



Kimmo Lindholm 2015-05-25

# Jakeluverkon älyverkkoratkaisuja

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Mikä on älykäs jakeluverkko ?

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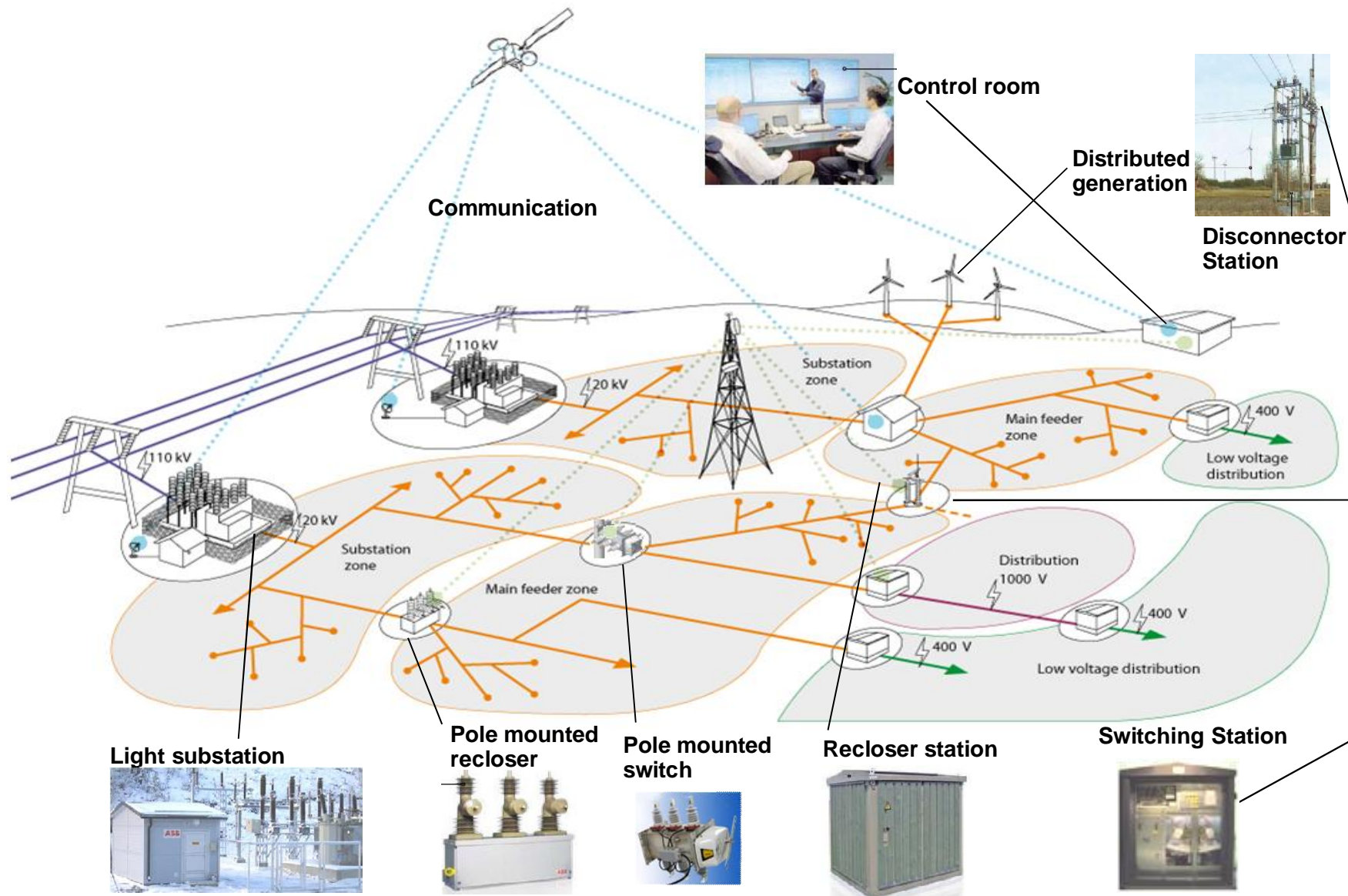
Monta oikeaa vastausta. Riippuu...

Jännitetasot MV ja LV

- Sähkölaitosverkko
- Teollisuusverkko
- Kiinteistöverkko

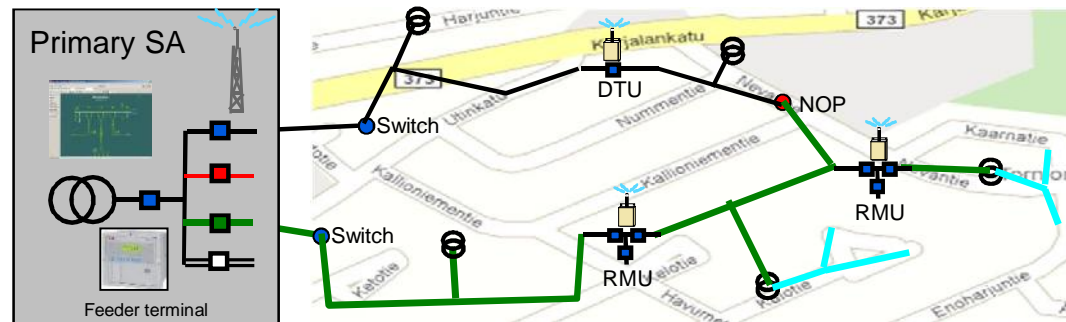
# Distribution Automation

## The Zone Concept – optimal network reliability





# Distribution Management in General Distribution Automation



The complete DA system requires that all levels are integrated

- Data from substation and feeders best used with overall picture in DMS
- Advanced DMS functions in NCS require data from substations and feeders to provide the best results

# Distribution Management Information Integration in DMS



- Customer data
  - Location of customers
  - Outage reports by customers
- Substation (relay) measurements
  - Fault Impedance (reactance)
  - Short circuit current
- Current and voltage measurements, fault indicators
- AMI/AMR integration for LV network management
- Other existing information can be added or imported to open DMS database
  - Site information, facilities, maintenance data etc.

