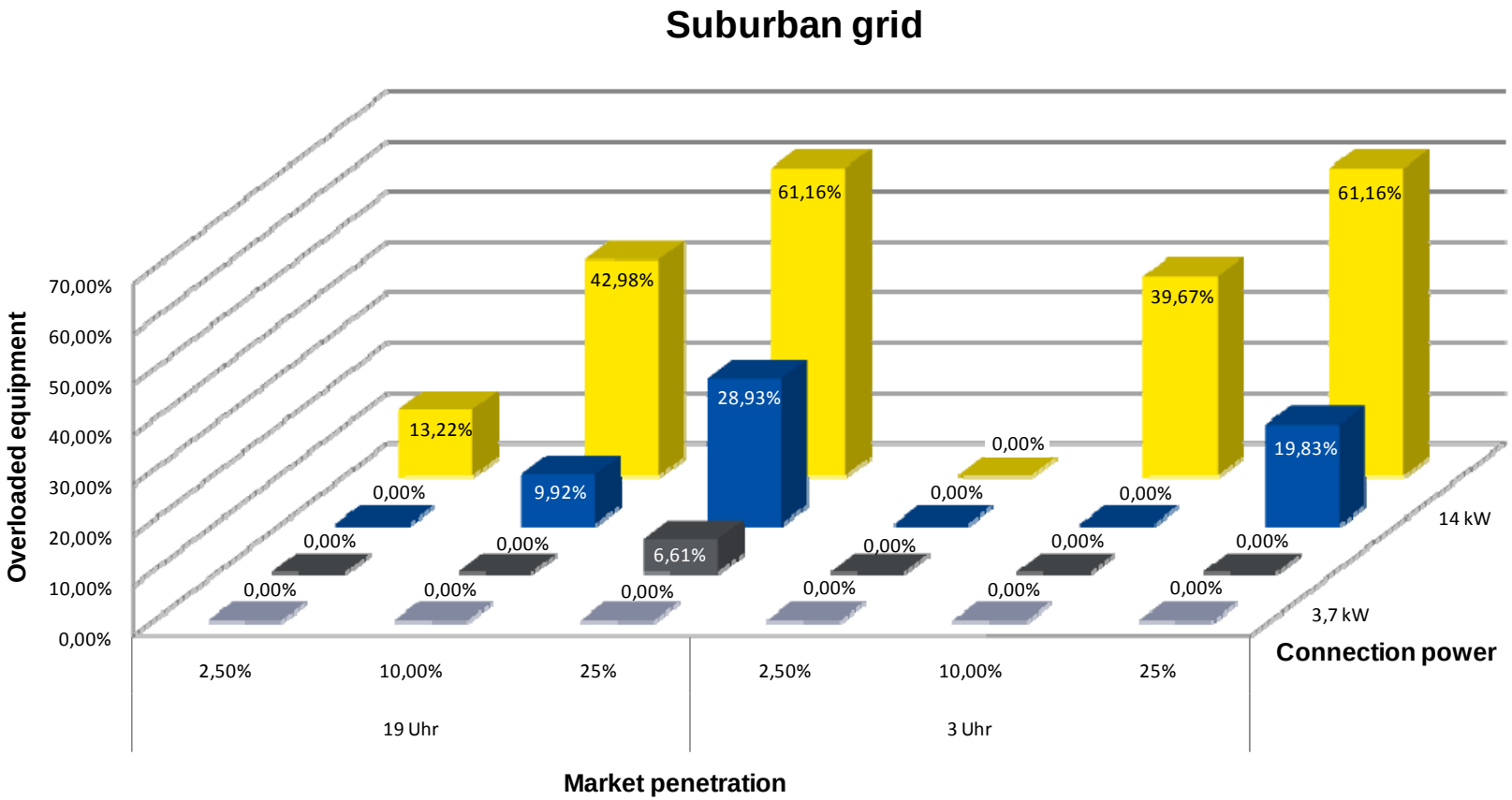
Suburban grid with fewer capacity reserve than urban grid

