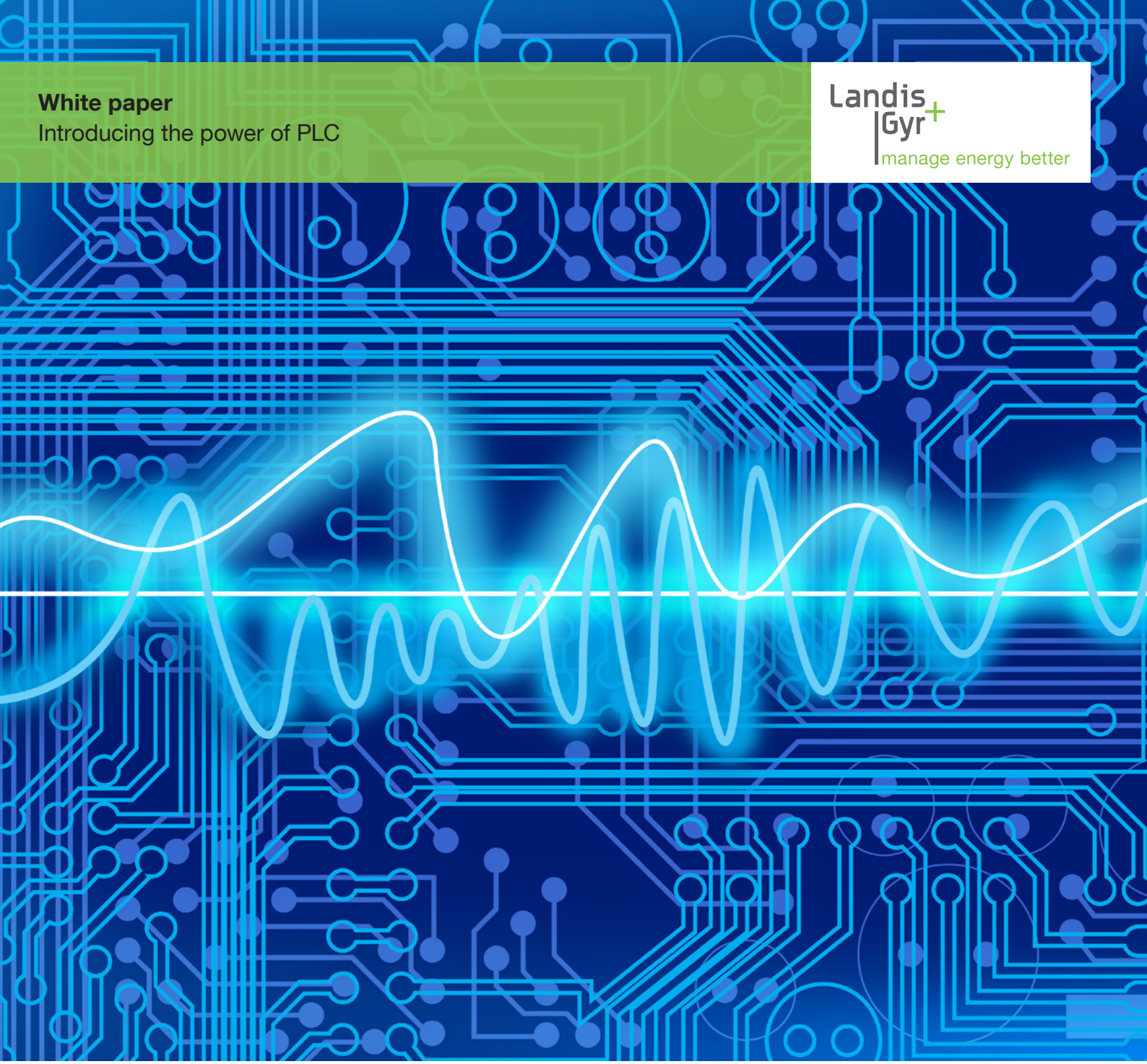
Landis+Gyr
manage energy better



Introducing the power of PLC

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Introduction

Power Line Communication (PLC) is a well-established communications technology that was initially used for telemetry purposes. The first large-scale PLC deployments took place in the 1990s. Today, PLC technology has reached maturity with many vendors offering fully operational communication solutions for a wide range of industry applications.

