EVS32 Symposium
Lyon, France, May 19-22, 2019

Norm for new buildings referring to plug-in vehicles: an example from Switzerland (SIA 2060)

Giorgio Gabba[1], Marco Piffaretti[2], Milton Barella[1], Ilaria Besozzi[1]

[1]*Protoscar SA, via Ronchi 18, CH-6821 Rovio (Switzerland), g.gabba@protoscar.com*

[1]*energie360° AG, Aargauerstrasse 182, CH-8010 Zürich (Switzerland), marco.piffaretti@energie360.ch*

Executive Summary

New buildings or major renovations in existing buildings should be conceived to facilitate the charging of plug-in vehicles, because in the future these vehicles will be dominant, or even the exclusive type of vehicle to be parked there. EU and some nations have already included this requirement in their legislation or norm. In Switzerland, to overcome the lack of a national legislation, the Swiss Association of Architects and Engineer (SIA) has decided to develop a new technical norm (SIA 2060). The core of the norm is the definition of 4 levels of "readiness for e-mobility" for new and deeply renovated buildings. In the basic level conduits for electric and communication cables have to be installed in the building for the future deployment of the supply and communication wires of the charging points (charging stations and/or sockets). In the highest level charging points have to be installed and be ready to charge. A minimum and recommended number of parking places where a charging point could be installed in the future is prescribed for each level, given as percentage of the total number of parking places. This paper describes the four levels of SIA 2060 and the quantity of parking places that must be equipped. In addition, some legislations and norms from other countries are taken as benchmark for a comparison with SIA 2060.

Keywords: policy, promotion, infrastructure, standardization

1 SIA 2060

Legislators (e.g. references [1] to [7]) have recognized the importance to equip the new buildings or existing buildings subject to major renovation with means to facilitate the charge of plug-in vehicles. They range from the installation of conduits for electric cables to the compulsory deployment of one or more charging stations.

In Switzerland there is a particular situation: on one hand the national government has included the e-mobility in its long-term strategy but on the other hand it cannot issue any norm in the building sector as EU or other countries do, due to the particular federal structure of the country. To overcome this situation, some Swiss stakeholders in the field of e-mobility decided to develop a set of guidelines [9], targeted to the professionals in the building sector, recommending the number of charging points to be implemented in new or renovated buildings and providing technical information about the conduits and other topics. Later on, the Swiss Association of Architects and Engineer (SIA) begun the development of a new technical norm (SIA 2060) which will be published during 2019. Protoscar was selected to develop it, with the support of the SIA ad-hoc working group, which included e-mobility experts, designers of electrical installation and members of several organization (e.g. federal government, power utilities etc.). The working group released the final version of the document, which was submitted to other working committees inside SIA. The final text was approved with minor corrections. As of April 2019, the document is in the public consultation process (Vernehmlassung), where anyone can give his feedback. Once these feedbacks will be received and analyzed, the document will be adapted and will be made official.

The norm is not compulsory but its fulfillment makes sure that a compliant building satisfies the present and future charging needs of plug-in vehicles.

2 The key concept of SIA 2060

A new building or a renovation of an existing building must last tenths of years, thus architects, engineers and investors must be aware that:

- during the life of a building the number of vehicles that have to be charged in that place may rise from 0 to 100%.
- From an economical point of view, an initial investment in additional conduits for electric cables is better than a retrofit (this motivation is also mentioned by legislators as in [1] and [8]).

Thus the key concept is that all the parking places of a building shall have the conduits for the supply lines of the charging points of the plug-in vehicles, because these vehicles will fully replace ICE vehicles [10, 11] in the long-term perspective. In addition to this basic requirement for "readiness for e-mobility", other levels have been introduced. Architects, engineers and investors can select to what level the building has to be compliant.

Four levels are defined (see Figure 1): A ("Pipe for power"), B ("Power to building"), C ("Power to garage/parking") and D ("Ready to charge").

