Advanced functionalities for the future Smart Secondary Substation

ESR 4.4

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Agenda

- Introductory plane
  - RES & DER integration
  - The transition to Active Network Management
- Motivation
- Approach
- Overview of the Conceptual Technical Architecture
- Anticipated addressed challenges
- Final remarks – Work Ahead

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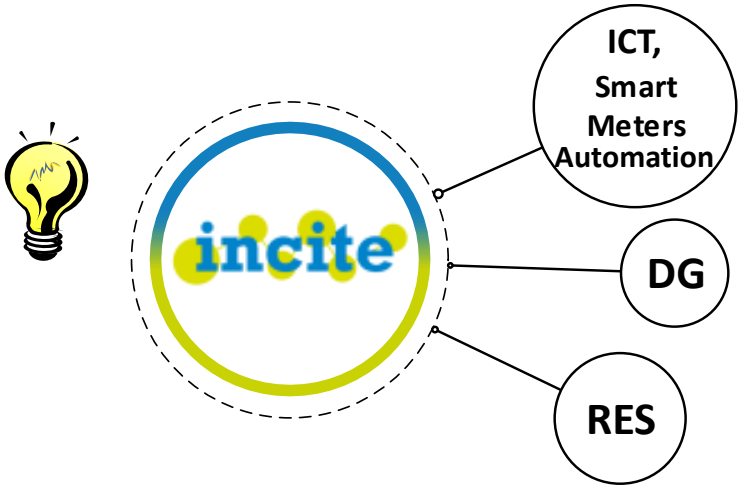

RES and DER

- Radical change of climate policy across EU
- De-cabornization pathways
- Significant global energy demand growth

⇒ Reduce Greenhouse Gas emissions

Remarkable Deployment of RES, DERs and microgeneration

The energy transition is the shift to sustainable economies through renewable, energy efficiency and sustainable development.

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Classic view of Power System

- Centralized Power Plants
- Bulk supply delivery points
- Deterministic (PF) Studies (Critical Cases)
- Low observability of LV grids (Reduced Automation)

"fit 'n forget"

Integration of DG

Induced Technical Challenges

- Voltage rise effect
- Power Quality (transient voltage variations & harmonics)
- Protection (internal DG, fault, inslanding)
- Stability

Alternatives to respond challenges

- **A1: Grid Reinforcement**
- **A2: Impart Intelligence to Grid- transit to Active Network Management**

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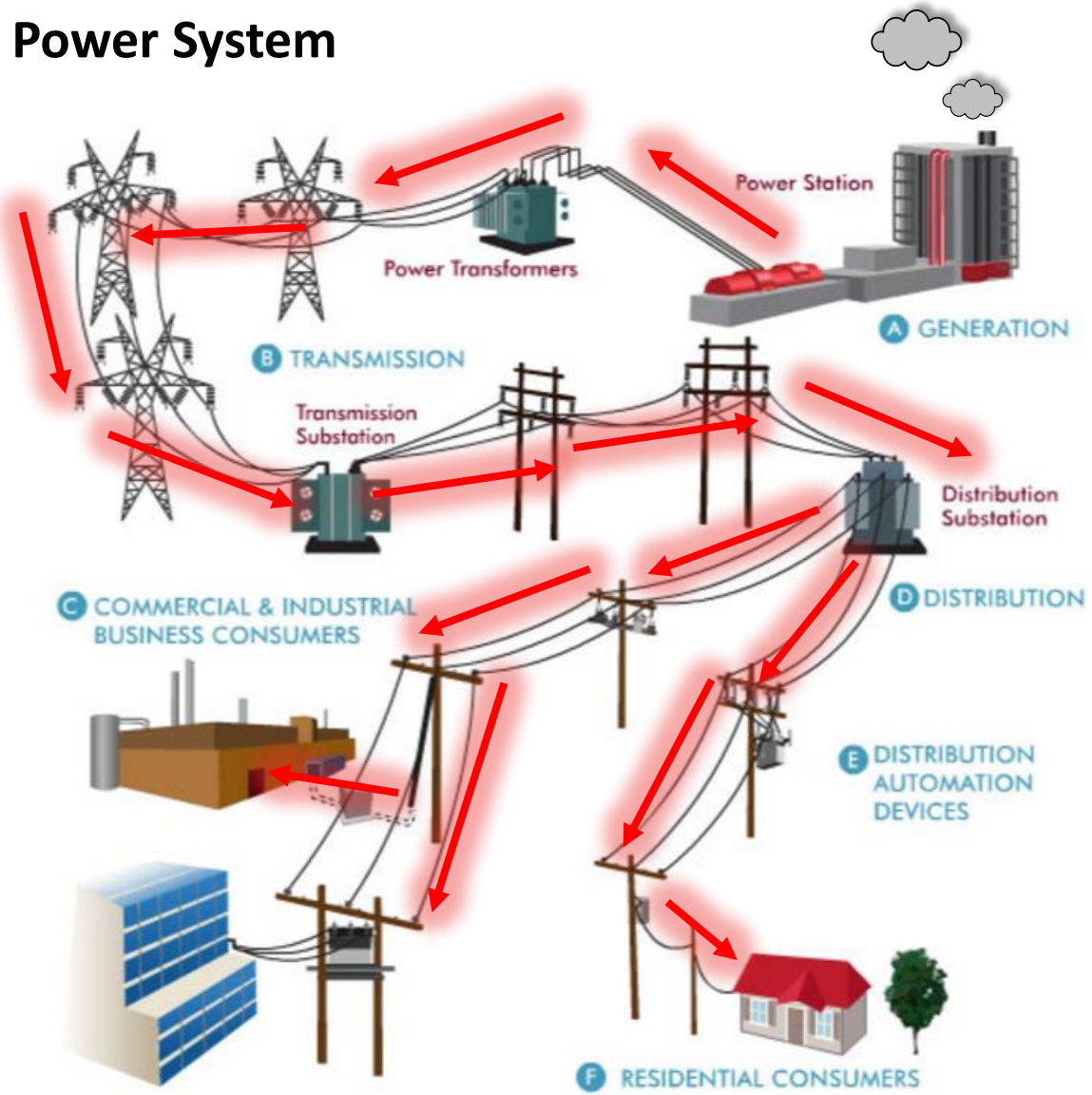
Classic view of Power System