In the late 1990s, energy utilities set out to use PLC technology in the smart metering rollouts, which has turned it into the dominant smart metering communications technology in Europe. PLC proved to deliver reliable performance at reasonable procurement, installation and operation cost points.

In recent years, new open OFDM-based PLC technologies have been developed and are currently being field-tested and deployed. This new generation of PLC technology will provide higher communication bandwidth for future advanced smart grid applications.

Landis+Gyr is a key PLC technology market player and is actively involved in the development of this future technology.

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PLC communication is the number one technology for smart metering in Europe

The table below shows the installed PLC endpoints in Europe by country.

Country	Endpoints [millions]	% of installed AMM base
Italy	36	99%
Sweden	3	58%
Finland	1.5	52%
Denmark	1.3	79%
France	0.3	Pilot
Spain	0.2	Beginning of rollout
Norway	0.15	76%

The European market data presented above has been obtained from the BERG IN-SIGHT research report

PLC accounts for the majority of smart metering installations in Scandinavia, whilst the Italian utility Enel operates the largest PLC installation in Europe.

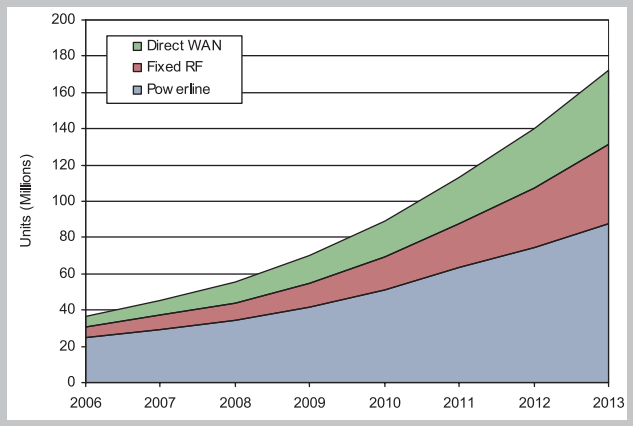
Large-scale PLC deployments:

- **France**: In 2011, ERDF carried out a pilot of 300,000 metering points with PLAN+ PLC communications. The pilot will be followed by a mass rollout of 35 million meters over the next five years. Currently, PLAN+ is the only technology available in the market based on the international IEC 61334-5-1 standard, which is fully integrated with the smart metering application standards of IEC 62056-61/62. Several international chip manufacturers offer chips supporting the PLAN+ technology.
- **Spain**: Iberdrola has successfully completed development of its "next generation" OFDM-based PLC technology PRIME, which is now in rollout phase. The PRIME PLC technology can be integrated with the smart metering application standards of IEC 62056-61/62. PRIME Alliance, founded by a number of leading industry players such as Iberdrola and Landis+Gyr, strives to develop a single specification and standard for CENELEC A-Band power line communications for smart grid products and services.

  Currently, large volumes of meters equipped with PRIME technology are being installed in Spain. Their number is expected to reach 1 million metering points by March 2013.

According to ABI Research, PLC technology is the number one smart metering technology in the world. This is a remarkable success for PLC technology considering the large number of national regulatory and legislative bodies in and outside Europe promoting the use of other communication technologies in smart metering.

Smart Meter LAN Communications Technology Installed Base by Type, World Market, Forecast: 2006 to 2013



Source: ABI Research

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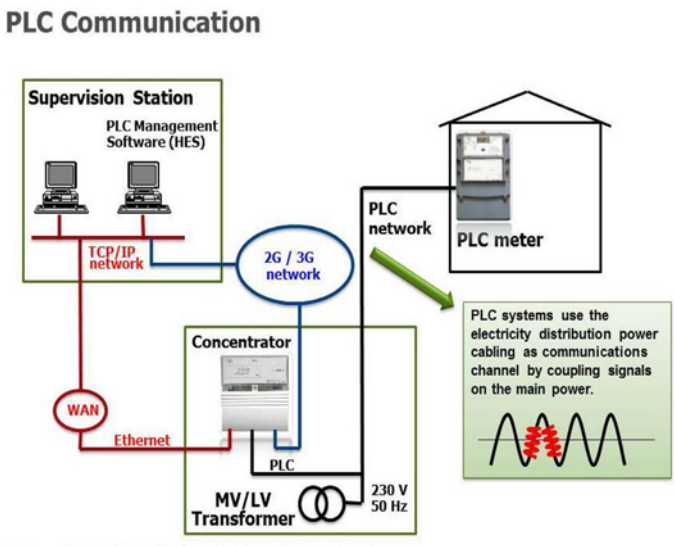
Utility-owned network

