Introduction to ISO 15118 Vehicle-to-Grid Communication Interface

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RWE
The energy to lead

Word Cloud ISO 15118-1

Word Cloud ISO 15118-2

Agenda

Part I

> Motivation for a high-level communication
> Philosophy of ISO 15118
> Architecture
> Use cases

Part II

> Information flows
> Sequence diagrams
> Data structures
> How to implement? (reference implementation, test cases)

Part III

> Privacy and security

MOTIVATION FOR A HIGH-LEVEL COMMUNICATION

Political and technical Regulations for E-Mobility

- European Union defined the 2020 climate and energy package, also known as “20-20-20“ targets and Clean Vehicle Directive.
  - “A **20%** reduction in EU greenhouse gas emissions from 1990 levels;
  - Raising the share of EU energy consumption produced from renewable resources to **20%**;
  - A **20%** improvement in the EU's energy efficiency.”
- Today (distribution) grid system configuration can be better operated with assistance of smart charging.
- Costs of grid enhancement exceed costs for “Smart Charging” clearly.
- Optimized usage of fluctuating renewable energy (photovoltaic, wind).
- Possibly development of new market(s) for selling flexibility of EV charging.

1. EU policy context of the next decade

Transport White Paper - March 2011
"Roadmap to a Single European Transport Area Towards a competitive and resource efficient transport system"

Identified Goals:

By 2030:

- Reduce transport GHG emissions by 20%
- Halve use of conventionally fuelled cars in urban centres
- Essentially free CO2 logistics in major urban centres

By 2050:

- Reduce transport emissions by 60%

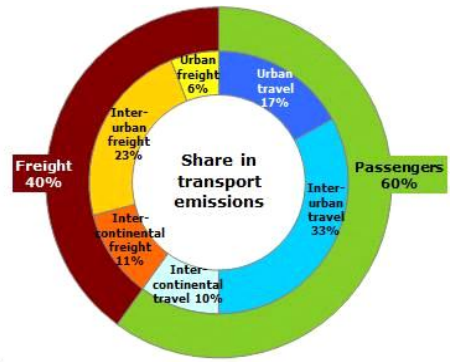
2. Co-evolution Electricity and Transport system

- Together both industries have more potential for optimization than independent from each other
- Possibility to enable grid optimization taking into consideration as well user and grid needs
- Usage of existing ICT systems to do authentification

eurelectric
ELECTRICITY FOR EUROPE

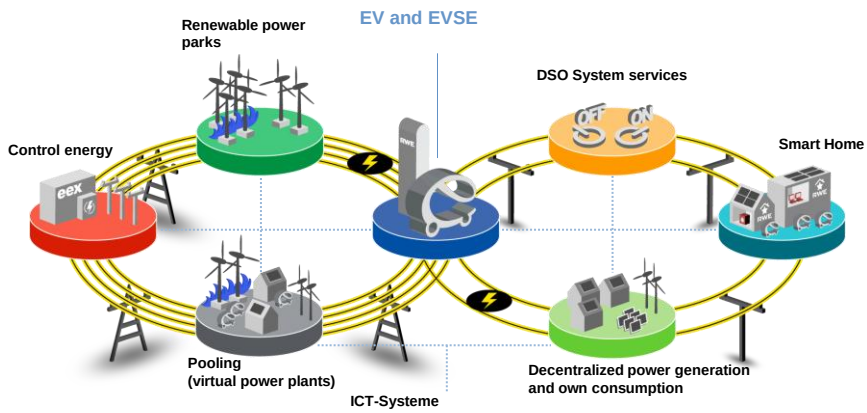
Towards sustainable mobility: Introduction of alternative fuels will be indispensable

- Transport accounts for about 1/4 of GHG emissions in the EU:
  - 60% comes from passenger transport (especially cars)
  - 1/4 is urban transport
  - 1/5 is inter-continental transport
  - over half is medium-distance transport



Source: *European Commission Transport White Paper 2011*

Electro mobility will play a major role in the future Smart Grid activities.