# DMS

## Interfaces with other IT systems (IT/OT)

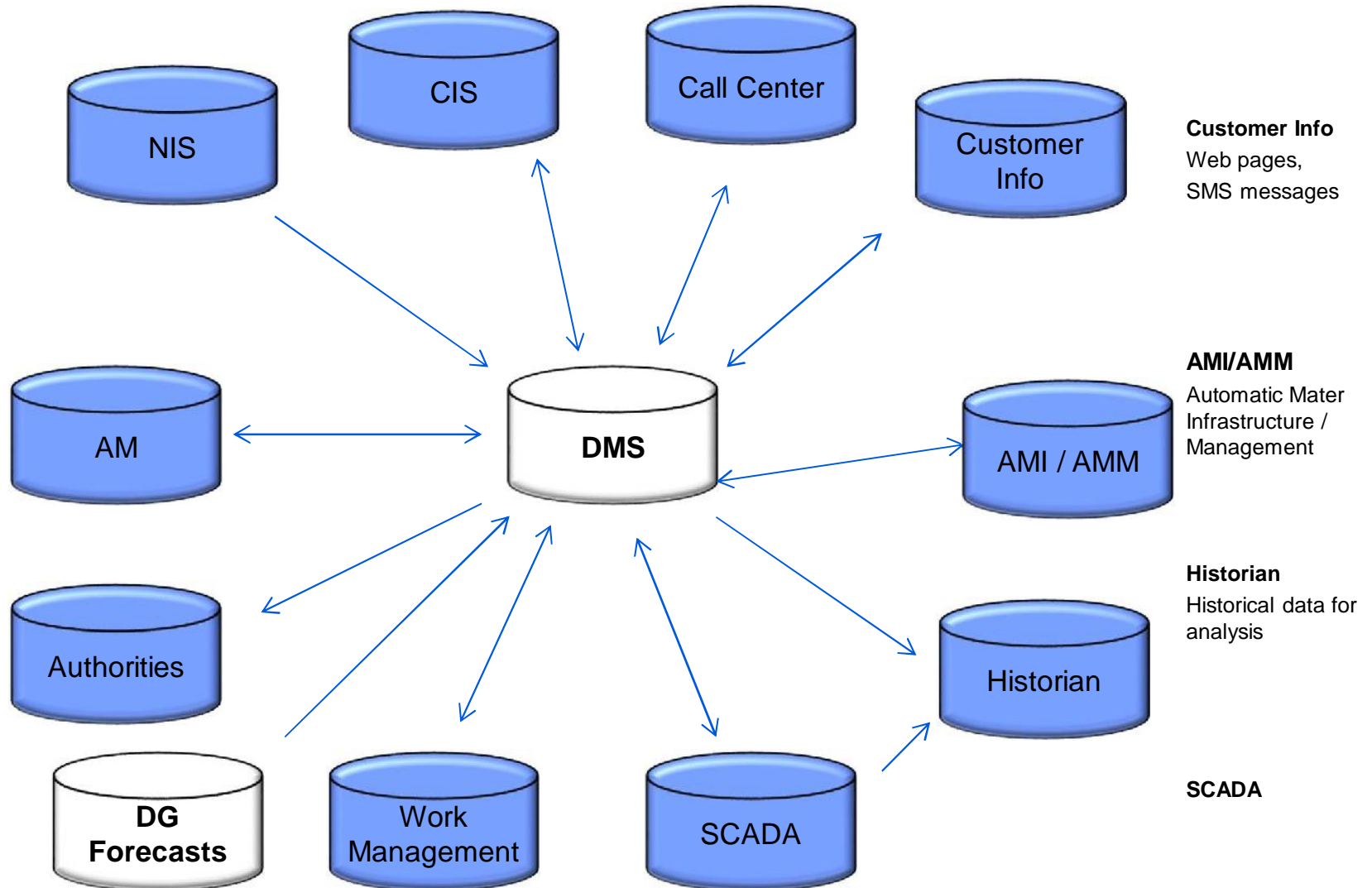
**CIS**  
Customer Information System

**NIS**  
Network Information System

**AM**  
Asset Management  
Maintenance data

**Authorities**  
Police  
Fire and Rescue Service  
Regulators

**DG**  
Distributed Generation



# Automatic Fault Isolation and Restoration. True case

- **T 00:02:01** Power restored **AUTOMATICALLY** to rest of the feeder by closing the Breaker.



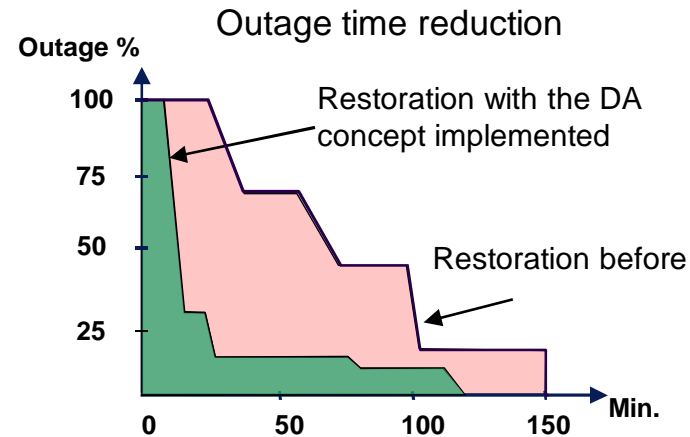


# Automatic Fault Location, Isolation and Power Restoration

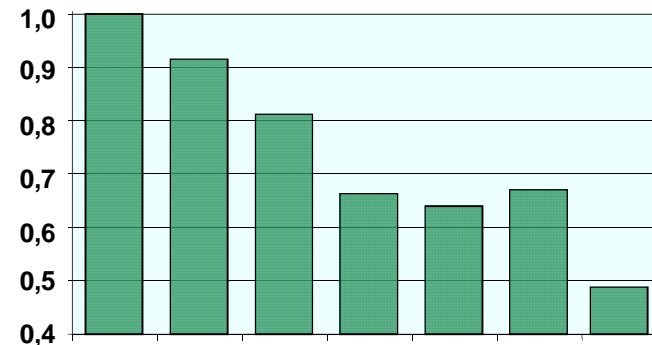
## Customer benefits

- Reduced outage times
- Shorter restorations
- Improved power quality
- Reduced amount of undelivered energy
- Lower maintenance costs
- Satisfied customers and utilities