With the introduction of PLC, the energy distributor adds value to his most important asset – the distribution network. In addition to the distribution of energy, the same network also provides the basis for smart metering-related communications.

By re-using the electricity distribution network for communications, the utility can also re-use maintenance tools and resources, thereby avoiding the maintenance costs of a dedicated communication network. With every extension of the electricity distribution network, the communication network grows accordingly.



In most EU countries, the regulator assigns responsibility for smart metering services to the network operator. The network operator has two options to deal with this task:

1. The utility subcontracts service provision to a telecom operator with a corresponding service-based contract. In order to get the necessary service guarantees, the utility has to enter into costly service level agreements with the telecom operator.
2. The utility provides the requested services directly by investing in the necessary infrastructure. In this case, PLC is the cost-efficient alternative based on CAPEX and OPEX considerations. In addition, PLC gives the utility complete control over the communication network and, thereby, provides the optimum basis to fulfill requirements set by the regulator.

Robustness of PLC installations

PLC offers the simplest type of installation out of all Neighborhood Area Network (NAN) access technologies. Installation is Plug-and-Play in any environment and does not require any additional work other than installing meter hardware.

Compared to wireless access technologies (GPRS, UMTS, RF Mesh, WiMax), PLC offers the following advantages:

- Immediate establishment of communication during the installation process and, thereby, avoidance of any costly waiting times for the installer
- No antenna tuning or adjustment of antenna direction required
- Communication is also possible in difficult environments (for example, metal-shielded cases, deep underground installations, etc.), where no other access technology can provide a solution
- Antenna cannot be removed during operation (tampering protection), antenna cannot fail (reliability). The fact that the communication interface is powered by 230V offers intrinsic security against tampering

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Compared to other wired access technologies (Ethernet, Fibre and PSTN), only PLC offers the key advantage: the communication channel is directly linked to the device itself. This means:

- No installation of additional communication wiring is required.
- Communication is seamlessly established by powering up the device.
- No communication cables or equipment can be removed or tampered with during operation.

PLC integration into transformer stations

PLC communication is almost always relayed via a transformer station. This offers major advantages:

- It is possible to combine classic data concentrator functions and smart grid/transformer station automation functions in a single device at marginal additional cost
- Smart grid (transformer and substation automation) features can be easily integrated into smart metering infrastructure by using a common communication network and IT infrastructure
- PLC offers inherent physical security aspects other solutions cannot offer:
    - Access to transformer stations is highly protected and supervised.
    - Power cables are typically laid underground to prevent tampering.
    - Carrying signals on 230V lines inherently provides a degree of natural protection. Physical access is much more difficult than to a wireless or low voltage network and presents a physical danger.
    - PLC sniffing/jamming equipment is much more difficult to obtain than wireless sniffing/jamming equipment.

Network topology

PLC is the only NAN access technology that is inherently linked to the topology of the power distribution network.

Knowledge regarding the network topology, such as problems and vulnerabilities on specific nodes, is extremely valuable information for a utility operator. Managing a smart grid requires detailed and timely information on the status of each node, potential breakdowns and malfunctions. Only PLC can offer such information without the installation of additional infrastructure and separate communication networks.

GIS systems can be easily integrated into the PLC infrastructure for visualization purposes.

Emissions

Compared to wireless access technologies, PLC offers the advantage that no wireless emissions are produced. Landis+Gyr's PLC operates in the Cenelec A band, where emissions are strictly limited according to international norms.

