STRATEGIC BUSINESS PLAN (SBP)

IEC/TC OR SC:	SECRETARIAT:	DATE:
SyC LVDC	**IEC CO**	**2021-01**

A. STATE TITLE AND SCOPE OF SyC

Low Voltage Direct Current and Low Voltage Direct Current for Electricity Access

The Scope of the SyC LVDC is:

- Standardization in the field of Low Voltage Direct Current (hereinafter referred to as LVDC) in order to provide systems level standardization, coordination and guidance in the areas of LVDC and LVDC for Electricity Access.
- To widely consult within the IEC community and the broader stakeholder community to provide overall systems level value, support and guidance to the TCs and other standards development groups, both inside and outside the IEC.
- To bring urgency to development of standards for Electricity Access enabling inclusive development of all communities.

Implementation of LVDC is a relatively new topic and requires urgent standardization. As work proceeds, it may be pertinent to review the scope and activities of LVDC, but SyC LVDC does not presently anticipate any change in its scope.

Several TCs will have interest in the work that SyC LVDC will do in the domain of LVDC. A relevant list of TCs is as follows:

Committee	Description
TC 8	Systems aspects for electrical energy supply
TC 9	Electrical equipment and systems for railways
TC22	Power electronic systems and equipment
SC 23B	Plugs, socket-outlets and switches
SC 23E	Circuit-breakers and similar equipment for household use
TC 25	Quantities and units
TC 34	Lamps and related equipment
SC 34A	Lamps
SC 34C	Auxiliaries for lamps
SC 34D	Luminaires
SC 36A	Insulated bushings
TC 38	Instrument transformers
TC 42	High-voltage and high-current test techniques
TC 59	Performance of household and similar electrical appliances
TC 61	Safety of household and similar electrical appliances

TC 64	Electrical Installations and Protection Against Electric Shock
TC 65	Industrial-process measurement, control and automation
TC 77	Electromagnetic compatibility
TC 82	Solar photovoltaic energy systems
TC 100	Audio, video and multimedia systems and equipment
TC 108	Safety of electronic equipment within the field of audio/video, information technology and communication technology
TC 109	Insulation co-ordination for low-voltage equipment
TC 112	Evaluation and qualification of electrical insulating materials and systems
TC 120	Electrical Energy Storage (EES) Systems
TC 121	Switchgear and controlgear and their assemblies for low voltage
SC 121A	Low-voltage switchgear and controlgear
SC 121B	Low-voltage switchgear and controlgear assemblies
SyC Smart Energy	Systems Committee on Smart Energy
ACEE	Advisory Committee on Energy Efficiency

B. MANAGEMENT STRUCTURE OF THE SYC

The work of SyC LVDC is managed through its secretariat which includes Vimal Mahendru (Chair), Gennaro Ruggiero (Secretary) and Sandrine Gosselin (Administrative Assistant to the Secretary). The structure of the SyC LVDC is shown in Figure 1