**The influence of the outage is reduced by 2.7**  
**The absolute outage time is 1.4 times shorter**



Relative outage duration development



Delivery reliability target set by the industry branch for 2020

- City max 1 h
- Suburban max 3 h
- Rural area max 6 h

# LV AMI/AMR integration

## Functionality

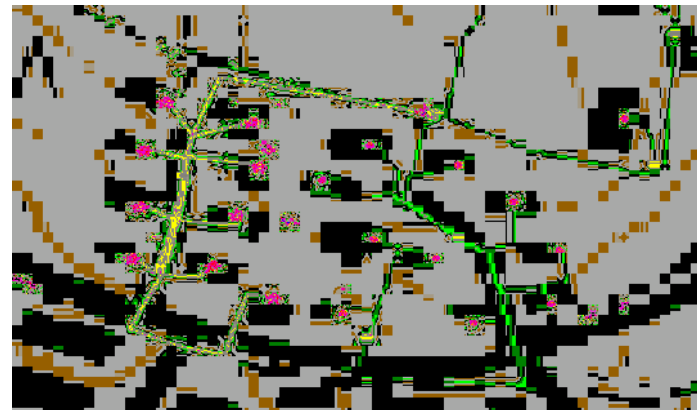
### Event types

- Phase missing
- Overvoltage
- Undervoltage
- Overcurrent
- Zero conductor broken
- MV line cut
- Switch and current level alarms etc.

### Measurement types

- Phase voltage(s) (V)
- Line current for each phase (A)
- (*Active power (W)*)
- (*Reactive power (VAR)*)
- (*Power factor (cos  $\phi$ )*)

## Alarms on Network Map



# Volt-VAr Control / Optimization

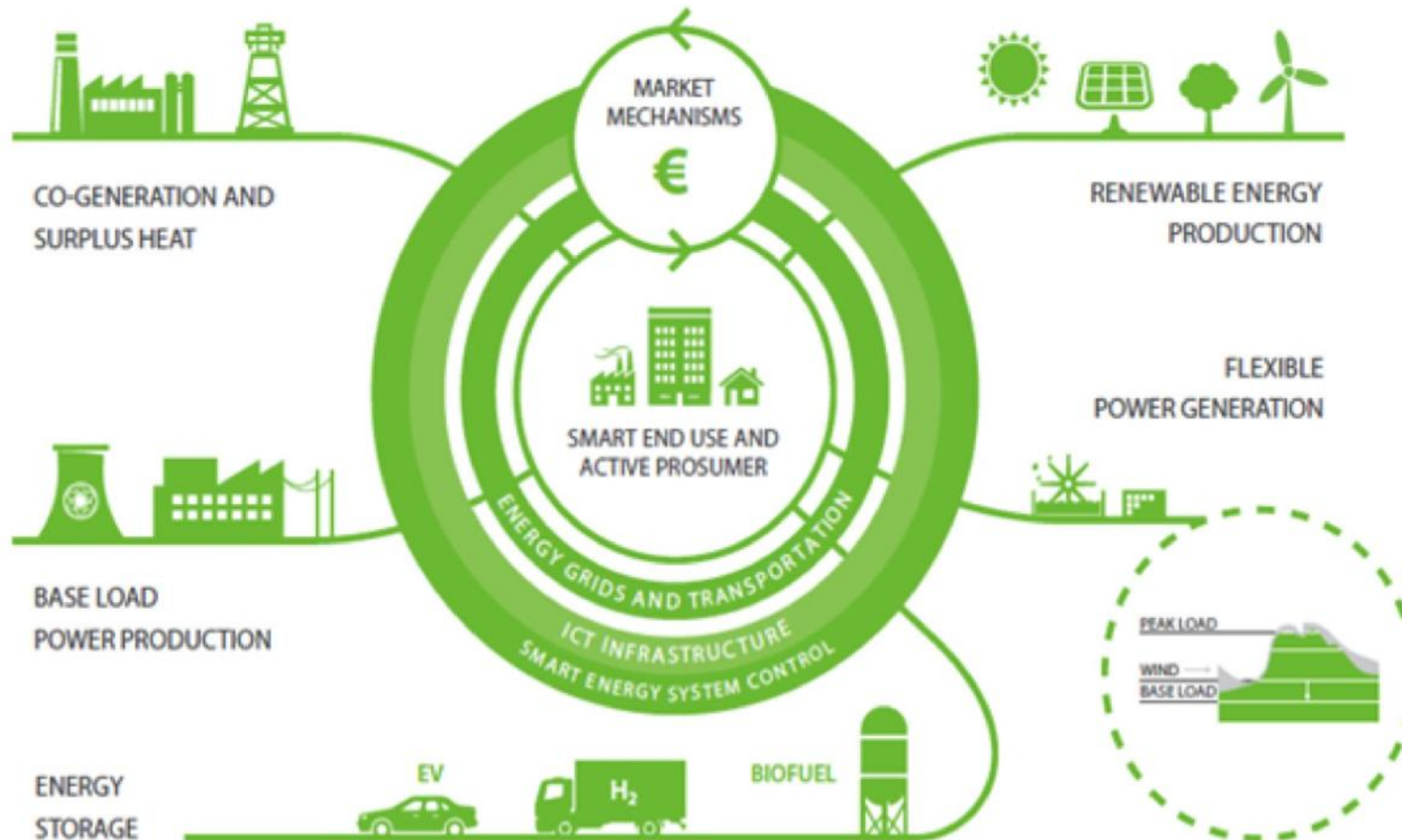
- Keeps voltages in limits
- Reduces losses by minimizing reactive power flows
- Reduces peak power by voltage reduction
  - The easiest demand reduction method
  - Related terms and needs
    - demand response
    - load shedding
    - peak shaving
    - peak shifting

## Reference study result

- 80 000 \$ savings per year per substation
- Reducing the customers utility bills by 130 000\$ per year

