Communication networks for power companies

ITSF 2021

Clive Wright

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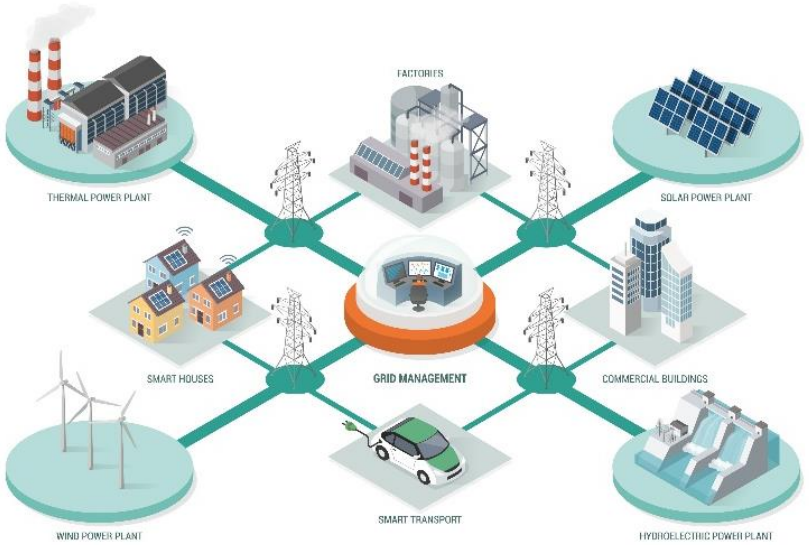
From central power generation to a smart grid



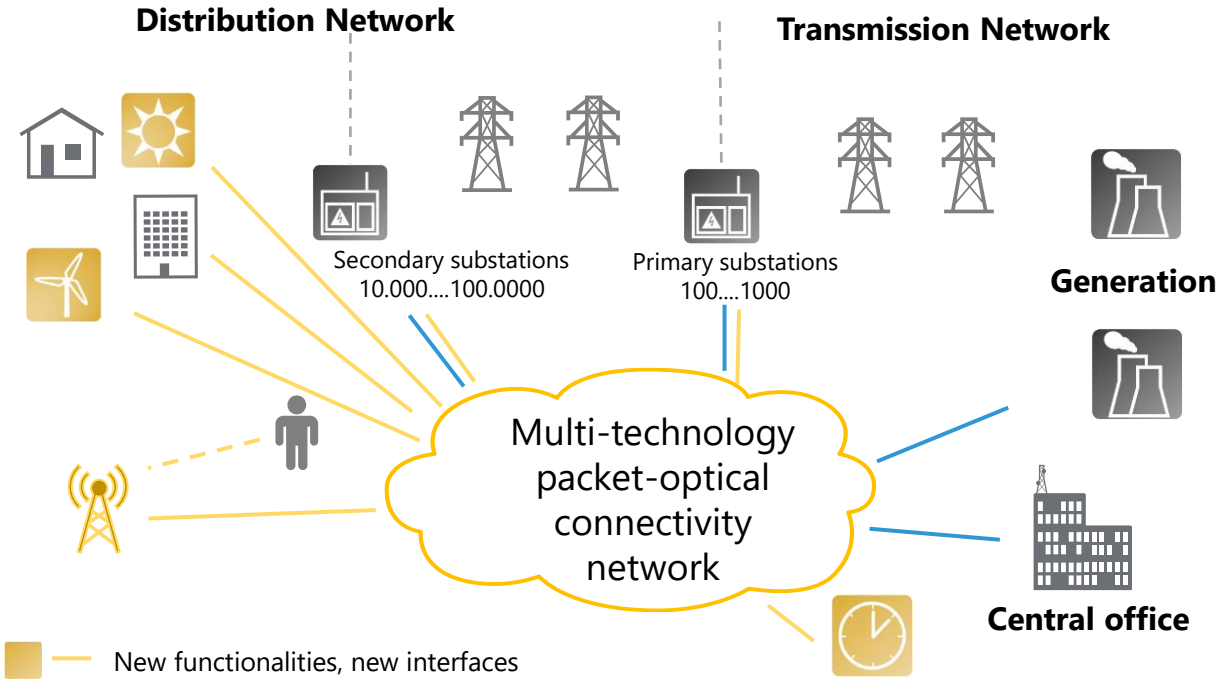
Utilities need to re-invent themselves

- Distributed renewable generation
- Operate grid closer to maximum capacity
- Reduce peak demand:

  Time of use tariffs - smart metering
- Real-time substation automation:

  IEC 61850 substation automation standard
- Robust microsecond timing
- Secure IP communication
- Wide Area Monitoring System (WAMS)

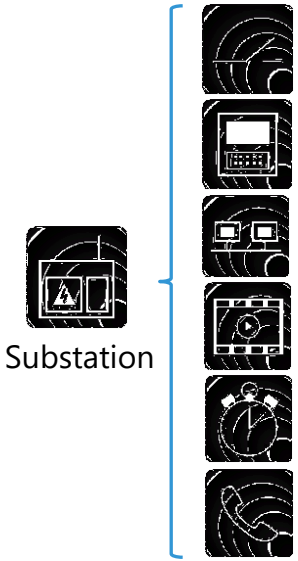
Future-proof communication networks



- Migrating from legacy interfaces to Ethernet
- Packet-optical transport to meet bandwidth demand
- IT/OT agility with software-defined functions and virtualization
- Improving operations with better timing accuracy
- Responding to increasing security concerns
- Enriching functionality with Iot and 5G

Distributed energy production is triggering digital transformation

Evolution of interface requirements at substations



Application	Legacy
Tele-Protection (delay < 5ms)	RS232, V.24 over PDH
Station-/field bus; RTUs	Modbus, et.al.
Inter control center comm	Proprietary, DNP
CCTV - monitoring	Coaxial
Time distribution	IRIG-B e.g. 1pps, serial V24
Phone	analog

Future	Connectivity requirements
IP (IEC 60870-5)	IP/Ethernet
IP/Ethernet (IEC 61850)	L2 Ethernet
IP (IEC 60870-6)	IP/Ethernet
IP/Ethernet	IP/Ethernet
IEEE 1588; power profile	L2 Ethernet
VoIP	IP/Ethernet

Migration to common IP/Ethernet connectivity network

Market-specific communication requirements

Need for change

- **End of life technology:** PDH systems and asynchronous interfaces (E1/T1, RS232, X24) for monitoring and control but also tele-protection to isolate failures on power lines
- **Fully connected:** Smart grid with need for real time control of any connected power device – production and consumption
- **Simplification:** SCADA using field bus systems and wide range of proprietary interfaces/protocols
- **Precise sync:** Legacy Synchronization with IRIG, ToD not accurate enough

Digital transformation

Interfaces and protocols **converge to IP and Ethernet,** driven by new sub-station technology
Increasing dependency on OT/IT impacts need for **high-available and secure connectivity** and connectivity to any device
Virtualization for agility and flexibility
Legacy timing technologies are **migrating to IEEE 1588 (PTP)** and network-delivered timing
Growing bandwidth demand creates need for **100G packet-optical transport**

Standards - IEC 61850 Substation Modernization

Time Sync accuracy requirements

PTP

1µs

NTP

1ms

Fault localization
Synchrophasor: voltage/current with accurate phase

IRIG

SCADA: supervisory control & data acquisition
Frequency measurement
Event recorder