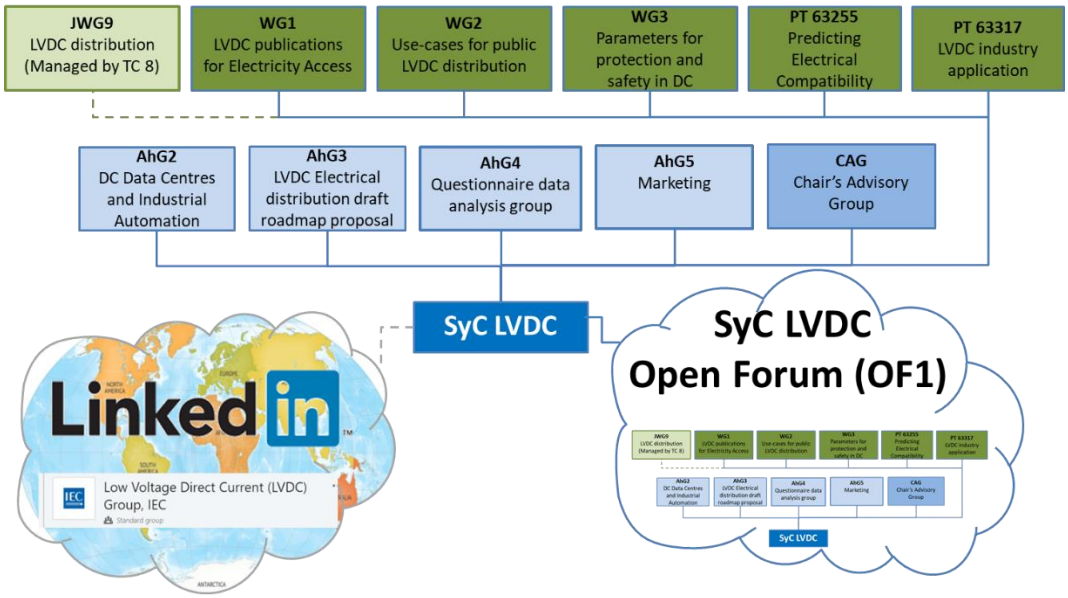

Figure 1 Structure of the SyC LVDC

The Terms of Reference for various groups:

Terms of reference for CAG 1: **Chair's Advisory Group**

Provide recommendations about the following matters:

- Scan and review external environment and industry for needs for standardization,
- Highlight areas for future external cooperation with external stakeholders,
- Promote IEC's LVDC standardization work and standards,
- Use-case listing, mapping and prioritization,
- Participate to define Program of Work (PoW) and Strategic Business Plan (SBP),

- Provide platform to WGs and AhGs for dialog,
- Provide support and oversight to WGs for coordination with their stakeholders.

Meetings of the CAG 1 are chaired by the SyC LVDC Chair.

Terms of reference for WG 1: LVDC publications for Electricity Access

- Federate specifications and standardization work on Electricity Access,
- Develop systems level publications for electricity access,
- Engage and coordinate with TCs to embed Electricity Access provisions in existing publications,
- Engage electricity access practitioners to seek ground level experiences and expectations.

Meetings of the WG1 are chaired by the Convener-WG1. Presently, the convener of WG1 is Mr Rajeev Sharma (IN).

Terms of reference for WG 2: Use-cases for public LVDC distribution

Compilation and articulation of the reference use cases for public LVDC distribution (upstream of the point of connection (POC))

The task of the WG is:

- Collection and formal description of use case information
- Determination of the reference use cases
- Prioritisation of the standardisation needs based on the reference use cases

Meetings of the WG2 are chaired by the Conveners-WG2. Presently, the conveners of WG2 are Mr Tero Kaipia (FI) and Mr Harry Stokman (NL)

Terms of reference for WG 3: Parameters for protection and safety in DC

Analyze the aspects concerning protection for safety including protection against electric shock, thermal effects, overcurrent, voltage variations and any electromagnetic compatibility phenomenon

Meetings of the WG 3 are chaired by the Convener Mr Cristiano Masini

Terms of reference for PT 63255: Predicting Electrical Compatibility

To develop the project Systems Reference Deliverable (SRD) 63255- Predicting Electrical Compatibility - Part 2: Test Methods and Data Packet Coding

Terms of reference for PT 63317: LVDC industry applications

To develop the project Systems Reference Deliverable (SRD) 63317 LVDC industry applications

Terms of reference for JWG 9 (managed by TC 8) LVDC distribution

To prepare IEC TR 63282: Assessment of standard voltages and power quality requirements for LVDC distribution.

The objective being to provide input for future normative works, as an example, a first list of the interested entities is:

- TC8 MT1 (voltages)
- TC8 WG11 (PQ requirements)
- SC77A WG8 (EMC-LF/Compatibility Levels)
- SC77A WG9 (EMC-LF/Measurement Methods)

Terms of reference for AhG2: DC Data Centres and Industrial Automation

The scope of the AhG2 is to:

- To define the use-case
- Agglomerate stakeholders and market needs
- Evaluate and advise if there is any system level work required, and how
- DC supply for industrial automation

Terms of reference for AhG3: LVDC Electrical distribution draft roadmap proposal

The scope of the AhG3 is to:

- Analyze and build consensus on Low Voltage Direct Current Electrical Distribution Draft roadmap proposals" (FRNC Green paper #2)
- Propose a way forward

Terms of reference for AhG 4: Questionnaire data analysis group

The scope of the AhG 4 is to:

Review, analyse and come out with a qualitative analysis of the data collected at the workshops on Electricity access

Terms of reference for AhG5: Marketing

The scope of the AhG 5 is to:

- Market the work of the SyC LVDC
- Market the platform for coordination
- Market the ideas of LVDC Use Cases

Terms of reference for LVDC Open Forum 1 and LVDC Linkedin® group

Platforms for open exchange of technologies, innovations, challenges in LVDC.

The LVDC Linkedin® group can be reached at https://www.linkedin.com/groups/8587064/.

C. BUSINESS ENVIRONMENT

In recent decades, with the advent of electronics, devices we use have changed to work with direct current (DC): multimedia and mobile equipment, LED lighting, IT equipment, electric vehicles, etc. More recently, washing machines, refrigerators, fans, heating/cooling systems have also adopted electric motors powered by DC sources, allowing speed control and improved energy efficiency. Power generation has also moved to DC with the proliferation of renewable energy power systems using solar and wind energy. With the latest improvements in battery technology, direct current has also become a widely recognised form of charging/discharging energy. This exceptional convergence of technological developments is happening together with a drastic reduction of the cost of DC devices.

This is why the time has now come to review the predominance of alternating current (AC) in developed economies. In most use cases, the main drivers for the use of DC arise from the expectation of economic benefits (reduced infrastructure and operation costs), improved technical performance and exploitation of renewable energy sources. In developing economies, DC brings the opportunity for a drastic living improvement to 1.1 billion[1] people on the planet that do not have access to electricity.

A very large number of stakeholders are involved: industrial-scale users of the LVDC technology, equipment and product manufacturers, academia, education and research institutes, standardization organizations, industry consortia, development banks and multi-lateral financial and aid institutions, governmental bodies and regulatory authorities. The most active industries have been telecom, data centers and transportation. The electricity distribution companies and the electrical contractors, who are beginning to explore LVDC use cases and to develop a standardization perspective, are invited to actively participate in the standardization work. LVDC standardization work requires specific expertise and the IEC community will have to reach out to related industrial associations and consortia.

The approach adopted to assess the market is based on the collection of use cases which have been defined taking into consideration the environment (domestic, tertiary, industry, and geographical area), the amount of power required by the user(s), and the distances over which the power needs to be transported. All of these parameters will influence the characteristics

[1] IEA, Energy Access Outlook 2017,

of the electricity supplied to each market. The main classes of use case established are: energy access; renewables and energy storage; data centers, commercial, industrial and domestic buildings; electric mobility; power over Ethernet and USB, LED lighting and signaling, including public areas; and the “last mile” of the public power distribution network. In fact, a potent tool used by the SyC LVDC to collect emerging trends and ideas on LVDC proliferation is the use of the IEC LinkedIn forum which has now in excess of 580 active users today. It is interesting to note that a large majority of these are outside of the traditional IEC Community. For more info, please visit https://www.linkedin.com/groups/8587064/.

Standardization of voltages is a key and urgent issue. Before defining voltages, it is necessary to establish the criteria to consider for voltage selection. The main criterion is the power to be delivered. Once the voltage for a given power is selected, the current and cable size will define the power efficiency at a given line length. The size of the cables will also impact the cost. Under certain conditions a threshold of 120V is globally agreed to be the limit under which direct current is considered safe. For protection against electric shock, IEC 61140 shall be applied to define the voltage threshold.

The LVDC safety principles are known and related standards can be applied for product requirements. Standardization work should be considered concerning over-voltage protection, power quality, protective devices (e.g. RCDs for electric shock or AFDDs for arcing), device coordination and selection, wiring rules, and islanded installations. In the whole process of development of this report, there was total unanimity among all experts that regardless of use-case, LVDC shall not be less safe than AC is today.