[1] http://www.engineeringfigures.in/2015/03/electric-power-system-grid.html

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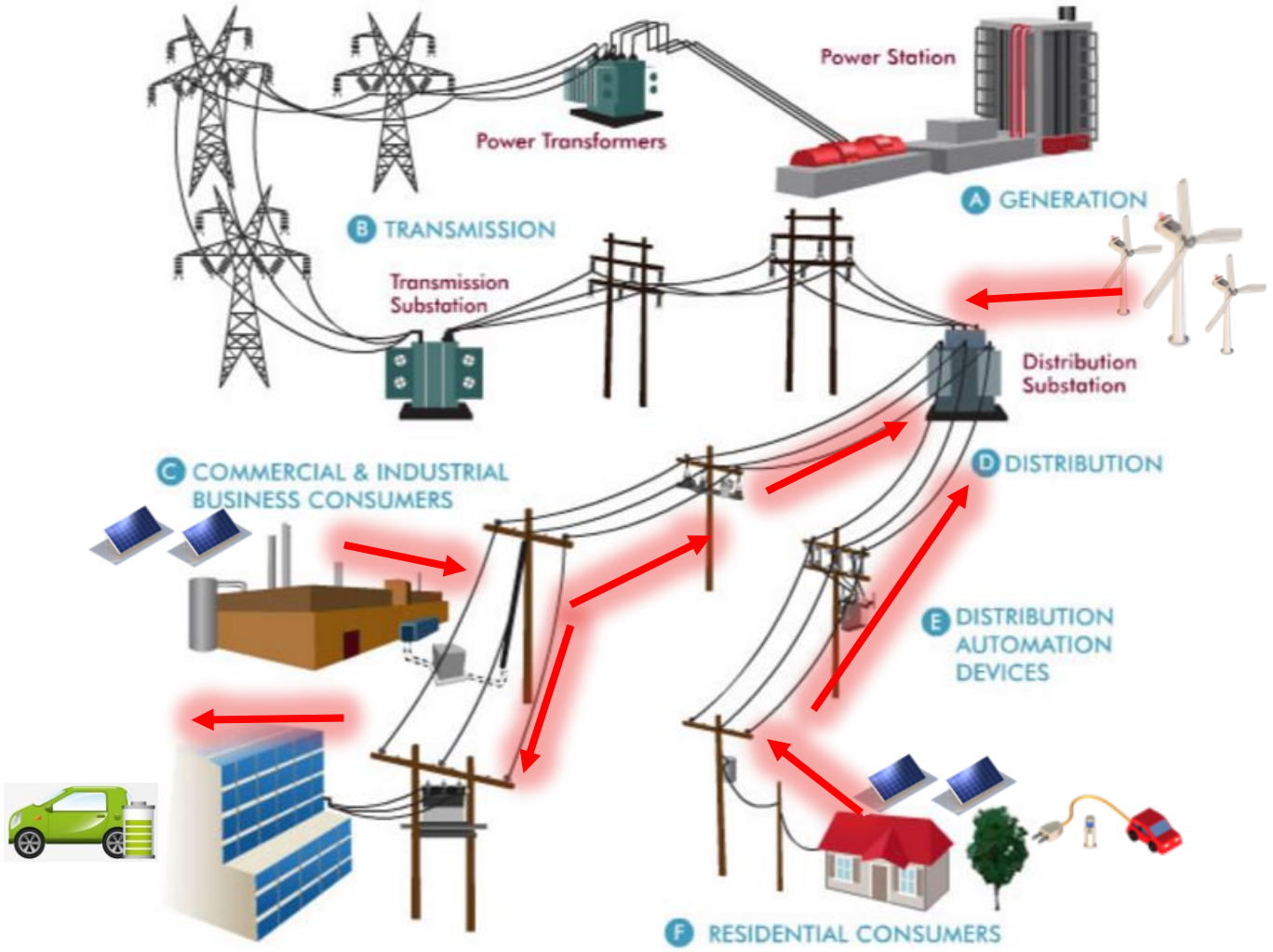
Active view of Power System