# CLEEN FLEXIBLE ENERGY SYSTEMS – FLEXe 2015-2019

A SUSTAINABLE, RELIABLE AND AFFORDABLE  
ENERGY SYSTEM

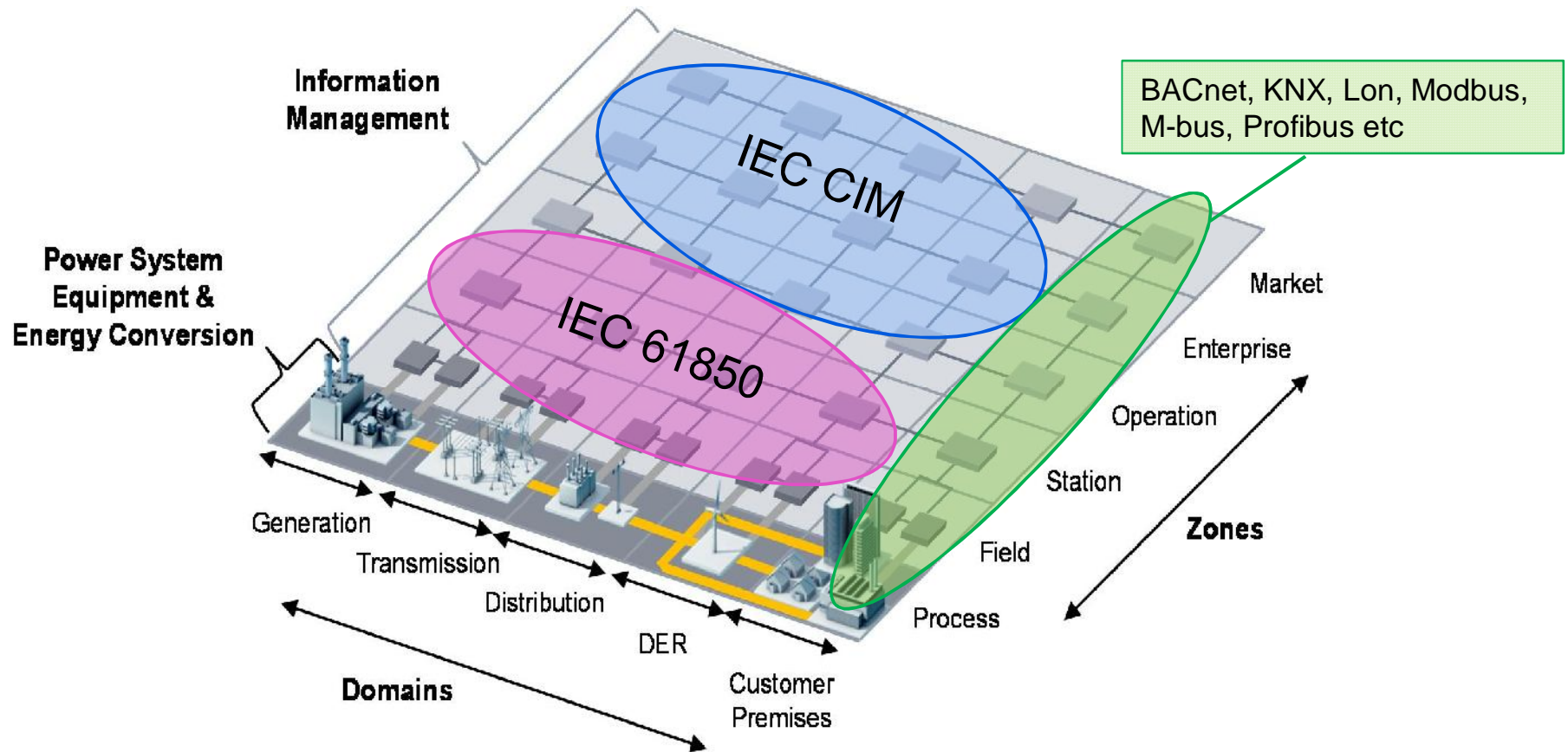




# Challenges

- Several players
- Market models
- Interest conflicts
- Power/Energy
- Less predictive
- Increasing process sensitivity
- Interoperability -> CIM as solution

# Smart Grid Architecture Model



**CIM – model** The Common Information Model (CIM) describes the electrical characteristics of the electrical network's individual components as well as their relation to each other. CIM simplifies the exchange of information by defining a common language at the interface between the participating applications and systems.

# CIM Interface characteristics

- The CIM interface is intended and suitable for **managing large variety of devices within the Smart Grid** taking into consideration the known and foreseen technical and market requirements.
- It covers data acquisition and control of industrial automation, demand response and various distributed energy resources including homes
- Was chosen within the SGEM
- The CIM when being standardized interface allows free competition between the automation suppliers on the sites as well enables competition between different service providers.
- The concept allows more than one service provider to provide different services to the same customer in parallel