Regarding existing product standards, there is a need for publications concerning the implementation strategy, the grid topology and the key performance indicators. This will support users, installers and financing organizations in the implementation of the projects.
Direct current has some differences compared with alternating current, namely voltages, plugs and sockets, and the effects on the human body. These will require to be addressed differently.

Other aspects also need to be reconsidered, including overvoltage and overcurrent protection, earthing principles, fault detection and corrosion. Most of the standardization work needed consists in adding provisions and requirements for DC into the existing AC standards. A very large number of publications, issued by over thirty IEC Technical Committees (TCs), are involved and will need updating. This maintenance work will require close coordination in order to introduce coherent and synchronized standards, while addressing the need for a migration path that will allow reusing parts of the existing AC fixed installations.

LVDC for Electricity Access

Electricity Access is not a yes/no concept but is mainly based on the power level and the number of hours of availability per day. It applies not only to rural but also to peri-urban and urban areas.
Among developing economies there is an urgent need for standards enabling Electricity Access for 48V ELVDC Systems in Tier-2 and Tier 3 of the ESMAP[2] multi-tier framework, including standards enabling compatibility specifically for appliances such as desert coolers, fans, LED lighting, domestic kitchen appliances such as mixers, grinders etc., small TV sets, mobile phone chargers, plugs and sockets, wires and cables.
For other tiers of the ESMAP[1]framework, i.e. Tier 1, 4 and 5, other voltages may be used, as deemed appropriate.

D. MARKET DEMAND

IEC SyC LVDC Standards are likely to have a very wide audience. This is because the very nature of LVDC is parallel to LVAC which has been around for about 130 years. Deep interest in LVDC and demand for LVDC standards are likely to arise from the following groups. This

[2] ESMAP: https://www.esmap.org/

was also witnessed during the recent Delft DC Week, hosted by the Delft University of Technology (TU Delft), Delft, the Netherlands, on January 16-17, 2020.

- Policy makers and regulators working toward enabling electricity access for all. This particularly resonates with developing economies.
- Regulators trying to move away from fossil fuels and enable green energy policies
- Industry
- Consumers
- Testing laboratories
- Conformity Assessment bodies

E. SUSTAINABILITY DEVELOPMENT GOALS

INDICATE THE SUSTAINABLE DEVELOPMENT GOALS (SDGS) THAT ARE ADDRESSED BY WORK WITHIN THE TC/SC. INDICATE EACH SDG INDICATOR AFFECTED (REFERENCE SPREADSHEET AVAILABLE AT HTTPS://WWW.IEC.CH/SDG/) , AND PROVIDE SPECIFIC INFORMATION ABOUT HOW THE TC/SC IS ADDRESSING THE SDG. CONSIDER BOTH DIRECT AND INDIRECT IMPACTS OF THE WORK OF THE TC/SC.

☒	**GOAL 1:** No Poverty	☒	**GOAL 10:** Reduced Inequality
☒	**GOAL 2:** Zero Hunger	☐	**GOAL 11:** Sustainable Cities and Communities
☐	**GOAL 3:** Good Health and Well-being	☐	**GOAL 12:** Responsible Consumption & Production
☒	**GOAL 4:** Quality Education	☐	**GOAL 13:** Climate Action
☒	**GOAL 5:** Gender Equality	☐	**GOAL 14:** Life Below Water
☒	**GOAL 6:** Clean Water and Sanitation	☐	**GOAL 15:** Life on Land
☒	**GOAL 7:** Affordable and Clean Energy	☐	**GOAL 16:** Peace, Justice and Strong Institutions
☐	**GOAL 8:** Decent Work and Economic Growth	☐	**GOAL 17:** Partnerships to achieve the Goal
☒	**GOAL 9:** Industry, Innovation and Infrastructure		

According to recent estimates released by the International Labour Organisation (ILO), each year 2.78 million workers die every year from occupational accidents and work-related diseases. Millions more are unintentionally injured on the job. Aside from the economic cost, there is an intangible cost in terms of the immeasurable human suffering caused by occupational accidents and work-related diseases. This is tragic and regrettable because, as research and practice over the past century have repeatedly demonstrated, they are largely preventable. Further, the loss of morale, camaraderie and feeling of helplessness that sets in after an accident, impacts economic performance. Any kind of development, measured on any dimension and using any metrics, cannot justify this kind of loss of life and loss in quality of life.