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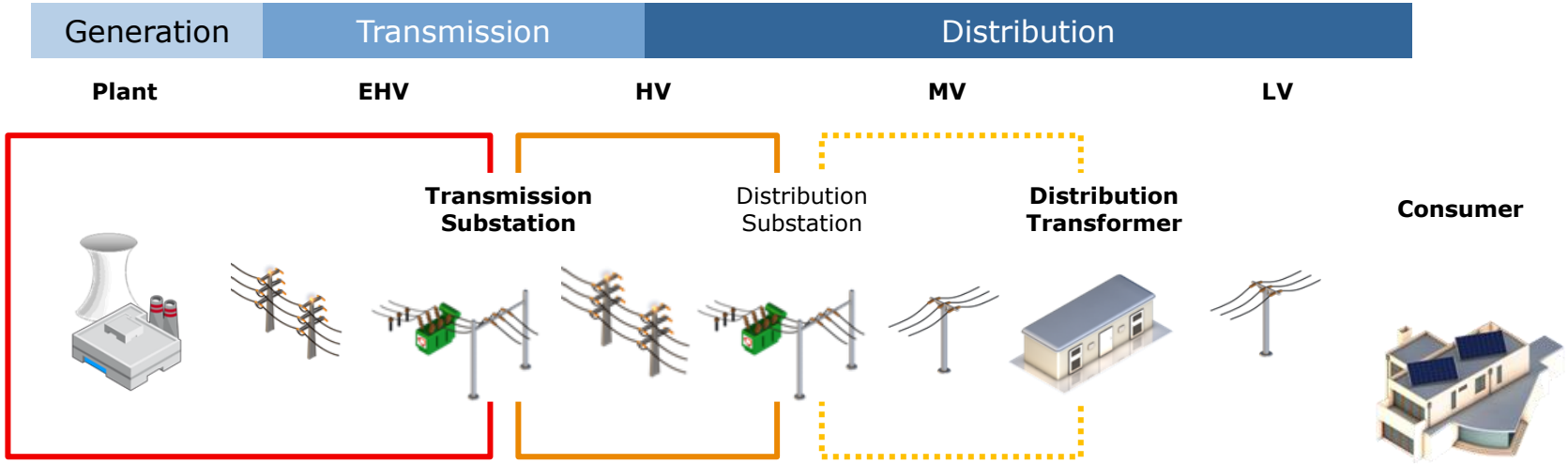

