Distribution grid planning for a successful energy transition – focus on electromobility

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Webinar: Next steps for energy systems integration

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Research questions of the joint study by the Agoras and RAP

1. What investments in power lines and transformers on low-voltage and medium-voltage networks are needed to further the energy transition in the areas of electricity, heat and transport?

2. To what extent does grid-friendly charging of electric vehicles reduce the need for network expansion and the associated investments?

3. What effects does the mobility transition from private cars to public transport, cycling, walking and shared mobility options have on grid expansion investments?

4. What regulatory framework is needed for charging electric vehicles?

Contractors

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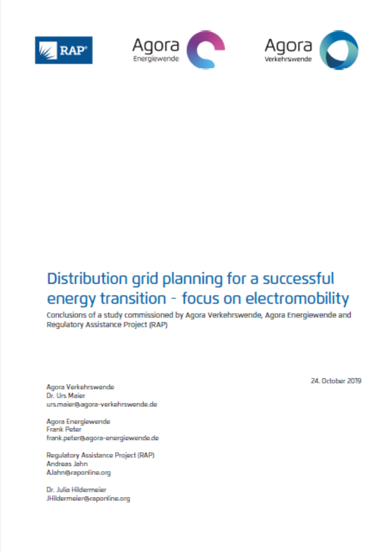
RE-xpertise

Study in German

Conclusions in English


Distribution grid planning for a successful energy transition - focus on electromobility

Conclusions of a study commissioned by Agora Verkehrswende, Agora Energiewende and Regulatory Assistance Project (RAP)