United Nations Special Rapporteur on hazardous substances and wastes, Mr. Baskut Tuncak, said at the September 2018 session of the Human Rights Council: “Workers’ rights are human rights. No one should be denied their basic human rights, including the rights to life and health because of the work they perform”. And hence, a better world for every citizen of the shared planet earth, it must be essentially safer with the eradication of accidents causing unintentional injury and even death.

The United Nation’s Sustainable Development Goals (SDGs) encourage governments and all stakeholders to pace themselves and aspire to the key essentials for development. As technology and machines are essential tools of development, it is thus obvious that SDG targets will require harnessing technology. Such development necessitates safety of the human beings. In that sense, talking of SDGs in framework of safety of the human – technology – machines interface is a natural and essential requirement.

A prudent approach is to consider safety of workplaces and environments. This goes beyond mere use of electricity. Safety and health at work can be key to sustainable development. Electricity access, specially for those communities and households which have never ever received electricity, has a huge transformational impact. As a result, mere provision for an electric bulb begins the transformation and then has multiple cascading benefits; eradication of poverty and hunger (SDGs 1 and 2), enabling rural and distance education (SDG4), empowering women and triggering gender equality (SDG5), reducing disease by easier access to clean drinking water (SDG6), affordable and clean energy for purposes of

productive and domestic work enabling better lifestyle (SDG7), and eventually bringing innovation to entire industry and the future of electric grid (SDG9) and enabling an egalitarian global community (SDG10 and 11).

Further, it may be noted that a lot of modern technologies, e-mobility, robotics, block-chain, smart cities, smart manufacturing, communications etc are all having an underlying layer of DC. As such the work of SyC LVDC becomes increasingly significant in the emerging future.

F. TRENDS IN TECHNOLOGY AND IN THE MARKET

There are three major trends which are impacting demand for LVDC standardization;

1. **Proliferation of electronics and communication into everything**: In the last 30 years, electronics have entered every form of electricity consumption. By most estimates about 80% of electricity is now consumed directly through devices using electronic circuitry, i.e. direct current. As a result, the consumption of current has almost entirely moved to direct current and away from alternating current.
2. **Power generation is moving from centralized to distributed, and from fossil fuel to renewable**: With the sharp lowering of prices of solar PV modules, the proliferation of solar PV for power generation is increasingly viable. At the same time, the cost of storage batteries has also come down. This is an added incentive to look at renewables as a source of energy, rather than simply the polluting fossil fuel plants.
3. **Regulators and policy makers' push**: Regulators and policy makers are now increasingly conscious of their responsibility to ensure sustainable development. Hence, policy makers are pushing for reducing carbon footprints and pollution. At the same time, there is demand to bring affordable, clean 24x7 electricity to all (1.1 billion people without electricity today). This is encouraging policy makers and regulators to push for new standards which enable such sustainable development.
4. **LVDC Industry applications:** The electrical distribution in industrial applications has a high amount of motor drives and machinery with high power peaks. More and more production sites integrates PV systems and battery storage systems to reduces this peaks or/and increase the reliability. Going to an DC distribution will cover that challenges and will further increase the efficiency. This can be archived in LVDC due to the fact, that there are less conversion losses and a cost-effective bidirectional integration of motor drives and batteries is possible. LVDC is already used in many corners of a production hall, but all parts have none or different standardized interfaces and are therefore not compatible to a central bus system.

All of the above is encouraging development of LVDC standardization.

G. SYSTEMS APPROACH ASPECTS (REFERENCE - AC/33/2013)

Yes, the Systems Committee-LVDC will require the Systems Approach. The systems approach will involve multiple TCs, SCs and perhaps some other committees as well. SyC LVDC will work jointly with TC8/JWG9.