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Source: FTD, RWE

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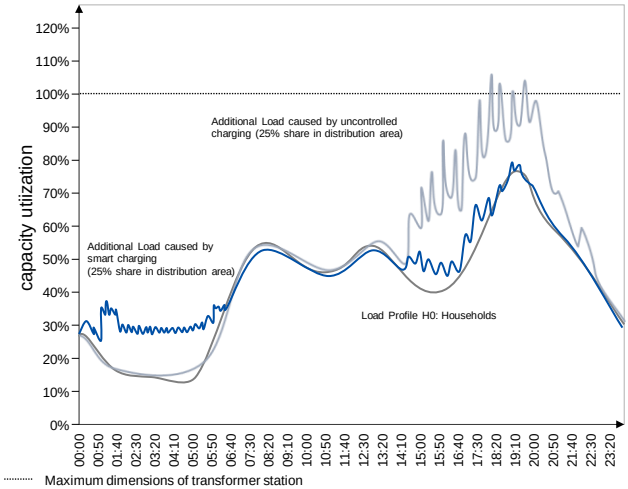
Smart Charging combines security of energy supply and customer convenience.

Effects of EV's and charging scenarios on the load curve



- Smart Charging limits the effects of additional loads on the distribution grid caused by EV's
- Overload situations can be avoided up to a high market share of EV's (~50%)
- Smart Charging offers the possibility to use the fluctuating generation of renewables
- No loss of convenience for the customer as the charging time is derived from customer preferences

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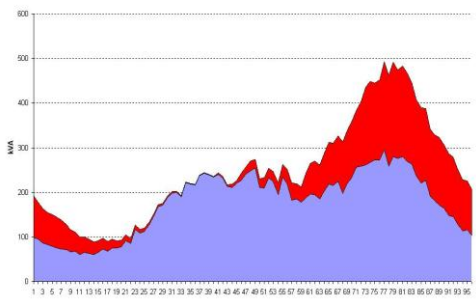
Comparison of Grid Effects with different charging Power (uncontrolled Case)

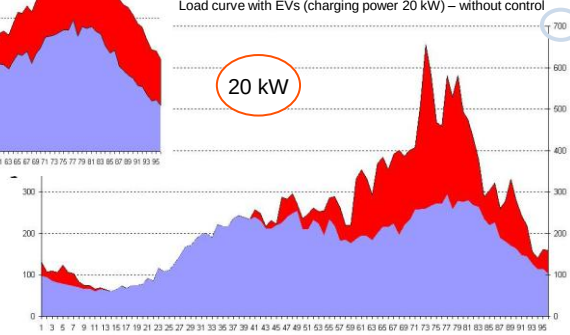
Load curve with EVs (charging power 3.7 kW) – without control



Assumptions:

- Suburban grid: 630 kVA per sub station
- Battery capacity: 16-35 kWh
- Penetration rate: 40 % (EV/Household)
- rund 250 Haushalte (2000-8000 kWh/a)

Load curve with EVs (charging power 20 kW) – without control



- Only short time overload
- How to react on this?

Source: Thomas Dederichs, IFHT-RWTH Aachen: "Elektrofahrzeuge als virtuelle Energiespeicher", BDEW-Fachtagung, Berlin, 14. Oktober 2010