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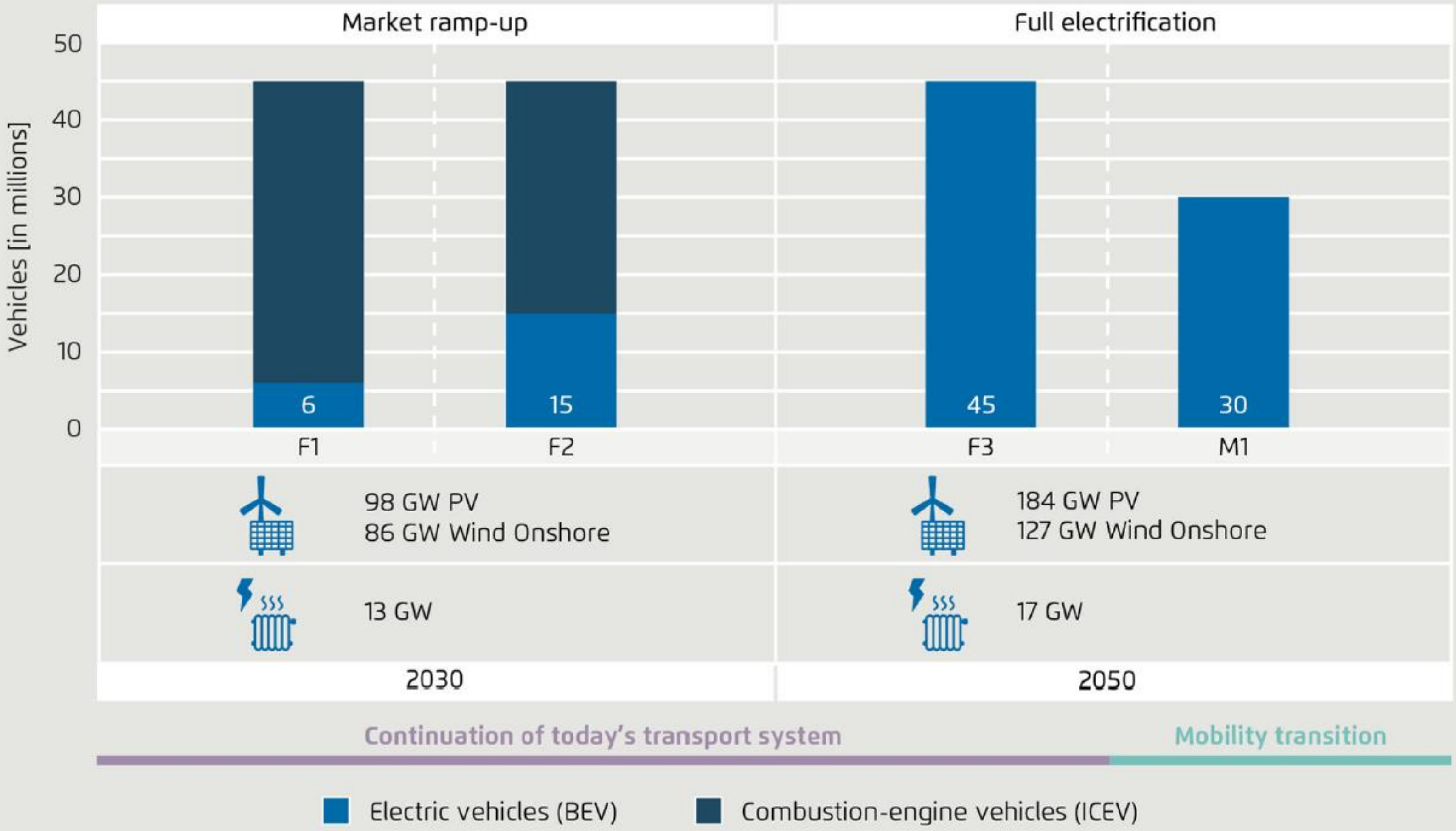
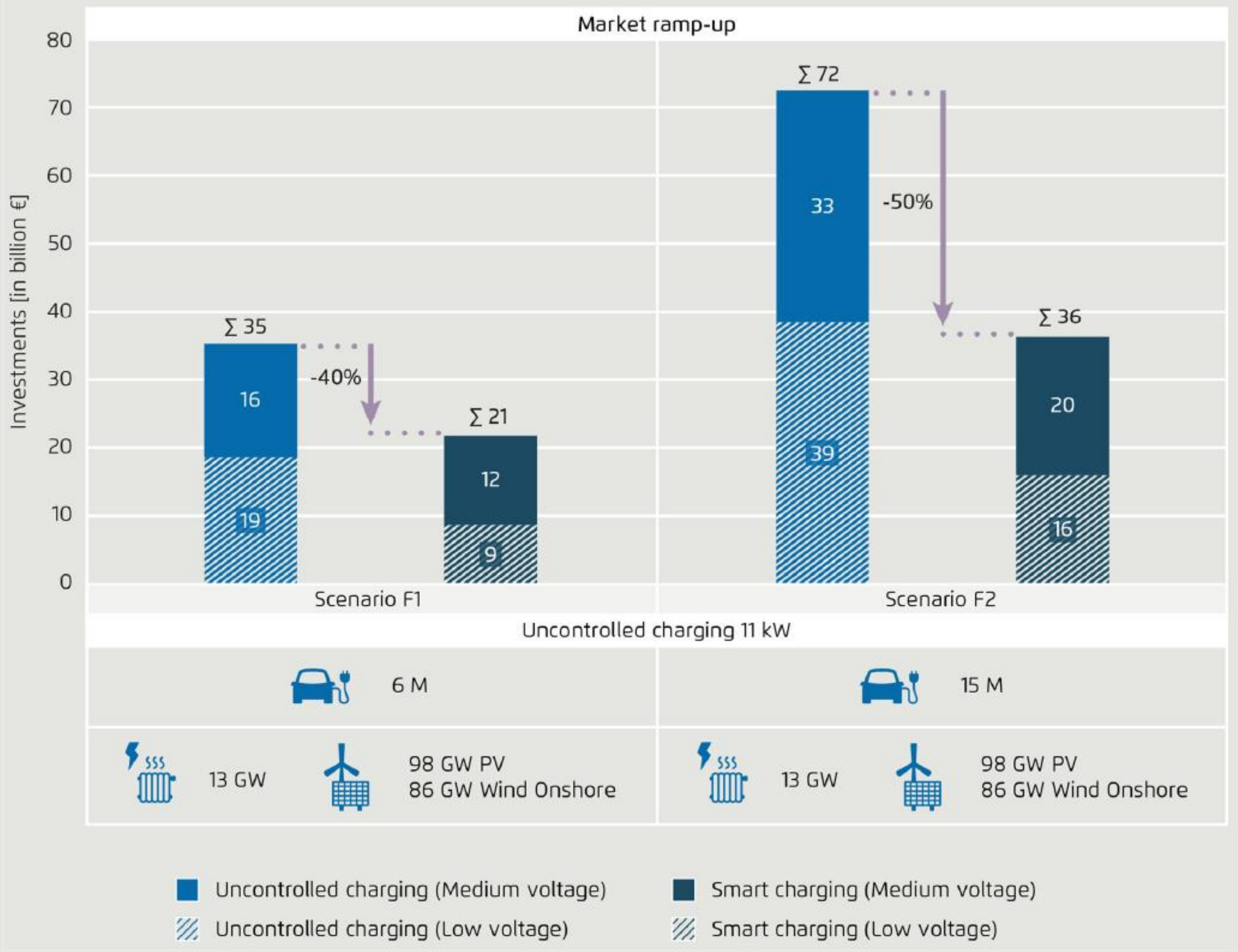
Scenarios of the energy transition in the power distribution grid