1s

Bulk metering
Customer premises metering

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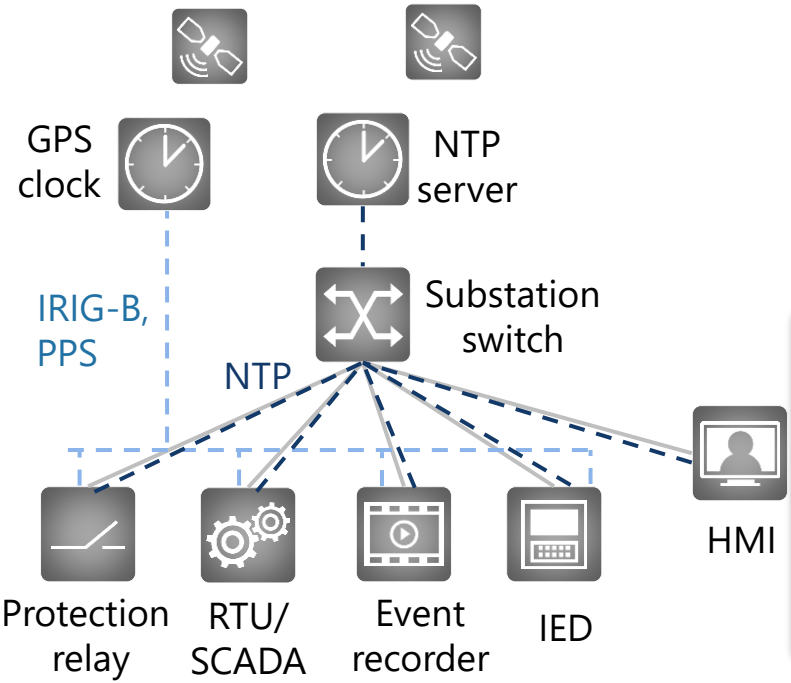
Substation Time Sync - today

- IRIG and PPS provide time over dedicated cables
- NTP provides msec precision
- GPS used as higher accurate local time reference



Presently applied solutions neither meet accuracy nor availability requirements

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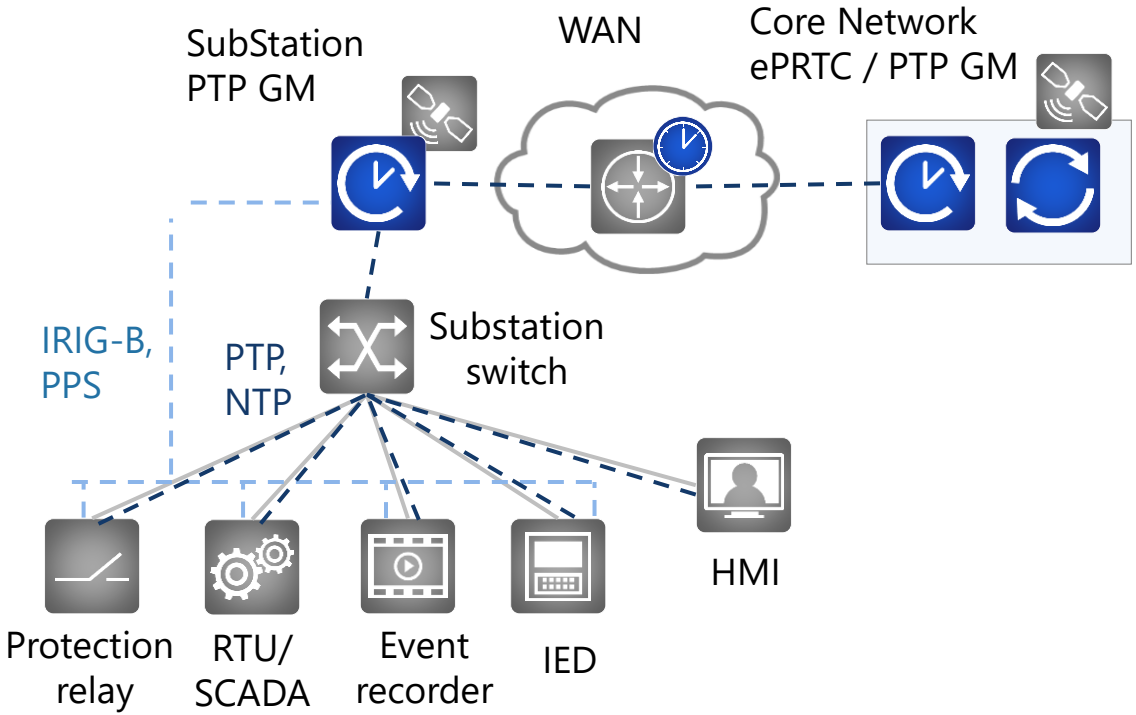
Substation synchronization - tomorrow