Dedicated frequency band and controlled output levels

The Cenelec PLC standard EN 50065-1 is accepted all over Europe. This standard specifies the output levels for PLC transmissions and assigns a dedicated frequency band (Cenelec A band) specifically for utility use. PLC is the only medium offering the utility a protected frequency band for exclusive use. Exclusive use of the dedicated frequency band is a prerequisite for communication reliability over the lifetime of the smart meter installation, which secures the utility's long-term investments. The Cenelec standard is recognized within Europe and throughout the world. This means that PLC users benefit from the wide range of high volume equipment offered by a large number of international manufacturers.

PLC transmits signals within a dedicated frequency band and a maximum power level that conforms to regulatory requirements. With over 10 years of

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experience and rollouts of 40 million metering points, Landis+Gyr is convinced that PLC networks can be operated without running the risk of interfering with any other communication services.

Finally, EN 50065-1 is backed by a comprehensive test infrastructure. Renowned national and international test institutes offer EN 50065-1 testing on a competitive basis.

A quantum leap forward in PLC technology

With the introduction of OFDM (Orthogonal Frequency Division Multiplex) PLC, the communication speed of smart metering applications will increase dramatically. While today's PLC technologies offer a physical layer throughput of 2 to 5kbps, the new OFDM PLC will have its throughput increased by a factor of 10.

Today, there are two different OFDM-based PLC technologies available in the market:

- PRIME PLC is supported by the PRIME Alliance with over 50 members chaired by Iberdrola. The technology has already won a strong market position with an installed base of 200,000 PRIME meters rolled out in Spain alone by the end of 2011.

- G3 PLC is supported by the G3 PLC Alliance. The driving force behind G3 is EDF in France. In the next two to three years, EDF will be field-testing G3 PLC technology. Mass rollout will start in 2015.

Both technologies are open and have been adopted as starting points of the official ITU standard, "G 9955 Narrow-band OFDM power line communication transceivers - Physical layer specification".

By supporting both technologies, Landis+Gyr is prepared to take its PLC portfolio offering to the next level.

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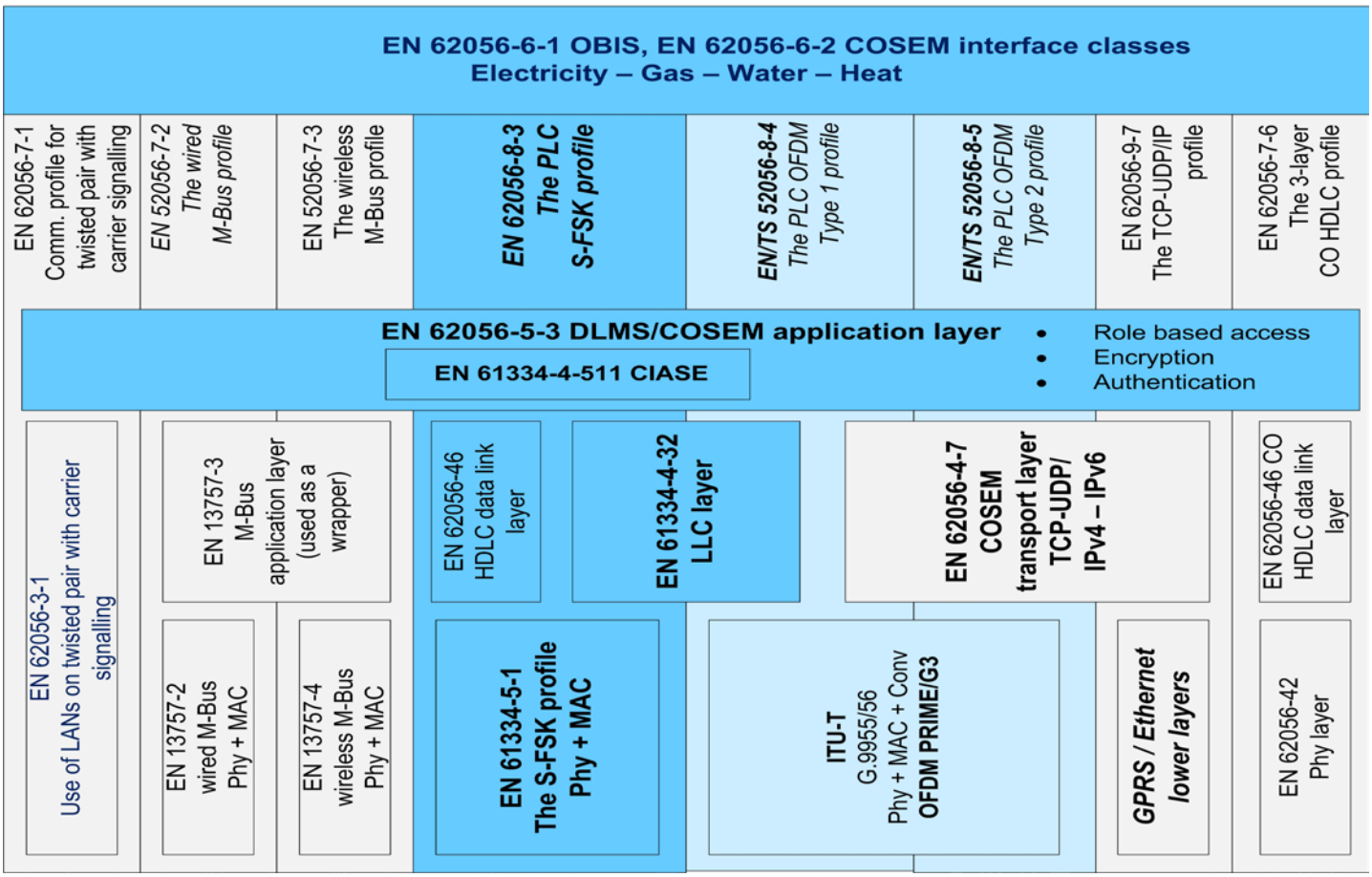
Interoperability