It is quite evident that LVDC is already very much in use at the consumption level. Most electrical appliances in homes and offices are now operating with DC as the primary energy. At the device, AC is converted to DC.

It is also well-documented that AC has been existing for over a 130 years and so AC systems, safety aspects have evolved slowly over a period of time, often at the cost of society. LVDC standardization requires multiple TCs, WGs, JWGs and SyCs working together, in harmony and unison, to develop the same level of robust DC standardization regime. This level of complexity can only be handled through the diligent applicability of principles of the systems

approach. The V-model and other tools created by the IEC SRG become very relevant to the work of SyC LVDC.

For robust and comprehensive standardization of LVDC, we require multiple committees to work together. For some key and urgent projects in LVDC, these are listed below.

Subject	**Leader**	**Experts committee to be asked for support and advice**	
Installation general characteristics	TC64	TC 8	Systems aspects for electrical energy supply
		TC 64	Electrical installations and protection against electric shock
		TC 22	Power electronic systems and equipment
		TC 23	Electrical accessories
		TC 32	Fuses
		SC37A	LV surge protective devices
		TC 65	Industrial-process measurement, control and automation
		TC 73	Short-circuit currents
		TC 77	Electromagnetic compatibility
		TC81	Lightning protection
		TC 82	Solar photovoltaic energy systems
		TC 109	Insulation co-ordination for low voltage equipment
		TC 121	Switchgear and controlgear and their assemblies for low voltage
Protection for safety	SyC LVDC	TC 64	Electrical installations and protection against electric shock
		TC 22	Power electronic systems and equipment
		TC 77	Electromagnetic compatibility
		TC 109	Insulation co-ordination for low voltage equipment
Equipment selection and installation erection	TC77	TC 64	Electrical installations and protection against electric shock
		TC 22	Power electronic systems and equipment
		TC 23	Electrical accessories

		TC 69	Electric road vehicles and electric industrial trucks
		TC 77	Electromagnetic compatibility
		TC 121	Switchgear and controlgear and their assemblies for low voltage
		TC 32	Fuses
		TC 85	Measuring equipment for electrical and electromagnetic quantities
		TC 109	Insulation co-ordination for low voltage equipment
		CISPR	International special committee on radio interference
Verification, maintenance, life time and sustainability	TC77	TC 64	Electrical installations and protection against electric shock
		TC 22	Power electronic systems and equipment
		TC 77	Electromagnetic compatibility
		CISPR	International special committee on radio interference
Corrosion	TC9	TC 9	Electrical equipment and systems for railways
		TC 22	Power electronic systems and equipment
		TC 64	Electrical installations and protection against electric shock
		TC 82	Solar photovoltaic energy systems
Requirements for dedicated applications (e.g. data center, hospital)	SyC LVDC	TC 9	Electrical equipment and systems for railways
		TC 64	Electrical installations and protection against electric shock
		TCxx	relevant TCxx (s) depending on the subject

Table 1 – Subjects to be handled by TCs

IEC SyC LVDC does not expect a new SEG or a SG to be formed for the purpose of deploying the systems approach by SyC LVDC.

Yes, there are certain other SDOs working in parallel to SyC LVDC. The objective of SyC LVDC is to include them in discussions leading to LVDC standardization.

H. CONFORMITY ASSESSMENT

The publications may be used for IECEE and IECRE.

I. 3-5 Year Projected Strategic Objectives, Actions, Target Dates

Strategic Objectives 3-5 years	Actions to support the strategic objectives	Target Date(s) to complete the actions
Develop and publish LVDC standards for Electricity Access	Formation of WG1 to commence working on these standards	Q3 of 2021
Develop a global event in the form and style of "IEC World DC Summit" to bring together thinkers, practitioners and influencers of technology to prepare a global agenda for DC. This will eventually be input to the SYC LVDC for development of its future program of work.	craft an organizing committee, find a host NC, curate the sessions, find speakers and administer the organization of the summit	Q2 of 2022
develop a glossary of definitions on direct current	review current global definitions related to direct current in context of electromedical and propose items for updating and addition. This will follow the IEC process of definition development	Q1 of 2022