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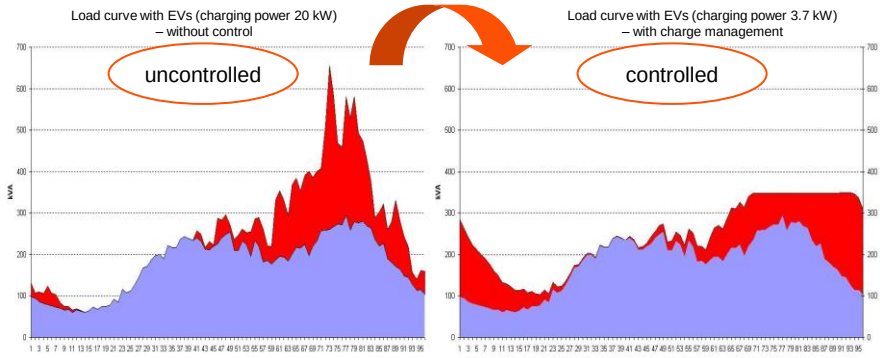
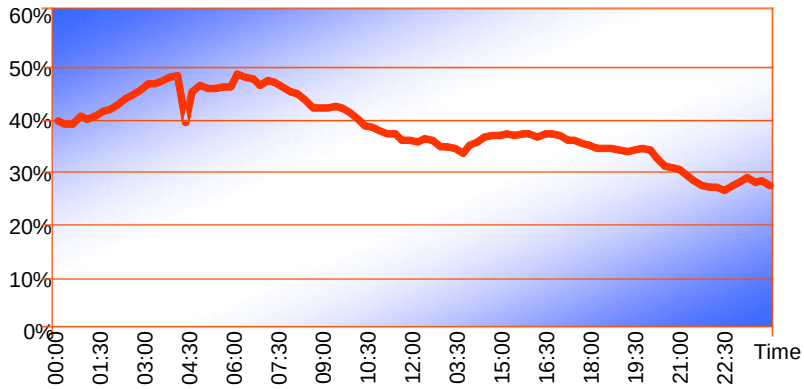
With target-oriented Management Grid Load can be reduced temporarily



With charge management a rate of 100% EV per household will be possible.

Source: Thomas Dederichs, IFHT-RWTH Aachen: "Elektrofahrzeuge als virtuelle Energiespeicher", BDEW-Fachtagung, Berlin, 14. Oktober 2010

Wind Power Production at Ireland in % of current Demand as of Monday, 05. April 2010



Source: Eirgrid, Senan McGrath "The eCar Ireland Project", ESB ecars, 5.09.2011

PHILOSOPHY AND STRUCTURE OF ISO 15118

Philosophy of ISO 15118

- > Use Control Pilot (CP) and Pulse Width Modulation (PWM) of IEC 61851-1 (similar to SAE J1772) for “safety”
- > Support of several services
- > Authentication “External Identification Means” (EIM) and “Plug ‘nd Charge” (PnC)
  - > Handling of digital certificates and electronic signatures
- > Charging AC (Alternating Current) and DC (Direct Current)
  - > Respecting customer requirements
  - > Allows respecting of availability of capacity and power at (distribution) grid
  - > Allows respecting of price tables from energy (re)seller
  - > (re)negotiation of a charge profile with new parameters
- > Value Added Services
- > Respect security and privacy
- > Provide enough bandwidth by using PLC technology based on HomePlug GreenPHY
- > EV acts as a client, EVSE acts as a server

Smart electric cars, smart grids and charging stations will use a single data standard.

Advantages of the bidirectional communications protocol ISO 15118

Simplicity	Grid friendliness	International importance
> Automatic authentication at charging points > Automatic contract handling operation (new contract, change of contract) > Quick and easy foreign authentication (⇨ Enabling of Europe-wide e-roaming) > High security against data manipulation	> Active load management through EV feedback > Time-controlled charging possible > Tariff-controlled charging possible > Integration of renewable energy	> European and American acceptance of the deployment for AC charging > Worldwide acceptance for deployment for combined charging system (CCS) DC > According to ACEA report of the OEM from 2017 integrated into all EVs

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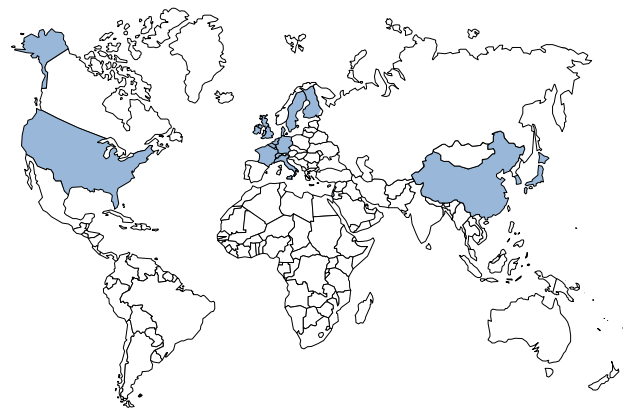
Broad Spectrum of Participants shows high acceptance for expected Market – ISO/IEC JWG V2G CI 15118 in Figures