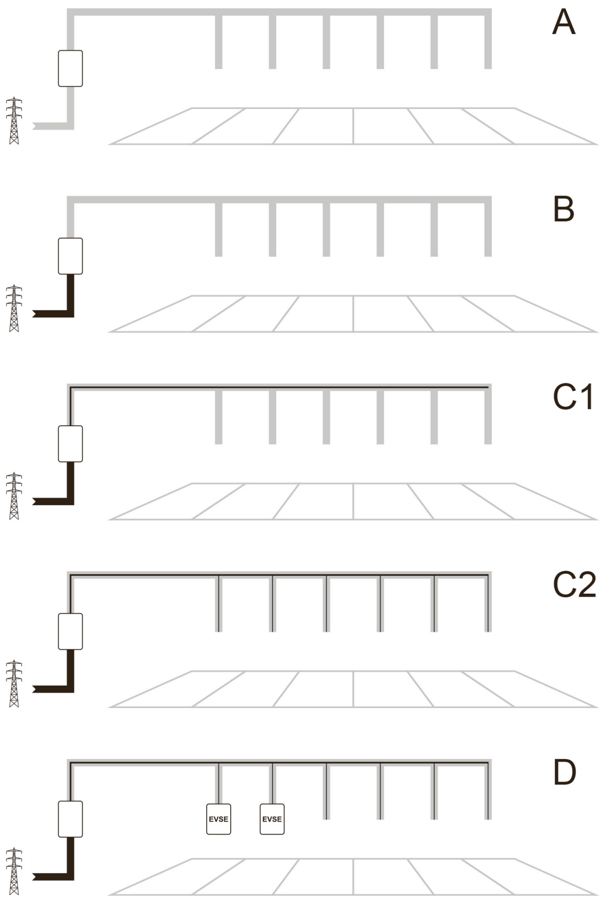

Figure 1: the 4 compliance levels defined by SIA 2060 (grey lines = conduits; black lines = supply cables)

Detailed descriptions of the levels are given here below.

A "Pipe for power": conduits/channels are provided in the building for the future deployment of the supply and communication cables of the charging points (charging stations-EVSE or sockets); the switchboard(s) shall have enough available space for the future addition of the electric protections and energy meters (if any) required by the supply lines of the charging points. In case dedicated switchboard(s) are foreseen, enough space for their installation has to be reserved.

B "Power to building": in addition to the requirements of level A, the electricity connection of the building to the grid is already dimensioned considering the future charging power demand.

C "Power to garage/parking": in addition to the requirements of level B, the electrical supply and communication system of the EVSE is implemented (wire, switchboard etc.) either up to garage (C1) or to the parking places (C2).

D "Ready to charge": in addition to the requirements of level C, charging points (EVSEs and/or sockets) are installed and fully operative.

Level A defines the minimal requirements all buildings have to fulfill. Architects, engineers and investors can decide to be compliant with a higher level since the very beginning of the building development. Once the level has been defined, it is possible to define the quantity of charging points to implement.

These levels reflect different time-horizons of the investments: Level A concerns the investments that are done once in the lifetime of a building; Level B and C investments that are done a few times; Level D investments having a time horizon of 10 – 15 years.

3 Quantification

The number of parking places where a charging point (EVSE and/or socket) could be installed in the future is given as percentage of the total number of parking places.

In Level A this percentage is 100%, i.e. conduits for electric and communication cables have to be installed in the building allowing a later implementation of charging points in all the parking places.

The percentages of level B, C and D are based on the Swiss e-mobility scenarios. In general, two values are provided:

- Minimum, corresponding to the market penetration of the Swiss e-mobility scenarios,
- Recommended, based on the assumptions of SIA 2060 Commission.

The Swiss e-mobility scenarios used for the quantification derive from the Swiss Government Energy Strategy 2050 [10]. Among the different scenarios, the "Politische Massnahme" (POM) scenario has been selected as a reference for the quantification of the levels B and C (Figure 2). The recommended values have been defined starting from the POM scenario and adapting the curve to the evolution of the registered xEV and other more recent scenarios like [11] and [12].