Assumptions for the power, heat and transport sector transitions



Navigant, Kompetenzzentrum Elektromobilität, RE-xpertise (2019)

Smart charging reduces investments in distribution grids by up to 50 percent



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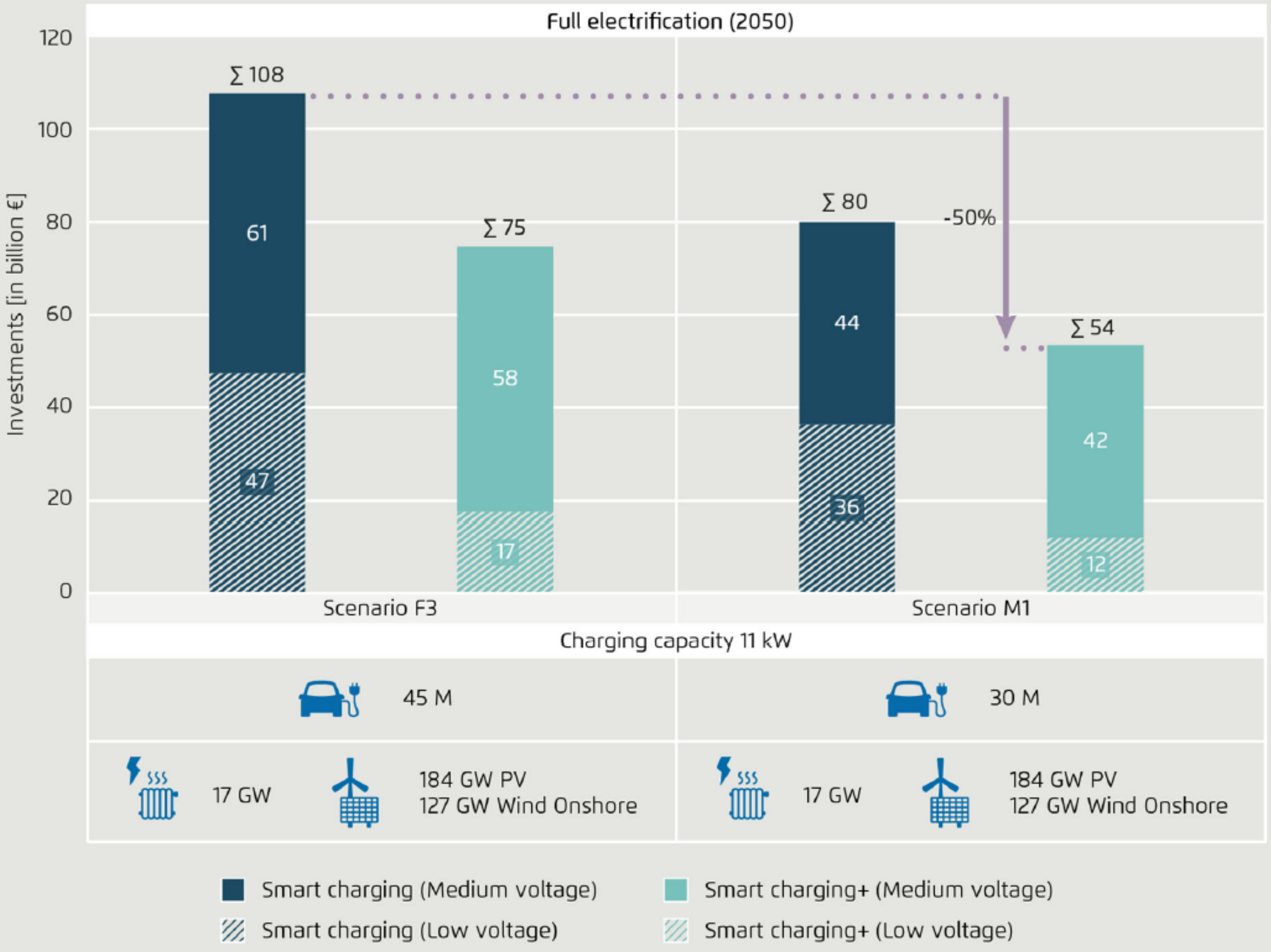
Smart charging+ combined with the mobility transition reduces investments by further 50 percent