> Registered experts: 138
> Active countries: 13
> Passive („reading“) countries: 14
> Number of official comments to 15118 documents: ~ 6000



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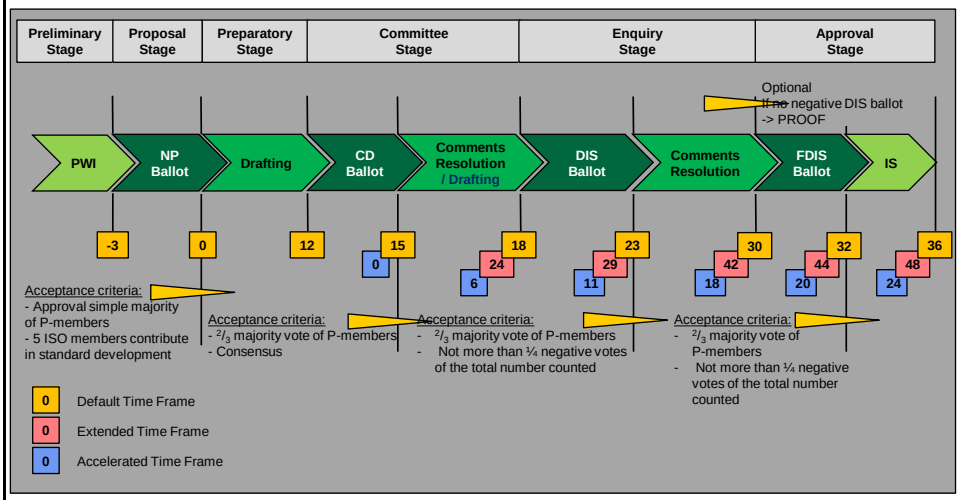
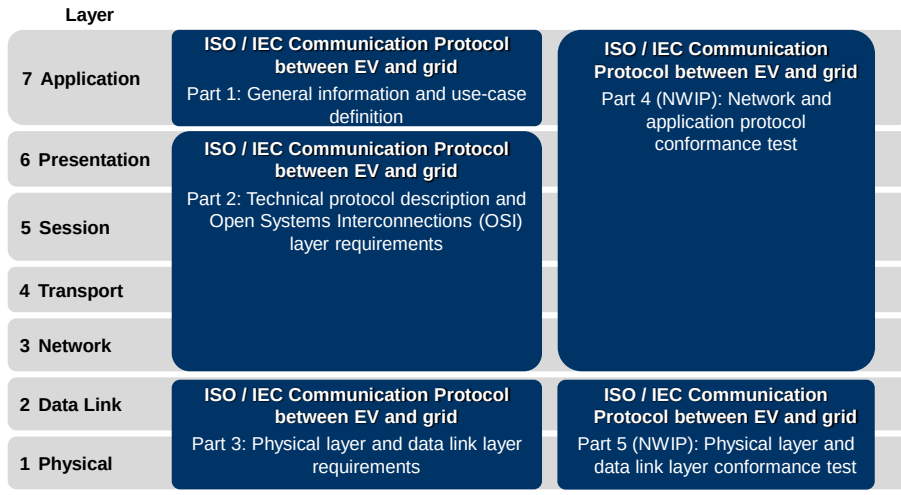
ISO Project Track (International Standard)



OSI-Layer - based standardization of Vehicle to grid communication – Analysis of options

Layer	Data Communication Requirements	Technologies
7 Application	• Payment & billing IDs and transactions • Anti theft, tamper detection • Pricing categories • Energy demand & response info (local limits, optional grid load levels, …) • Vehicle charge status & setup • Additional provider info (location, etc.) • Smart Energy Profile integration	• Smart Meter Language (SML) http://www.sym2l.org • Common Information Model (CIM) • Zigbee / HomePlug / Smart Energy Profile 2.0 (SEP 2.0) • New standard
6 Presentation		
5 Session		
4 Transport	• Reliable transmission • Secure & protect customer data • Directly send data to customer	• SML transport layer • Internet Protocol Suite (TCP/IP & UDP) incl. security (TLS) • New standard
3 Network		
2 Data Link	• Use available industry standards • Seamlessly integrate into public charge spots and Smart Home infrastructure • Grounding circuit continuity monitoring and diagnostics	Wired/Wireless Powerline Communications, HomePlug, ITU, PWM
1 Physical		