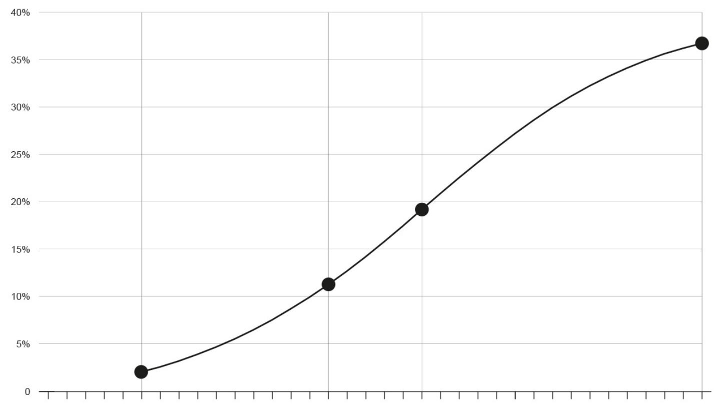

Figure 2: number of plug-in cars in Switzerland according the POM scenario [9]

The quantity of charging points of Level B (Table 1) was initially set to the plug-in vehicle penetration in a time frame of 50 years. During the review process, it was decided to increase this value up to 60%, also as a consequence of the more active Swiss government politics [13], announced during the norm development. Level B implies the implementation of the cable for the grid connection already dimensioned to supply the charging points (EVSEs and sockets). 50 years corresponds to the typical time frame of a major renovation of a building. The reference scenario does not cover e-bikes and electric 2 wheelers/light vehicles, thus it has been decided to recommend higher percentage than for cars, because charging points consist on a simple socket, plus the power and energy requirements are limited.

Building	e-Vehicle	Minimum	Recommended
Residential (multifamily)	Cars	60%	80%
	2-wheelers, quadricycles	60%	80%
	Bikes	100%	100%
Non residential	Cars	60%	80%

Table 1: Percentages of charging points for level B, according the type of building and type of vehicle.

Level C has a time frame similar to level B. The percentages range from the ones of Level B to the ones of level D. It is up to the investor willing to be compliant with Level C, to select the quantity of conduits where electric cables have to be laid out.

The quantity of charging points of Level D (Table 2) correspond to the plug-in vehicle penetration in a time frame of 10/15 years. Level D means the implementation of EVSEs (or sockets) ready to charge the vehicles. 10/15 years corresponds to the typical lifetime of the EVSEs.

Building	e-Vehicle	Minimum	Recommended
Residential (multifamily)	Cars	16%, min. 1	20%, min. 2
	2-wheelers, quadricycles	-	1 socket for apartment
	Bikes	60%	80%
Non residential	Cars	16%, min. 1	20%, min. 2

Table 2: Percentages of charging points for level D, according the type of building and type of vehicle.

Both in Level B and in Level D the percentages for electric 2-wheelers and quadricycles are not given for the non-residential buildings, because the diffusion of these vehicles in Switzerland is quite limited. In the first discussions it was decided to define minimum and recommended levels both for e-bikes in the non-residential buildings. However, during the development, it was agreed not to provide recommendations, because there are no scenarios available to estimate the charging demand in non-residential building for e-bikes.

4 Impact of the compliance levels on the investments

The investments required to be compliant with the levels defined in chapter 2, increase moving from Level A to Level D. How much they increase depends on the specific situation of each building. Nevertheless, an example may help to understand the economic impact of each compliance level.

Let’s assume to have a residential building with a garage with 10 parking places. The compliance to Level A means to lay down 20 conduits from the position of the switchboard to each parking place, 10 for the supply cables and 10 for the communication cables. In addition to the conduits, boxes will be installed into the walls, where the conduits end. Assuming that the longest conduit is approx. 30 m long, the order of magnitude of the costs can be estimated in 8’500 CHF (ø23 mm conduits are used in this example). The cost is evaluated using the standard values provided by the Swiss Association of Electricians (the market costs are usually lower and strongly depending on the Swiss region, but, for comparison purposes, they can be used).

Level B means that, in addition to these conduits, the electrical connection of the building to the grid shall be already dimensioned to supply 6 to 8 charging points. Selecting the recommended value, i.e. 8, and the nominal power of each point (11kW), the additional investment is given by the costs related to the bigger section of the wires + conduit and the higher current rate of the electrical protection and accessories in the main switchboard. The required charging power is not 88kW (i.e. 8 x 11kW), because in Switzerland it is mandatory to have a load management when the building has more than 2 charging points. In this case, SIA 2060 suggests a value of 44kW for the dimensioning of the connection to the grid. Assuming that the rated current increases from 63A to 125A and that the building supply cable + conduit are 25m long, the compliance to Level B means that the investment is approx. 25% higher than Level A.