# CIM Interface background

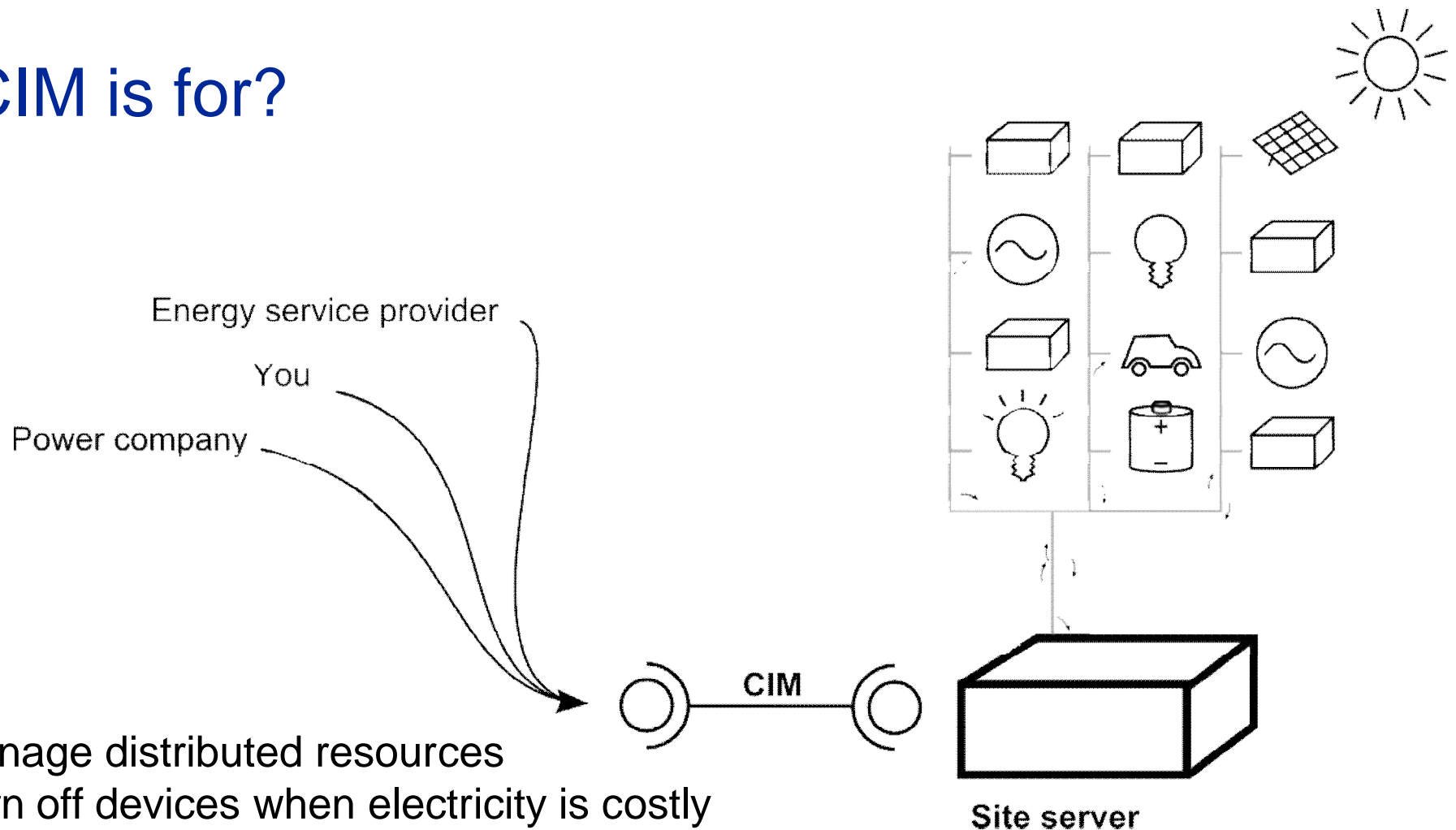
During the Finnish Smart Grids and Energy Markets research program (SGEM 2010-2014), the potential and need was identified to utilize the increasing number of smart devices, owned by distribution network customers, for demand response and demand management.

At the same time, these same smart devices were additionally seen as a great pathway to improved and extended offering of other “customer services”. The existing service providers such as distribution network operators and electricity vendors and foreseen new service providers may in addition to traditional and demand response services offer a versatile variety home, premise, energy and safety and other type of services for the consumers and prosumers of distribution networks.

The working group identified the parallels of these two goals and began to look for the best way to converge them. A major obstacle to realizing the potential benefits was the lack of a commonly agreed way of combining this fragmented data into information. After a thorough search and study of several alternative candidates (e.g. OpenADR), the IEC CIM series of standards was chosen. The IEC CIM covers modeling of distribution network hierarchy, structure, elements and devices and additionally contains the necessary methods and flexibility to support the future variety within the modern smart society.



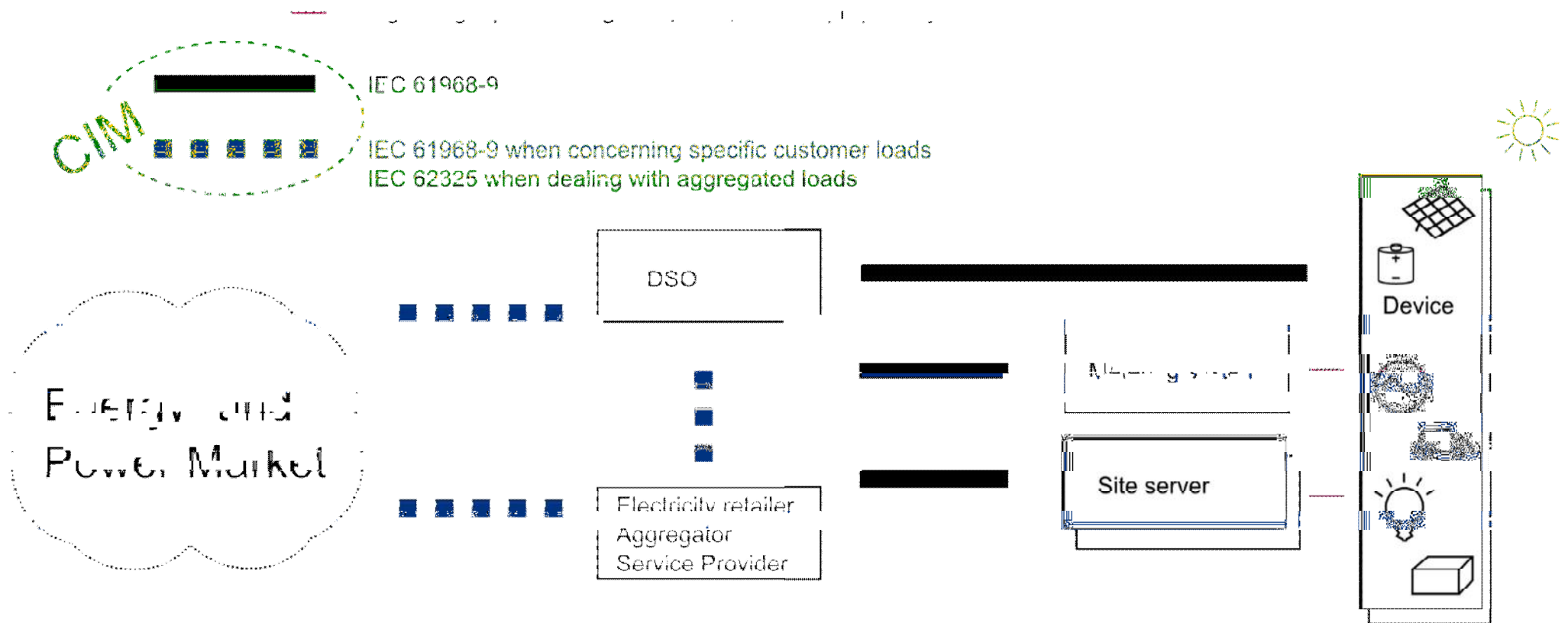
# What CIM is for?