[2] Efacec Automation Unit

Automation Reach

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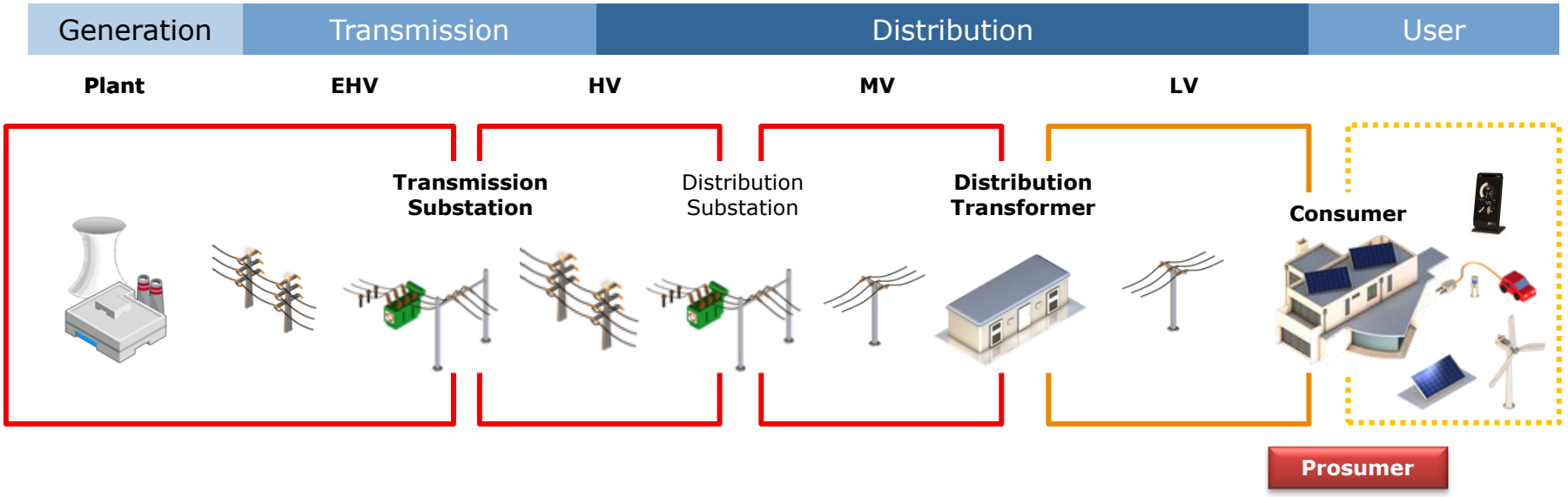
Introductory Plane



Automation Reach

IEC 61850
IEDs
Smart Meters
ICT

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The Active Grid in Smart Grid Concept

Main drivers of Smart Grid:

- Two parallel interacting networks; (Power & ICT network)
- Advent of Automation (Substation & Distribution) in LV network
- Distributed Intelligence

These technological advances enable DERs participation on network operation & planning

- Aggregators are introduced : service providers to retailers, DSO or market itself