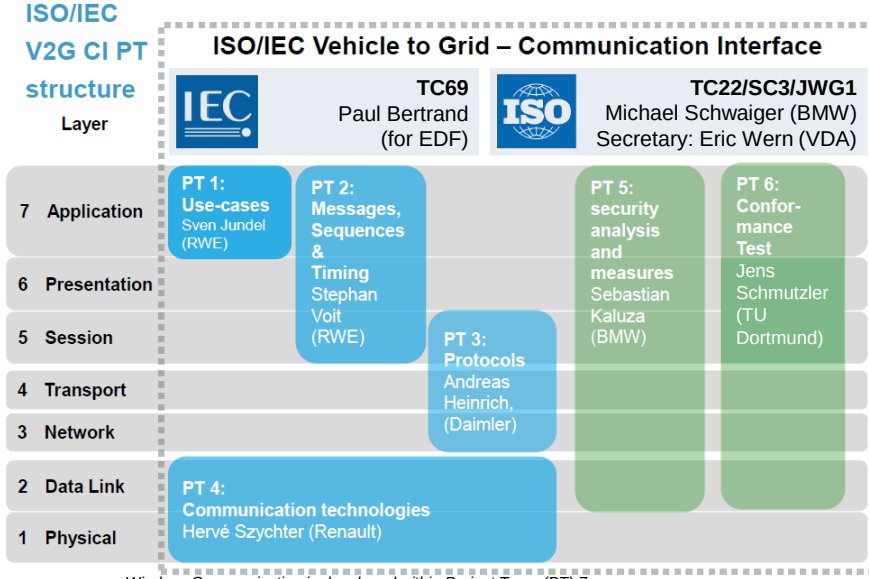
ISO/IEC Road vehicles — Communication protocol between electric vehicle & grid - Document structure



International Organization for Standardization

Commission Electrotechnique Internationale International Electrotechnical Commission Международная Электротехническая Комиссия

ISO/IEC V2G CI PT structure

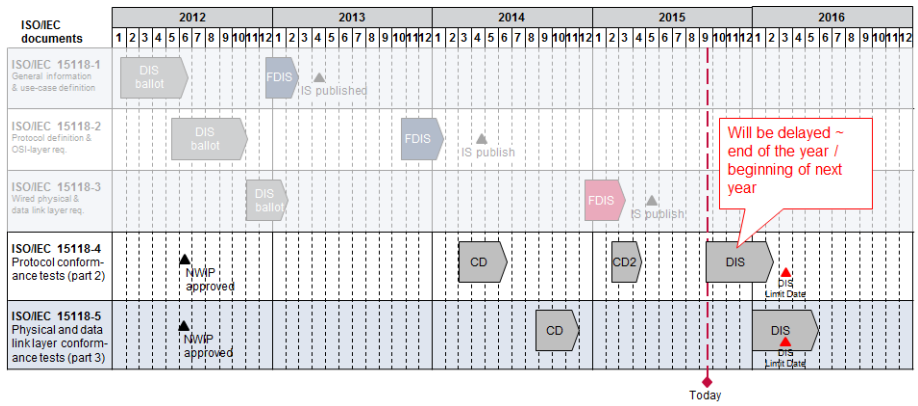


Wireless Communication is developed within Project Team (PT) 7.