Concerning Level C, the sub-level C2 is selected because it is the most capital intensive. In this case the 8 charging point supply cables with the related electrical protections (residual current device and overcurrent protections) are added together with a dedicated switchboard. The compliance to Level C2 requires to double the investments in comparison to Level A.

In Level D, the additional investments for the purchase and installation of two charging stations are added. A typical list price of a station with controlled access and load management capability, is around 1’500 CHF, hence the whole investment, including the installation and commissioning of the charging stations is approx. 2.4 times higher than in Level A.

In Table 3 the relative investments are summarized.

Compliance Level	Investment
A	100
B	125
C2	200
D	240

Table 3: relative required investments in a residential building with 10 parking lots.

In this example, a rather limited initial investment (less than 9’000 CHF) compared to the building costs, allows to get all the parking lots ready for the future installation of charging stations. With an investment approx. 2.4 times bigger, but again still limited, it is possible to equip 80% of the parking places with the electric supply and 20% already equipped with a charging station.

5 Comparison of SIA 2060 with other legislations and norms

The SIA 2060 approach presents some differences when compared with norms and legislations of other countries. Some legislations and norms ([1], [2], [3], [4], [5], [6], [7]) have been selected as benchmark and are compared to SIA2060 according five features:

- Segmentation according the type of building: in all the selected examples there is at least a basic segmentation in 2 categories (multifamily residential and non-residential). There are sometimes more granular segmentations.
- Segmentation according the type of vehicles: this is typical of SIA 2060, but it is worth mentioning that both the French *Code de la construction et de l’habitation* [2, 3 and 4] and VDI [7] includes the two-wheelers.
- Lower limit for the applicability: in other approaches the conduits are mandatory only for buildings having a number of parking places or apartments greater than a limit value. Sometimes other criteria are added, like the surface of the building or the number of inhabitants of the urban area where the building is.
- Levels of applicability: the 4 levels approach is a unique feature of SIA 2060. In the benchmark examples only one or two levels are required. They are equivalent to A or D of SIA 2060. Levels B and C are not featured in the benchmark examples.
- Quantification: the percentages range from less than 5% up to 100%.

Table 4 compares SIA 2060 and the benchmark examples according to the above parameters for the residential (multifamily) buildings and focusing on the cars.

Reference	Limits of applicability	Level of applicability	Quantification
EU 2018/844 [1]	> 10 parking places	A	100% of the parking places
France [2]	≤ 40 parking places > 40 parking places	A	50% of the parking places (min. 1) 75% of the parking places
Italy [5]	≥ 10 apartments	A	20% of the parking places
California [6]	≥ 17 apartments	A	3% of the parking places (min. 1)
VDI 2166 [7]	none	A	1 parking place for apartment
SIA 2060	none	A D	100% of the parking places 16% (min. 1) to 20% (min. 2) of the parking places

Table 4: Comparison of SIA 2060 with other legislations for residential (multifamily) buildings.

Table 5 compares SIA 2060 and the benchmark examples according to the above parameters for non-residential buildings.

Reference	Limits of applicability	Level of applicability	Quantification
EU 2018/844 [1]	> 10 parking places	A D	min. 20% of the parking places min. 1 charging station
France [3]	≤ 40 parking places > 40 parking places	A	10% of the parking places (min. 1) 20% of the parking places
Italy [5]	≥ 500 m^2	A	20% of the parking places
California [6]	51-75 parking places 76-100 parking places 101-200 parking places ≥ 201 parking places	A	1 parking place 2 parking places 3 parking places 3 % of the parking places
VDI 2166 [7]	none	A	For employees: 2.5% of the employees (min. 2) For others: 5% of the parking places
SIA 2060	none	A D	100% of the parking places 16% (min. 1) to 20% (min. 2) of the parking places

Table 5: Comparison of SIA 2060 with other legislations for non-residential buildings.

In residential buildings, the parking lot is the preferred choice, both for the quantification and for the definition of the limits of applicability. Exceptions are represented by Italy [5] and VDI [7] where the number of apartments is used for the definition of the limits of applicability [5] or for the quantification [7]. Concerning the quantification, SIA shares a 100% value with EU 2018/844 [1] only.