PLC is the only access technology with proven IEC standards (IEC 61334 series). PLC standards form the core of a comprehensive smart metering architecture based on international standards.

Several technology manufacturers are providing PLC chips in accordance with the IEC 61334-5-1 standard and several smart metering solution providers are offering end-to-end solutions based on interoperable PLC components. PLC is the widest spread smart metering communication technology, and it offers



The smart metering architecture shown on this page is also considered as a basis for the standardization work issued by the European Commission under the mandate M/441. M/441 architecture is built around a PLC communication stack that is structured to fit perfectly into the existing application standards framework. The OSI layering ensures expandability taking the evolution of PLC technology into account, while at the same time maintaining backwards compatibility with proven solutions.

components from different manufacturers. By investing in standardized PLC technology, a utility can avoid the risk of stranded investments due to proprietary technology.

The standards framework on this page allows enough flexibility to incorporate new PLC technologies, thus providing a smooth upgrade path from today's field proven S-FSK technology towards the emerging OFDM technologies.

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The combination of standardized PLC with the global concept of the expandable COSEM data model offers the user consistency between today's solutions and future technologies and applications. The universal message- based security features offered by the application layer are independent of the PLC technology and can even be used in any other communication medium.

PLC offers the lowest Total Cost of Ownership (TCO)

The TCO analysis of a smart metering system covers the following aspects:

- The cost of the smart metering equipment
- The cost of installing the equipment and setting up the system
- The cost of operating and maintaining the system

In order to get a fair assessment of the TCO of a PLC-based smart metering solution, the following points must be considered:

Cost of smart metering equipment (CAPEX)

- A PLC meter is the most cost-effective smart meter due to the following:
  - PLC chip sets are mature and available from many vendors. From the technical point of view, integration into a meter is quite simple.
  - The large installed base has already driven the cost down (economies of scale).
- Cost of data concentrator:

In densely populated areas the ratio between metering points and a data concentrator on average is 1:200 (and can go up to 1:1000). This results in minimal costs for each metering point.

Installation cost of field equipment (OPEX)

- Installation of the data concentrator:
  Installation of the data concentrator is done at the transformer station typically owned by the utility. The installation takes just a few minutes.
- "Plug and play" installation of the PLC meter:
  Once the meter has been installed, it is ready to communicate. This reduces the installation cost of PLC communication to almost zero and is a significant cost advantage over RF solutions. Meters serve as repeaters thus strengthening the network.
- Establishing the PLC communication network:
  Landis+Gyr supports the entire installation process with powerful installation tools and the central system. The PLC communication network itself does not require an installation process.