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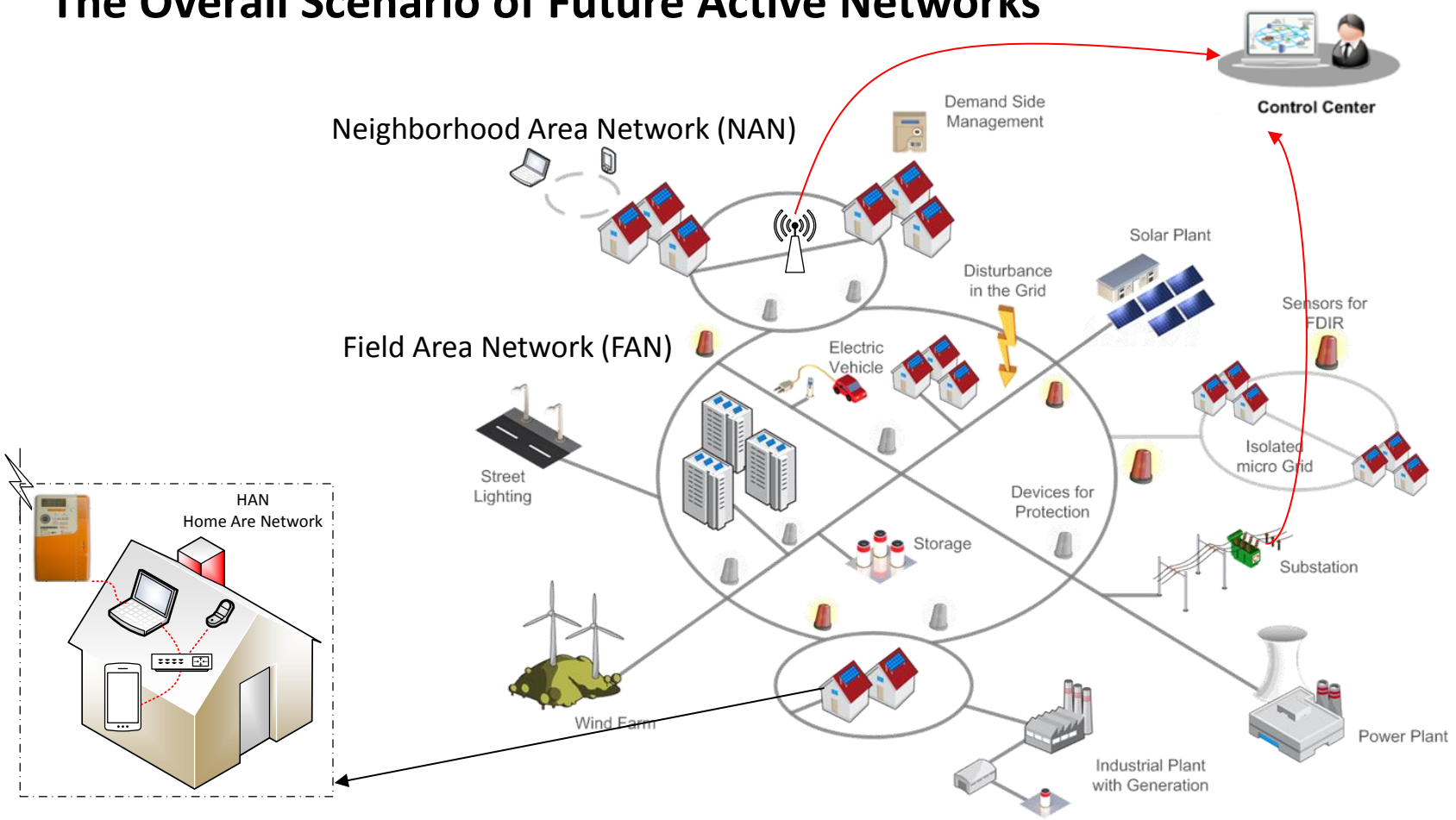
The Overall Scenario of Future Active Networks



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Heterogeneous communications

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Motivation

"There is no theoretical upper limit for the integration of Renewable energies in electrical grids"

- **Which are the profits of traversing the path of Active Network Management?**

  - Demand Management
  - Asset Management
  - Disturbance Management
  - Congestion Management

"Anticipation Denotes Intelligence"

- **How significant is to retrofit Secondary Substations to Smart S/S?**

  - Compose the linchpin of power systems
  - Important functions of the utility
  - Need of intelligent and autonomous functions

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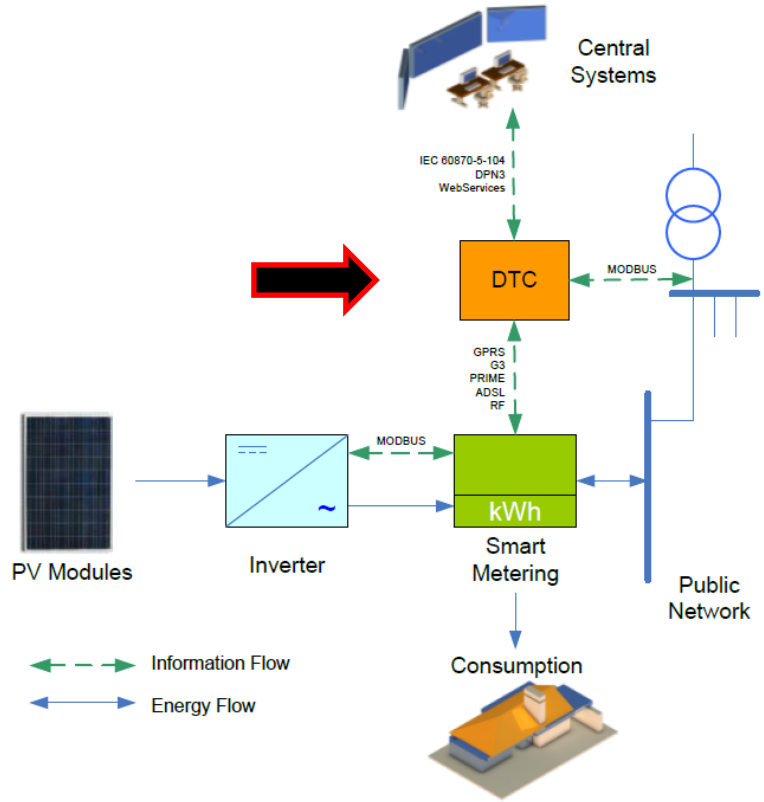
Pivotal element of the proposed architecture