International Organization for Standardization

IEC Commission Electrotechnique Internationale International Electrotechnical Commission Международная Электротехническая Комиссия

Timeline for ISO 15118-4 and -5



As of September 2015 (see official project status at ISO project portal)

Structure of Norm ISO 15118 „Road vehicles — Vehicle to grid communication interface“

- **Part 1**: General information and use-case definition (*International Standard* (IS) available since 04/2013)
- **Part 2**: Network and application protocol requirements (IS available since 04/2014)
- **Part 3**: Physical and data link layer requirements (IS available since 05/2015)
- **Part 4**: Network and application protocol conformance test (CD2 available since 02/2015)
- **Part 5**: Physical layer and data link layer conformance test (CD available since 08/2015)
- **Part 6**: General information and use-case definition for wireless communication (DIS available since 09/2015)
- **Part 7**: Network and application protocol requirements for wireless communication (CD under development)
- **Part 8**: Physical layer and data link layer requirements for wireless communication (CD under development)

Availability: Paper or PDF versions of DIS, FDIS, CDV and IS can be bought at ISO (www.iso.org) and IEC (www.iec.ch). CD versions are only distributed within Joint Working Group.

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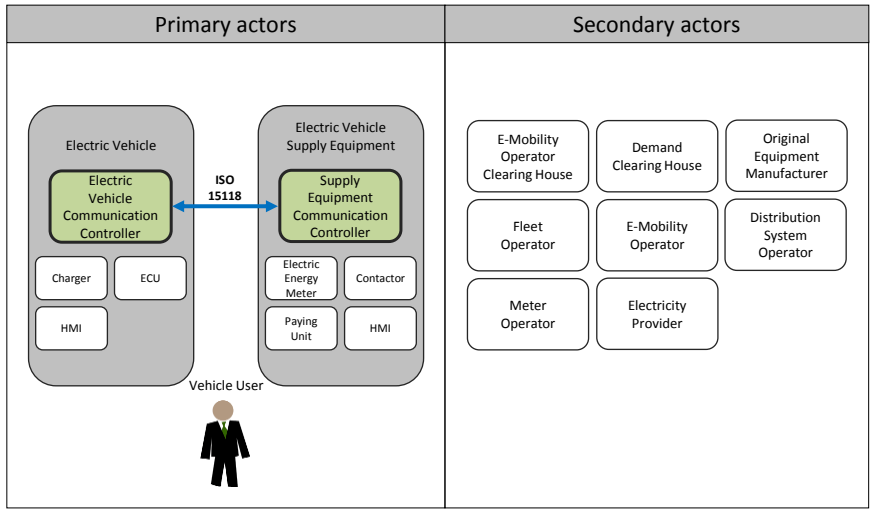
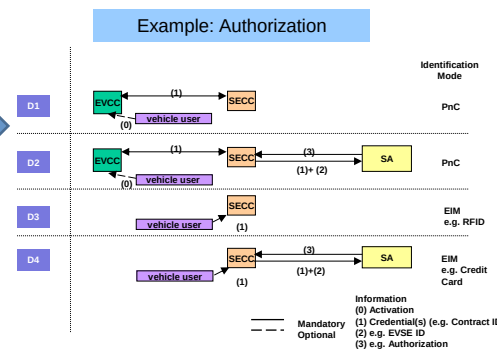
Role Model within ISO 15118



Use Cases provided by ISO 15118

A	Start of charging process
B	Communication setup
C	Certificate Handling
D	Identification and Authorisation
E	Target Setting and Charge Scheduling
F	Charge controlling and Re-scheduling
G	Value Added Services
H	End of charging process

The Use Cases A to H are detailed into several Use Case Elements



ISO 15118-1: Overview Use Case Elements (1/2)

No.	Use case element name / grouping
A1	Begin of charging process with forced High Level Communication
A2	Begin of charging process with concurrent IEC 61851-1 and High Level Communication
B1	EVCC/SECC communication setup
C1	Certificate update
C2	Certificate installation
D1	Authorisation using Contract Certificates performed at the EVSE
D2	Authorisation using Contract Certificates performed with help of SA
D3	Authorisation at EVSE using external credentials performed at the EVSE
D4	Authorisation at EVSE using external credentials performed with help of SA
E1	AC charging with load levelling based on High Level Communication
E2	Optimized charging with scheduling to secondary actor
E3	Optimized charging with scheduling at EV
E4	DC charging with load levelling based on High Level Communication
E5	Resume to Authorised Charge Schedule