- Precision Time Protocol for **sub-µs timing accuracy**
- Converging PTP, NTP and IRIG-B into **single PTP solution over Etherent**
- Mitigating GNSS outages with network-based backup for **highest availability**
- Assuring business continuity by **monitoring sync quality**



Highest accuracy and best availability with satellite **and** network based timing

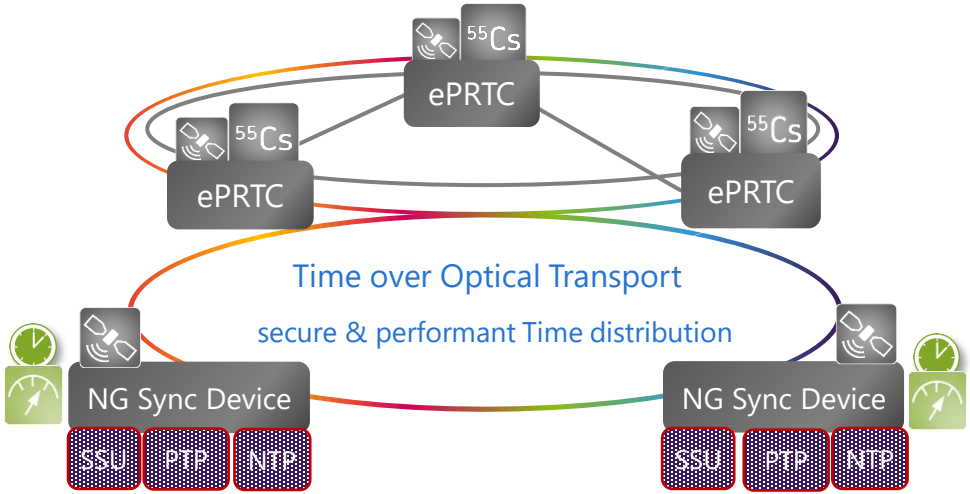
The new Time Sync Architecture – Time keeping, distribution & assurance