- Manage distributed resources
- Turn off devices when electricity is costly
- Remote control your home
- Monitor distributed generation and energy storage
- Optimize energy usage in a large scale site
- Read measurements and states
- Send control commands, setpoints and schedules
- Read trend data
- List available devices (eg. Home, warehouse, solar plant)

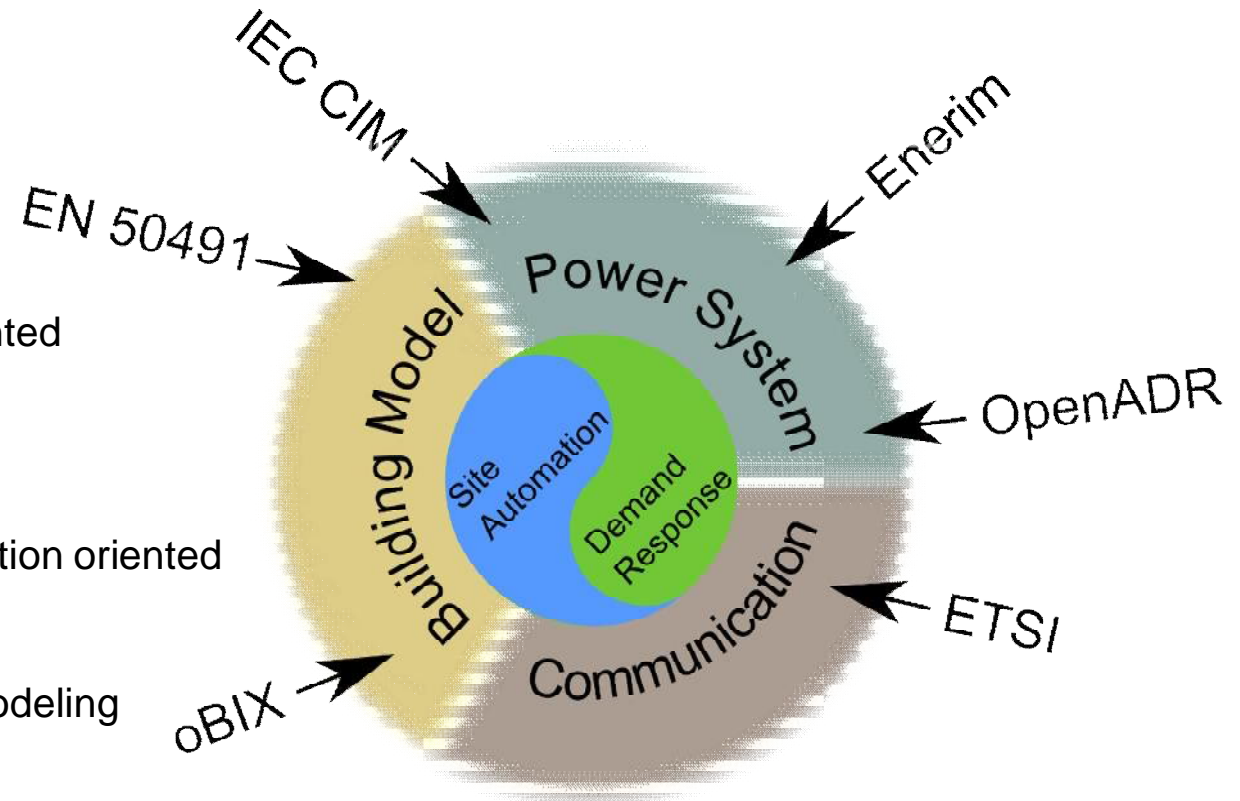
# Background

- Using IEC 61968-9: Meter Reading and Control
- Defined in the SGEM by the Kalasatama technical consortium (ABB, Fingrid, Helen, HSV, Mitox)

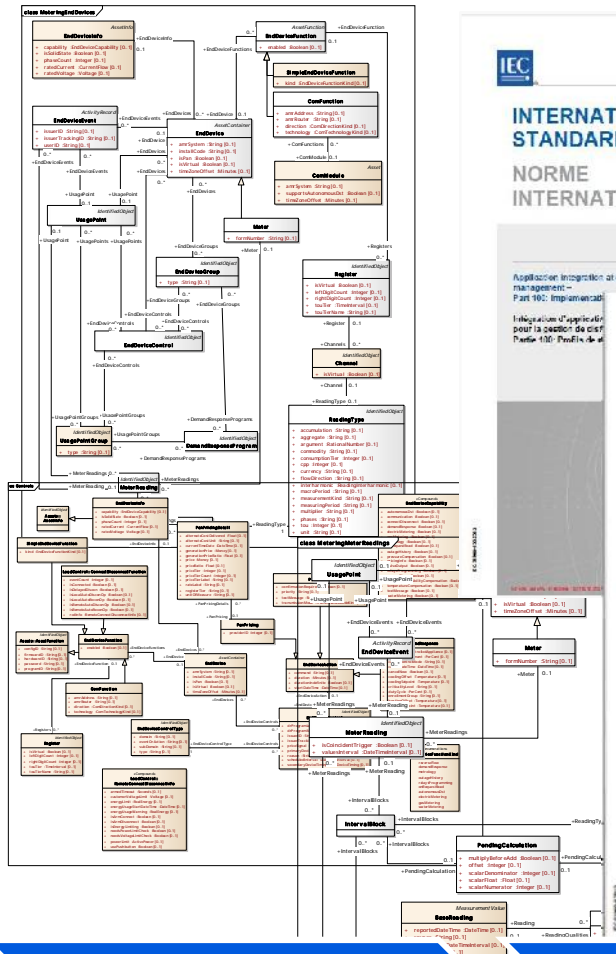


# The interfaces we looked into

- **OpenADR / IEC 62746-10**
  - + Simple structure
  - Less Power system modeling
- **Enerim**
  - Strictly Demand Response oriented
  - SGEM specific
- **ETSI GS OSG 001**
  - +/- Lower level, more communication oriented
- **oBIX**
  - + Links to Building Information Modeling
- **CIM**
  - + Integrated from Transmission networks down to usage points
  - + Versatile
  - Broad in scope
- **EN 50491**