SIMULATION OF GRID IMPACT FOR SUBURBAN GRID



Source: Grid study Fraunhofer / RWTH Aachen

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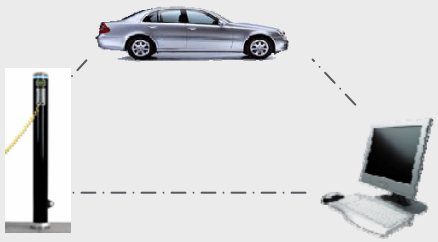
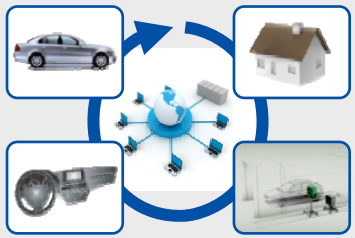
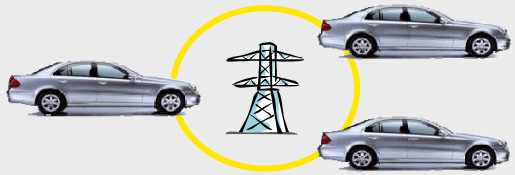
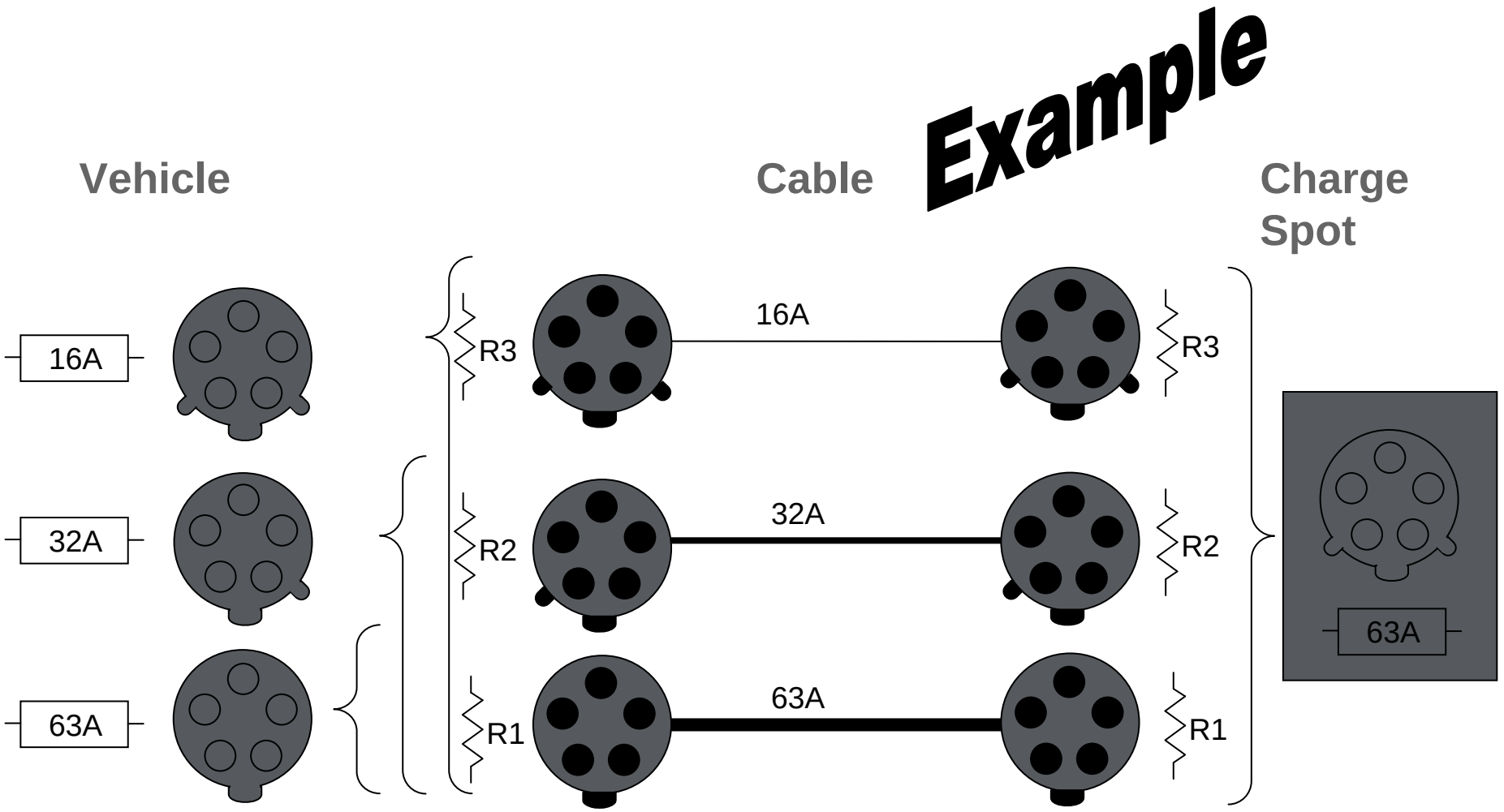
E-Mobility was the initiator of the de facto-standardization efforts in Europe