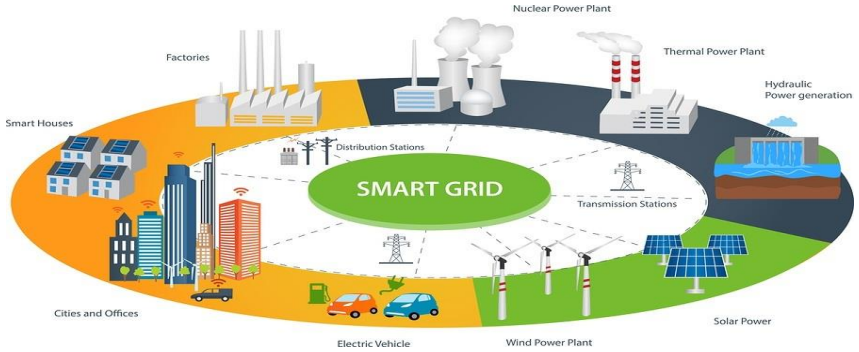
Core Network

Ensemble of highly precise and accurate Time Clocks (ePRTC's)
< +/-30ns to UTC

Substations/Smart Grid IoTs

enabled to provide time information
+/- 100ns - 1ms to UTC





Network & Service Management

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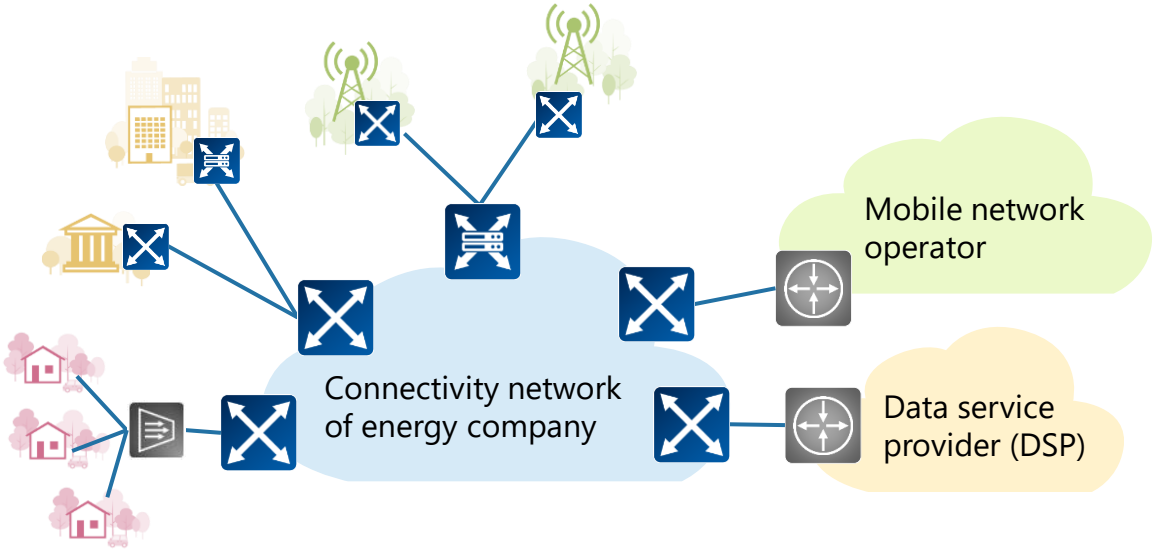
Utelco – utility is offering communication services



Packet transport

Packet transport and hosting of virtual network functions

Business services

- Ethernet and IP connectivity
- Edge-hosting of virtual network functions

Managed bandwidth and hosting services

- Wholesale services
- Connectivity services to fixed and mobile network operators

Preferred access architecture

GPON for residential

FTTH/B/C for business and mobile

Strong separation from OT/IT: separate fiber or separate wavelength

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Digital transformation for power utilities

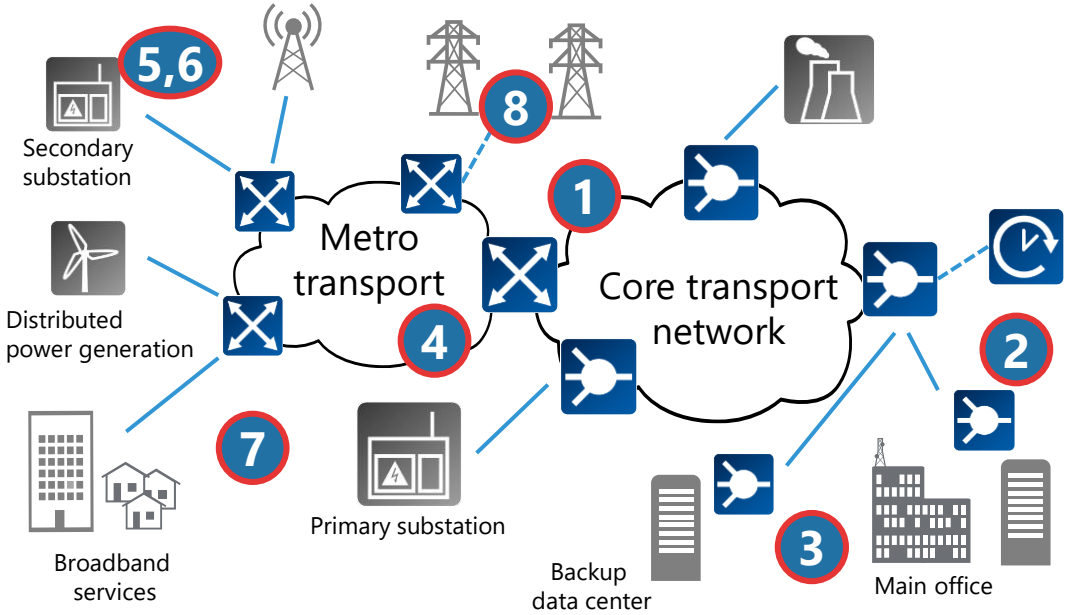
Some Key Changes			
1.	Core transport	5.	Connecting substations
2.	Core synchronization	6.	Synchronizing substations
3.	Business continuity	7.	Broadband services
4.	Metro transport	8.	Monitoring power lines