# What is CIM



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<xs:schema xmlns="http://langdale.com.au/2005/Message" xmlns:m="http://iec.ch/TC57/2011/EndDeviceConfig" xmlns:s="http://www.w3.org/2001/XMLSchema" targetNamespace="http://iec.ch/TC57/2011/schema/message">
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    <xs:element name="ConnectDisconnectFunction" type="m:ConnectDisconnectFunction" minOccurs="unbounded"/>
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  </xs:complexType>
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      <xs:element name="CreatedDateTime" type="xs:dateTime" minOccurs="1" maxOccurs="1" sawsdl:modelReference="http://iec.ch/TC57/2011/CIM-SS/EndDeviceConfig#m:CreatedDateTime" />
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      <xs:element name="IsPan" type="xs:boolean" minOccurs="0" maxOccurs="1" sawsdl:modelReference="http://iec.ch/TC57/2011/CIM-SS/EndDeviceConfig#m:IsPan" />
      <xs:element name="Names" type="m:Names" minOccurs="0" maxOccurs="1" sawsdl:modelReference="http://iec.ch/TC57/2011/CIM-SS/EndDeviceConfig#m:Names" />
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  </xs:complexType>
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```

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    <Verb>reply</Verb>
    <Noun>EndDeviceConfig</Noun>
  </Header>
  <Reply>
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    <Error>
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  <Payload>
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          </NameType>
        </Names>
      </EndDeviceConfig>
    </Payload>
  </ResponseMessage>
```



- EAP
- PDF
- XSD
- XML





# What is used

- **IEC 61968-100: Implementation profiles**
  - Defines SOAP interface, eg WSDL
  - Defines envelope structure
- **IEC 61969-9: Interfaces for Meter Reading and Control**
  - Defines profiles, eg XSD
  - Defines message structures for AMR & Home Automation
- **IEC 61968-1: Interface architecture**
  - Defines process for extending standard profiles

Documentation published and available in Cleen/SGEM portal

Link to Cleen SGEM: (<http://www.cleen.fi/en/sgem>)

Link to CLEEN public deliverables: [http://www.cleen.fi/en/sgem/public\\_deliverables#Technical](http://www.cleen.fi/en/sgem/public_deliverables#Technical)

**Link to the specification document:**

[http://www.cleen.fi/en/SitePages/publicdeliverables.aspx?fileId=2279&webpartid=g\\_1449a1fa\\_9f05\\_4750\\_900e\\_6294262dcbd4](http://www.cleen.fi/en/SitePages/publicdeliverables.aspx?fileId=2279&webpartid=g_1449a1fa_9f05_4750_900e_6294262dcbd4)

**Link to the Schema document:**

[http://www.cleen.fi/en/SitePages/publicdeliverables.aspx?fileId=2280&webpartid=g\\_1449a1fa\\_9f05\\_4750\\_900e\\_6294262dcbd4](http://www.cleen.fi/en/SitePages/publicdeliverables.aspx?fileId=2280&webpartid=g_1449a1fa_9f05_4750_900e_6294262dcbd4)

# What profiles specifically utilized

	Profile	Purpose
IEC 61968-9	MeterReadings	Message for transferring measurements