In non-residential buildings, the number of parking places is still the preferred choice both for the quantification and for the definition of the limits of applicability, with the exception of Italy, where the applicability is defined by the building useful surface. SIA and VDI [7] share the idea that Level A compliance shall be applied to all the non-residential buildings, whatever be the number of available parking places. The biggest difference between SIA and the other benchmarks, stays in the quantification. In SIA it is much higher, but that value is a recommendation, while in EU [1], France [3], Italy [5] and California [6] examples, the quantification is defined by a national regulation.

6 Conclusions

The concept of different levels of "readiness for e-mobility" is not new. However only SIA 2060 encompasses all the possible levels found in similar legislations/norms and has been conceived around them. These levels correspond also to the different types of investments that can be done to get a building compatible with the charging needs of the vehicles, allowing the investors to select the ones that better match their investment strategy. Thus SIA 2060 may be useful even outside Switzerland, providing a benchmark and a possible inspiration, both for the countries still lacking of legislation or norms on this topic and for the review of existing legislations.

7 References

[1] European Union, *Directive 2018/844 of 30 May 2018, art. 8*.

[2] République Française, *Code de la construction et de l'habitation, Article R111-14-2*

[3] République Française, *Code de la construction et de l'habitation, Article R111-14-3*

[4] République Française, *Code de la construction et de l'habitation, Article R136-1*

[5] Repubblica Italiana, *Decreto del Presidente della Repubblica 6 Giugno 2001 n° 380, Rev 3.2 del 1 settembre 2017, Art .4 (L)*

[6] State of California, 2013 Title 24, Part 11, *California Green Building Code*

[7] Verein Deutscher Ingenieure, *VDI Richtlinien 2166 Blatt 2*, Düsseldorf 2014

[8] City of Denver, Community Planning and Development, *Amendment proposal (New) IRC Section R324 Electric Vehicle Charging Options*, Denver 2015

[9] *Ratgeber für die Installation von Ladesystemen für eFahrzeuge*, https://emobility-schweiz.ch, accesed on 2018-09-06

[10] Swiss Confederation, Bundesamt für Energie BFE, *Die Energieperspektiven für die Schweiz bis 2050 - Energienachfrage und Elektrizitätsangebot in der Schweiz 2000 – 2050*, Prognos AB, Basel 2012

[11] P. de Haan et al., Szenarien der Elektromobilität in der Schweiz – Update 2018, EBP Schweiz AG, Basel 2018

[12] Auto-Schweiz, *Branchelziel 10/20*, https://www.auto.swiss/themen/alternative-antriebe/branchenziel-1020/, accessed on 2018-09-06

[13] Federal Department of Environment, Transportation, Energy and Communication, *Roadmap Elektromobilität 2022*, https://roadmap2022.brainstore.com/de/roadmap_elektromobilitaet_2022/home, accessed on 2019-01-09

8 Authors

Giorgio Gabba holds a master degree in Aeronautical Engineering from Politecnico di Milano. He has always worked in the e-mobility field. On 1999 he joined Protoscar SA as project manager and senior researcher/analyst. Current activities focus on charging infrastructure analysis (quantification of charging infrastructure, definition of the sites, planning, deployment plans and recommendations), WTW assessment, fleet analysis.

Marco Piffaretti studied car design at the Scuola d'Arte Applicata e Design, in Torino and at the Art Centre College of Design, in La Tour de Peilz. In 1987 he created Protoscar where he was the managing director until September 2019. From 1994 to 2001 he was also director of the large market pilot project for electric vehicles in Mendrisio, VEL-1, one of the biggest pilot projects achieving a market share of 8%. Today he is the Director of the new mobility division of Energie360°, in Zürich.

Milton Barella has a M.Sc. degree in electric engineering from the Swiss Federal Institute of Technology in Zürich (ETH) and an MBA of the University of Bath, UK. At the present time, he is involved in several strategic and operational projects in the field of electromobility, such as development of business models, writing of guidelines and technical specification of charging stations.

Ilaria Besozzi holds an MBA from Università L. Bocconi, Milan. She joined Protoscar on 2018 as senior analyst. Her current activities focus on charging infrastructure for plug-in vehicles and related business models and plans.