Network modernization

- Security
- Sync
- Assurance
- IT/OT convergence

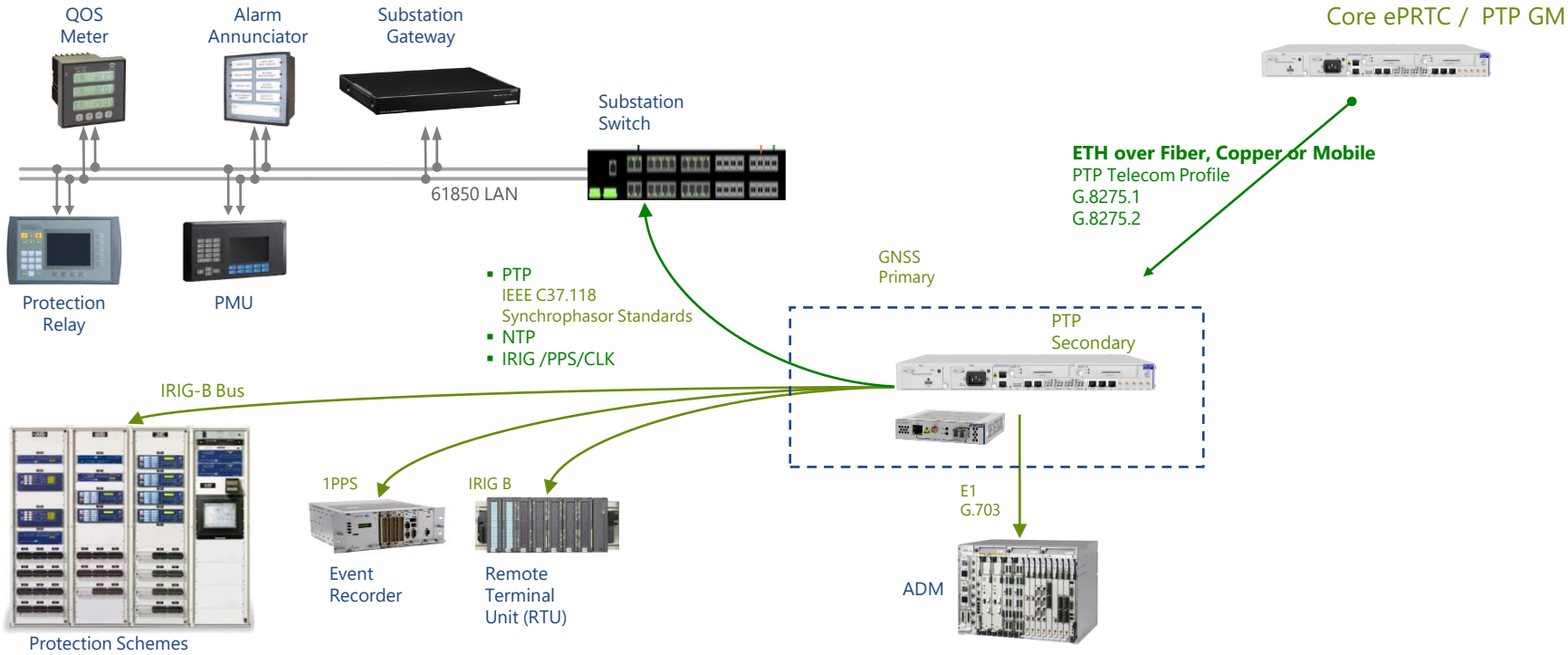
Communication services

- Residential
- Commercial
- Wholesale



Timing Delivery For Substations

… Today and Tomorrow



IEEE C37.238 "IEEE Standard Profile for use of IEEE 1588™ PTP in Power System Applications" and IEC PAS 61850-9-3 "PTP profile for power utility automation"