- Meter data concentrator (RTU role)
- Act as the gateway interface with the upstream network (dynamic node)
- Implementation of advanced applications and controls

- Supervision & Management of LV consumption and m-DG, considering the topological status and the related operational values of LV feeders



[3] N. Silva, P. M. Silva, L. Seca, A. Madureira, J. Pereira, F. Melo, "LV SCADA- How to effectively manage LV Networks with limited topology and electrical characteristics data", CIRED 23nd International Conference on Electricity Distributiom 2015, Lyon

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Portraying the Smart Secondary Substation

Inputs

Sensors (IED, Smart Meters)

Com Link with MV network

Distribution Transformer Controller

- **Monitoring** (Advanced RTU features, I-V sensors)
- **Tele-control** (Communication with breakers)
- **Power Flow Control** (Power Control Algorithms through tracking m-DGs and responsive-Loads)

Substation

Com Link with downstream Grid connected Smart Devices (i.e. smart meters, smart inverters etc.)

Dispatch set-points, Auto-regulation of OLTC

Outputs

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Functionalities on the Distribution Transformer Controller

- **DSM/DR Area Controller**
  - Development algorithm to manage the flexibility of m-DG and responsive load (i.e. Dispatch optimal set-points)
  - Network operation within permissible bounds (i.e. reassuring the operating point is amid the regulatory limits)
  - Quality of Service improvement
  - Fraud prevention and detection

- **Automatic Voltage Controller**

  - Control algorithm triggers from detected voltage unbalance through the AMI infrastructures
  - Manage all the controllable grid assets in order to provide a close-to- real time solution to cope with voltage deviations

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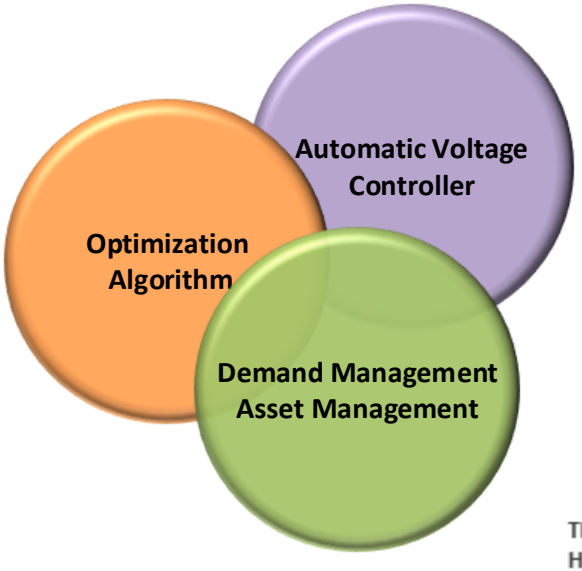
Additional tools on the Controller

- State estimation for LV (predict the state of the system by making use of historical data)
- Storage Scheduler
- Adaptive EV charging
- Street Lighting management

Asset Management



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How?

- Implementation of multi-objective problem considering uncertainties of DGs ($\min\{P_{losses}, \sum C_j\}$)
- 3-PhaseProbabilistic Power Flow with partial knowledge of network topology (State Estimation)
- Considering the asset management of responsive devices (m-DGs, EVs, shed-able loads)

Dynamic Decision Making problem

Target *: through the coordination of mechanisms to reach an optimized operating schedule (maximizing DER integration and minimizing cost from different stakeholders perspectives)*

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Final Remarks

- Developments will be encompassed on LV network performing **intelligent control strategies**

- **Network and control management**
  - Making use of DG flexibility

- **Co-ordination features with MV (upstream) network**

Work Ahead

- **Detail the research questions to be addressed**
- **Focused literature review on control methods for the research questions**
- **Create the use cases that will frame the work to be developed**
- **Establish scenarios to be created that support the work proposal and validate the algorithms**
- **Initial benchmarking grids to be built and modelled**
- **Detect and explore synergies with other IRP**

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