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On average, future EV grid integration does not require more investment in cables and transformers than in the past

Annual distribution grid investment requirements of the scenarios, compared to historical investments by distribution grid operators

Note:

The figure compares investments in **low and medium voltage grids** (left) with investments in **low, medium and high voltage grids** (right).

The investment requirement at the **high-voltage level** up to 2050 can be estimated on the basis of literature at around 60 billion € or 1.7 billion € per year.

Navigant, Kompetenzzentrum Elektromobilität, RE-xpertise (2019)

Electromobility finances the expansion of the distribution grid until 2050

Electromobility can fully finance the expansion of the distribution grid – in terms of lines and transformers – for the electricity, heat and transport sectors in Germany until 2050.

- 45 million electric cars increase electricity sales by around 120 terawatt hours in 2050.
- Today, grid charges are around 7 cents per kWh.
- 4 cents per kWh by 2050 would bring in up to 75 billion euros. They would be needed for the scenario "45 million electric cars, smart charging+".
- The financial contribution of electromobility must be determined politically.

Goals of smart regulation for grid expansion and for smart charging

Adequate financial contribution of electromobility (grid charges, construction cost subsidies)

Comprehensive controllability of electric cars (financial incentives and, possibly, obligations)

Rapid distribution of information and communication technology for forecasting and control

Priority of preventive, indirect control (time of use tariffs for grid charges, maximum timetables)

Direct control by distribution grid operators only as an Ultima Ratio

Main results

1 **The energy transition in the power distribution grids can be successful, even if all passenger vehicles are electrified.** Grid-friendly charging reduces the peak loads created when vehicles and electric heat pumps are charged simultaneously. It can also shift electricity consumption to times with abundant generation from solar photovoltaics and wind turbines.

2 **Combining grid-friendly charging with the broader mobility transition can fund the energy transition in the electricity distribution grids by 2050, supplying 1.5 billion euros of annual investments in power lines and transformers.** Without the mobility transition, annual investments of 2.1 billion euros would be needed to accommodate 45 million, instead of 30 million, electric cars.