Essential contribution for the Innovation position Germany

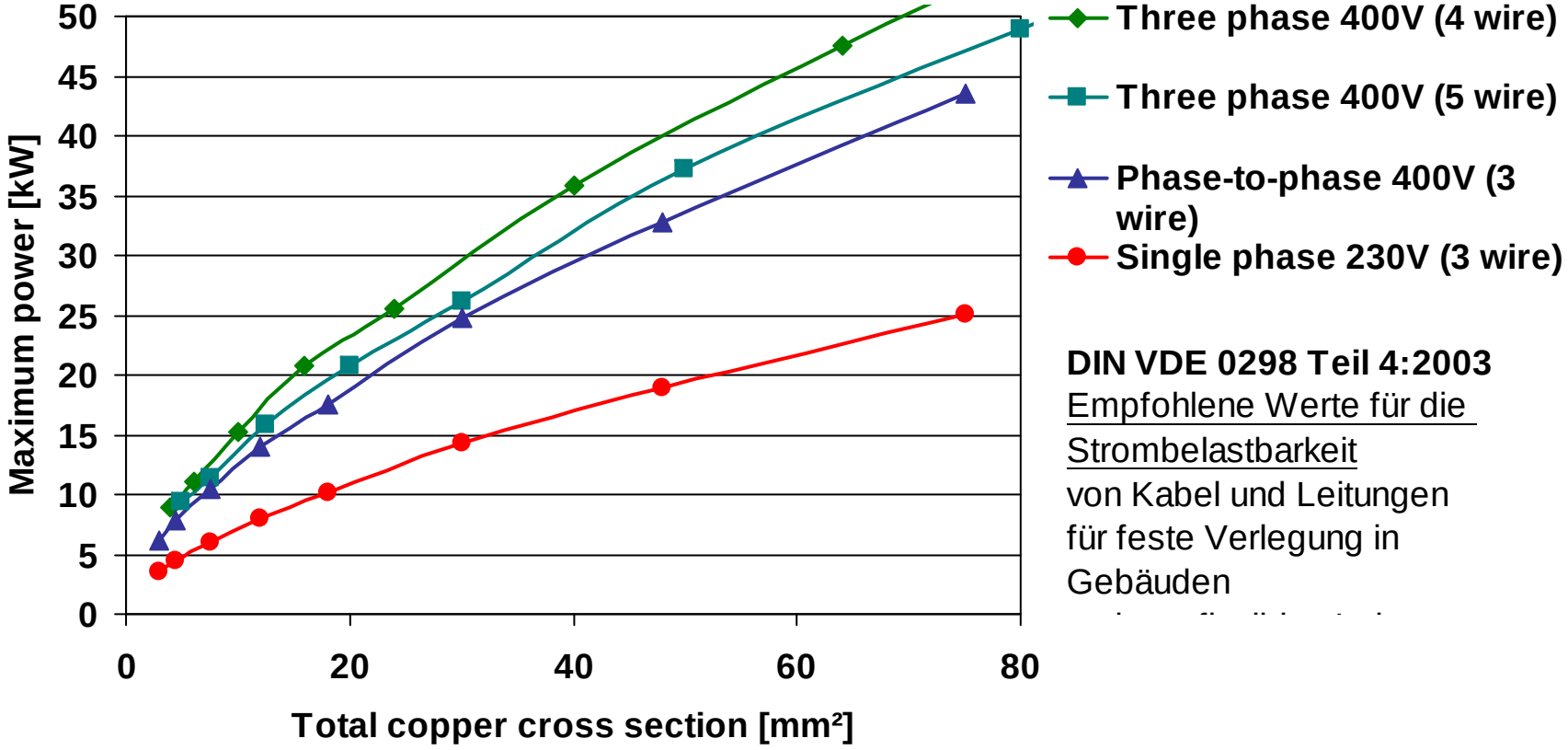
Innovative Informations- and Communication technologies	Innovative Systemintegration	Innovations in Positioning of the electricty network for E-Mobility
		
> **Entwicklung innovativer Informations- und Kommunikationslösungen** im Bereich **E-Mobilität** > **Entwicklung** neuer und / oder **Adaption bestehender Protokolle / Standards für Datenaustausch** > **Schaffung Quasi-Standard** für Schnittstelle Ladestation	> **Innovationen** in der **System-integration** von Elektrofahrzeug, Ladeinfrastruktur, Stromnetz- und zentrale Intelligenz (Control Center) in Deutschland > **Erstmalige großflächige Demonstration** in Deutschland	> **Entwicklung Grundlagen** für **Aufrüstung Stromnetz** mit **intelligenten Funktionen** (Beispiel: Integration Multi-Utility-Communication (MUC)) > **Grundlagenentwicklung** von **V2G- und G4V-Anwendungen** durch Gesamtsystemlösung (damit Erhöhung Potenzial Erneuerbare Energie)

Coding of charge cable power limit



Use of three phase power

Power vs. copper cross section for single phase, two phase (phase-to-phase) and three phase



DIN VDE 0298 Teil 4:2003
Empfohlene Werte für die Strombelastbarkeit
von Kabel und Leitungen
für feste Verlegung in
Gebäuden