Cost of operating and maintaining the smart metering system (OPEX)

- The cost of operating the PLC network is independent of third-party network operators and therefore low compared to 2G/3G operation costs. But most importantly, because of the unmatched communication reliability, the cost of human intervention is minimal.
- The PLC network needs very little maintenance from the system side. Moreover, the PLC network monitoring capabilities of the system enable basic network supervision.
- The firmware of the data concentrator and the meter can be remotely updated; hence no additional site visits are required.

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PLC compared to other communication technologies for smart metering

In order for the utility to achieve a reliable communication network and to fulfill the required SLAs (Service Level Agreements) at the lowest Total Cost of Ownership (TCO), it is essential to choose the right communication technology. The selected communication technology must fit in the geographical environment and satisfy the utility's business requirements.

Today, there are basically four "last mile"* communication technologies that can be used in smart metering:

- Power Line Communication (PLC)
- RF Mesh
- Point-to-point communication using a public mobile network (2G/3G/4G)
- Point-to-point communication using a private broadband connection (e.g. FTTH)

In the comparison table on this page, these technologies are rated based on key aspects applicable to the smart metering solution.

Based on 25 years of experience in smart metering in EMEA, Landis+Gyr considers PLC to be the "last mile" technology that provides the most benefits to the utilities.

**The "last mile" refers to the final leg of connectivity from the utility to the consumer.*

Key aspect	PLC	RF Mesh	Public mobile network	Broadband connection
Meter point cost (incl. communication infrastructure such as Data concentrator / RF collectors) In medium to dense areas such as villages & cities	++	+	-	+
Meter point cost (incl. communication infrastructure such as Data concentrator / RF collectors) In rural areas	+	++	-	+
Meter point installation costs	++	0	0	0
Performance for smart metering	+	+	++	++
OPEX over lifetime	++	++	--	++
Risk of service discontinuation in 15 years	++	0	-	0

Rating: ++ / + / 0 / - / --

As noted above, all four technologies have their advantages and disadvantages, which need to be carefully evaluated during the solution analysis phase. Landis+Gyr is well positioned to assist its customers with this task.

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Conclusion

With an installed base of over 40 million metering points in Europe, PLC is by far the most commonly used communication technology for smart metering.

Over the past 15 years, all advantages of the PLC technology in large installations have been fully proven. The electricity network was not designed to be used as a communication channel; however, PLC technology is mature enough to deal with even the most challenging environments. Filtering techniques, repetition of messages and sophisticated routing algorithms guarantee exceptionally robust communication.

Connecting the meter to the PLC communication network is just as simple as connecting the meter to the mains. No additional work is required. The Landis+Gyr PLC solution makes Plug-and-Play installation a reality.

By using PLC technology, the utility retains full control over its distribution network. Smart metering based on PLC is the first step towards smart grid.

With the introduction of OFDM encoding, PLC is brought to the next level, securing its prime position for the next decade.

At Landis+Gyr, we believe that interoperability between different manufactures is a must for successful smart metering solutions. Based on the widely used PLC technology and the IDIS (Interoperable Device Interface Specification) initiative, we can offer maximum flexibility and investment protection to our customers.

In summary, this report demonstrates that PLC, with its low CAPEX and OPEX levels, is the most cost-effective technology choice for smart metering rollout in densely populated areas.

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About Landis+Gyr

Landis+Gyr is the leading global provider of integrated energy management products tailored to energy company needs, and unique in its ability to deliver true end-to-end advanced metering solutions. Today, the company offers the broadest portfolio of products and services in the electricity metering industry, and is paving the way for the next generation of smart grid.

Landis+Gyr, a standalone growth platform of the Toshiba Corporation and 40% owned by the Innovation Network Corporation of Japan, operates in 30 countries across five continents, and employs 5,000 people with the sole mission of helping the world manage energy better.

More information is available at www.landisgyr.com.

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