Main results

3 **Electromobility can finance the expansion of the distribution network until 2050. Electric mobility increases electricity sales, while the overall investment needed for power lines and transformers does not increase.** However, it is important that the participants in the mobility transition pay their fair share of grid fees.

4 **Smart charging can be designed to ensure that users hardly notice any restrictions.** To achieve this, grid-friendly managed charging must become the standard. We need secure information and communications technologies, incentives and, if necessary, obligatory managed charging. Precautionary indirect control, in the form of incentives for grid-friendly charging, should take precedence over direct control by the distribution grid operator.

Thank you!

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Smart charging reduces the per capita investment* in network expansion especially for rural citizens

Table 1: Annual distribution per capita of network investments 2015-2030 in urban, suburban and rural areas

Annual per capita investment in € (2015-2030)	6 million electric cars		15 million electric cars	
	uncontrolled	controlled	uncontrolled	controlled
Urban	14	11	40	28
Suburban	23	13	52	24
Rural	61	33	99	39

Navigant, Competence Center Electric Mobility, RE Expertise (2019)

- 60 % due to smart charging

- Peak loads due to simultaneous charging can be reduced more significantly in rural areas because the share of “charging at home" is larger.
- Feed-in peaks from renewable energies are mainly generated in rural areas. They can be reduced by smart charging.

*Simplifying to clarify the effect. Grid investments are passed on to electricity customers via grid fees and are not distributed per capita.

Charging points and their characteristics

Ladeort	Anzahl Fahrzeuge pro Ladeort	Ladeleistung pro Fahrzeug (in kW)	Maximale Gleichzeitigkeit	Anzahl Ladepunkte 2050	
				Fortschreibung des heutigen Verkehrssystems (F3)	Mobilitätswende (M1)
Zu Hause	1	11*	Basiert auf MiD 2008[1,2]	22 Mio.	16 Mio.
Arbeitsstelle	15 (kleine Betriebe) 75 (mittlere Betriebe) 150 (große Betriebe)	11*	Basiert auf MiD 2008[3]	13 Mio.	6 Mio.
Schnellladestationen	Flexibel[4]	350	1	40.000	40.000
Öffentliche Ladepunkte vor Wohnhäusern	1	11*	Basiert auf MID 2008[5]	500.000	300.000
Halböffentliche Ladepunkte (z. B. Supermarkt)	1	11*	1	500.000	300.000
Ladepunkte an Betriebshöfen für betriebliche Flotten	62	3,3	1	1 Mio.	600.000
Ladepunkte für Fahrzeuge in kleinen Flotten	1	11*	1	4 Mio.	2 Mio.
Betriebshöfe für Busse	Je nach Anzahl der Busse pro Kreis; max. 150	50	1	60.000	60.000
Betriebshöfe für stationsbasiertes Car-Sharing	20	3	1	–	3 Mio.
Betriebshöfe für Ride-Sharing & -Pooling	30	5	1	–	900.000

* Für das Szenario F1 mit ungesteuertem Ladekonzept wurden zusätzlich 3,7 kW und 22 kW Ladeleistung betrachtet.
1 BMVI (2009).
2 Siehe Abschnitt 4.2 für die Erklärung der stochastischen Bestimmung der Gleichzeitigkeit basierend auf BMVI (2009).
3 BMVI (2009).
4 Die Ladeleistung von Ladesäulen kann gebündelt an einem Ladepunkt oder verteilt auf mehrere Ladepunkte genutzt werden. Zum Beispiel könnte ein Pkw mit 350 kW oder 7 Pkw mit je 50 kW laden. In den Szenarien gibt es 20 000 Schnellladestationen mit zwei Ladesäulen mit einer Leistung von je 350 kW.
5 BMVI (2009).

Navigant, Kompetenzzentrum Elektromobilität, RE-xpertise (2019)