ISO 15118-1: Overview Use Case Elements (2/2)

No.	Use case element name / grouping
F0	Charging loop
F1	Charging loop with metering information exchange
F2	Charging loop with interrupt from the SECC
F3	Charging loop with interrupt from the EVCC or user
F4	Reactive power compensation
F5	Vehicle to grid support
G1	Value added services
G2	Charging details
H1	End of charging process

Data Communication controls Charging Session for better Integration of renewable Energy

Electric Vehicle		EV Supply Equipment (Charge point)
Cable connected, CP/PWM ok, ask for service available	1	Chose highest protocol version, send service list
I want to charge with costs, my contract ID is "1234"	2	Checking contract ID, perhaps request at eRoaming platform
Calculation of charging profile; chosen price table	3	Valid ID can be used for charging up to 22 kW; load & price table enclosed
Lock connector; I will charge from 2 AM to 6 AM at 5 kW	4	Capacity reservation, perhaps communication with Smart Grid
Charging	5	Contactor closed; send start meter reading
	6	Special wind offer: 4 AM to 6 AM, price minus 10%
Offer accepted: I will charge from 4 AM to 6 AM at 11 kW	7	Capacity reservation, perhaps communication with Smart Grid
I want to stop charging session; open contactor	8	Contactor opened
	9	Send stop meter reading; please sign meter reading
Signing drawn energy, unlock cable, end of communication	10	Provide charge data (Service Detail Record) for billing

Example: Controlling charging session according to ISO 15118-2

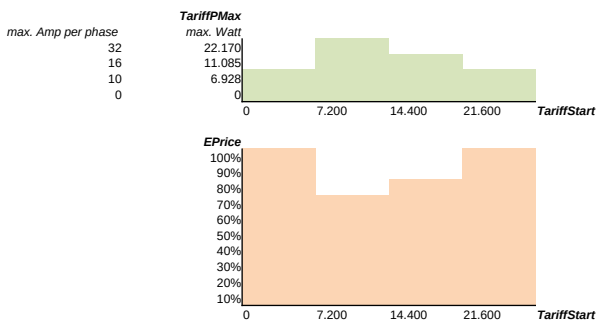
ISO 15118 uses P_{max} and Tariff Tables for easy Integration of EVs into Power Grid and Power Production

Grid and Power Production Tariff Table

TariffStart	[Seconds from now]	0	7.200	14.400	21.600
TariffPMax	[Watt]	6.928	22.170	11.085	6.928
EPrice	[relative, in %]	100%	70%	80%	100%

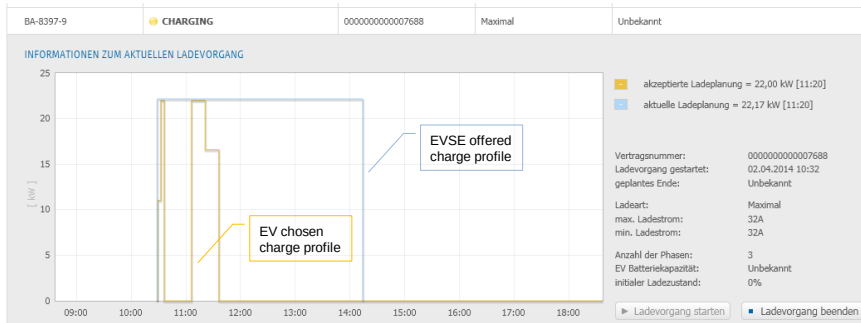
TariffTableType

Currency	REL
Tariff	T1
EPriceUnit	1 (one percent)
EPriceMuliplier	1



Source: According to Committee Draft ISO 15118-2

Load Management according to ISO 15118 with a Smart fortwo ed 3 connected to an RWE Charge Spot



> Charging power was restricted by cable, installation, feed-in and grid transmission capacity to max. 22 kW.

> Electricity reseller offered a special price for this charging session at 50 % off, but between 10:30 and 11:00 AM normal price (100 %) had to be paid. During this period EV stopped charging.