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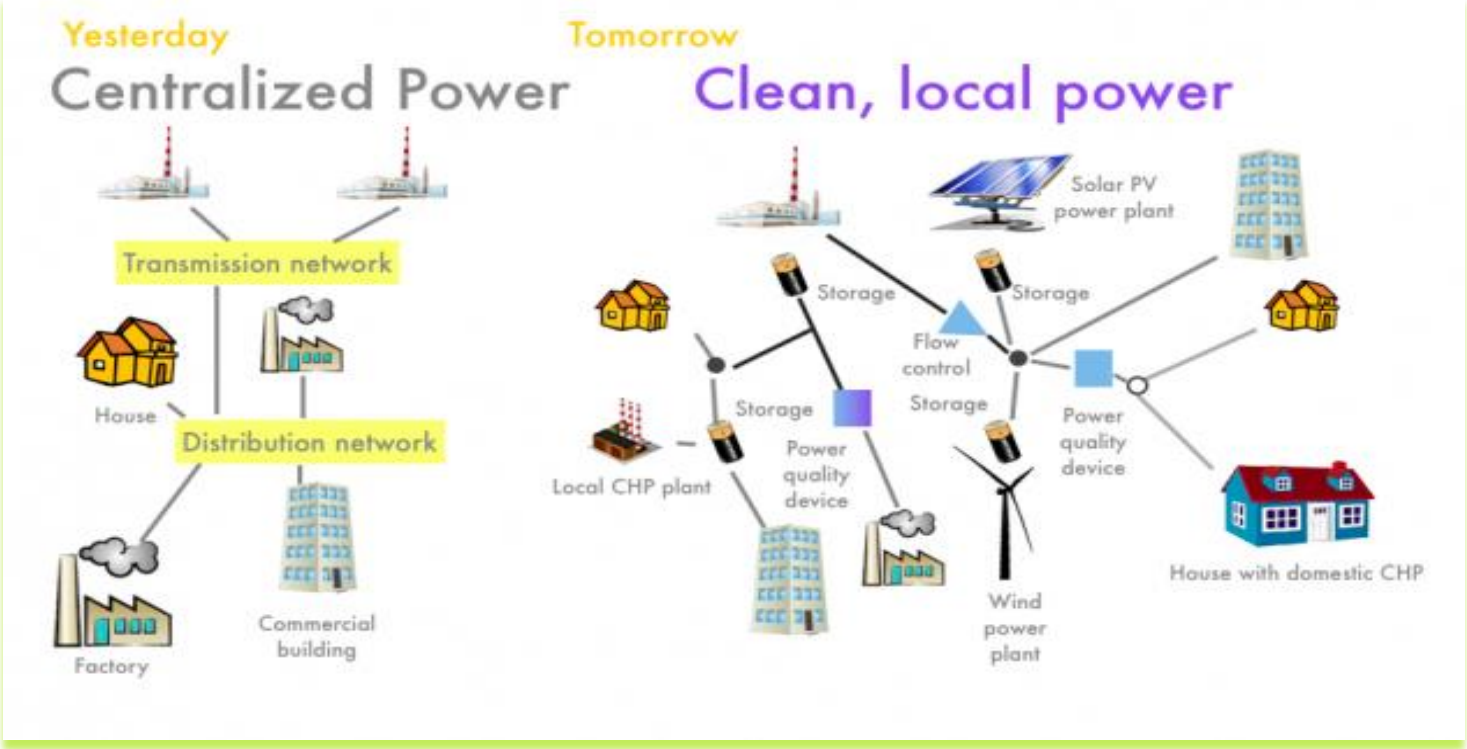
Renewable & decentralized Energy Production



Smart Grid (IoT) in the Distribution will require 5G

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Thank you

Thank you

cwright@oscilloquartz.com