	MeterReadSchedule	Message for defining how often a measurement should be updated
	GetMeterReadings	Message for querying measurements of a specific time
	EndDeviceEvents	Spontaneous events
DIY	EndDeviceControls	Control commands (HA & DR)
	EndDeviceConfigAdvanced	Listing available devices and capabilities

# Communication on energy market level

- **IEC 62325: Framework for energy market communications**
  - Defines energy market communications
  - Supported by ENTSO-E
  - Same CIM model in the background
  - Higher level communication



**Finnish Smart Grids Highlights**

## CONTROLLING SMART DEVICES

Risto-Matti Keski-Keturi, ABB – Juha Mikola, ABB  
Minna Näsman, Helsingin Energia

### About the task

A specification and pilot implementation were done for controlling service point level smart devices in a distribution network. The interface complies with IEC 61968-9 Interfaces for Meter Reading and Control.

There are many contenders but no established standard for the Distribution Network Demand Response<sup>SM</sup> use-case. Our work shows that the CIM is



suitable for such use. The benefit of CIM compared to other similar standards is the underlying model that can express the structure of the power system from transmission networks down to the usage points.

Another relevant standard in the CIM family is IEC 62325, which defines the energy market communication. Our interface can be mapped to such communication due to the shared data model.

### The specification

The underlying standard defines most communication scenarios, but our document adds identifiers and clarifies the

specific use cases with examples and explanation.

One new communication exchange compliant with the underlying CIM model was defined for exchanging configurations on a site, eg.

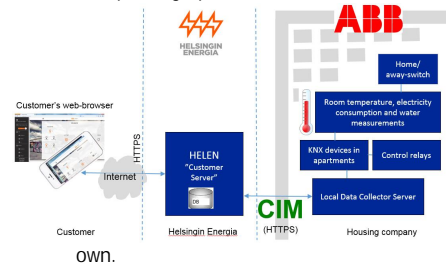
- Listing the devices available
- Describing their hierarchy
- Describing the available functions.

The whole specification along with WSDL and XML schemas is freely available on the SGEM public site. It should be read together with the relevant standards.

### Research Pilot: Kalasatama

In Kalasatama Fiskari and Fregatti there is a total of 95 apartments and 48 parking spaces from where measurement data is collected. The measurement data is transmitted to Helsingin Energia by CIM and can be controlled by commands.

Measurement data from the apartments and parking spaces is collected on a local



# Smart Grid- solution using CIM-model in Kalasatama apartments



Kalasataman Fregatti

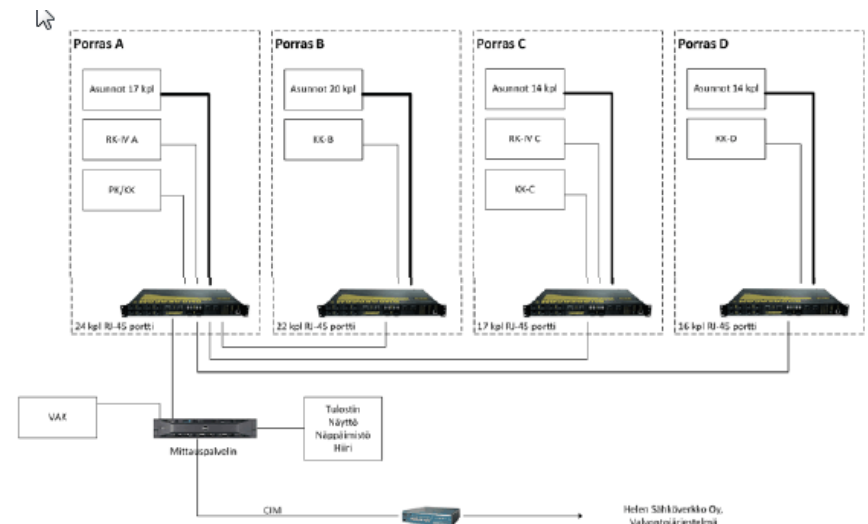
95 flats + 48 Electrical Vehicle load station.

Advanced data collection and data exchange platform for apartment and building automation data.

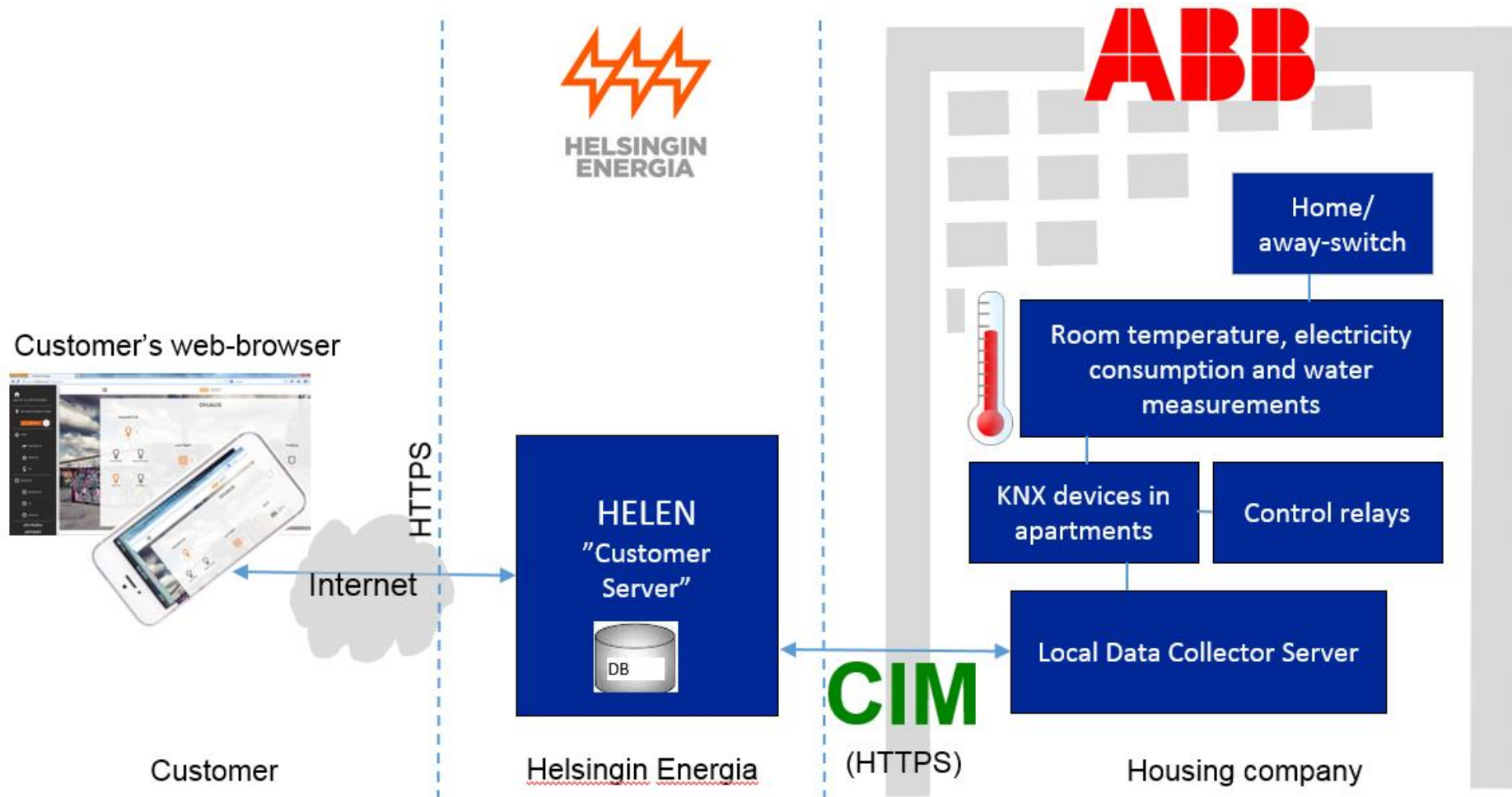
Interface to service providers via CIM-data model .

KNX-automation at apartments

- 18 controllable loads, home away-switch and hot/cold water consumption measurements.
- Measured and controlled vehicle outlets
- Wiring accessories and Näpsä-electricity cabinets



# System principle



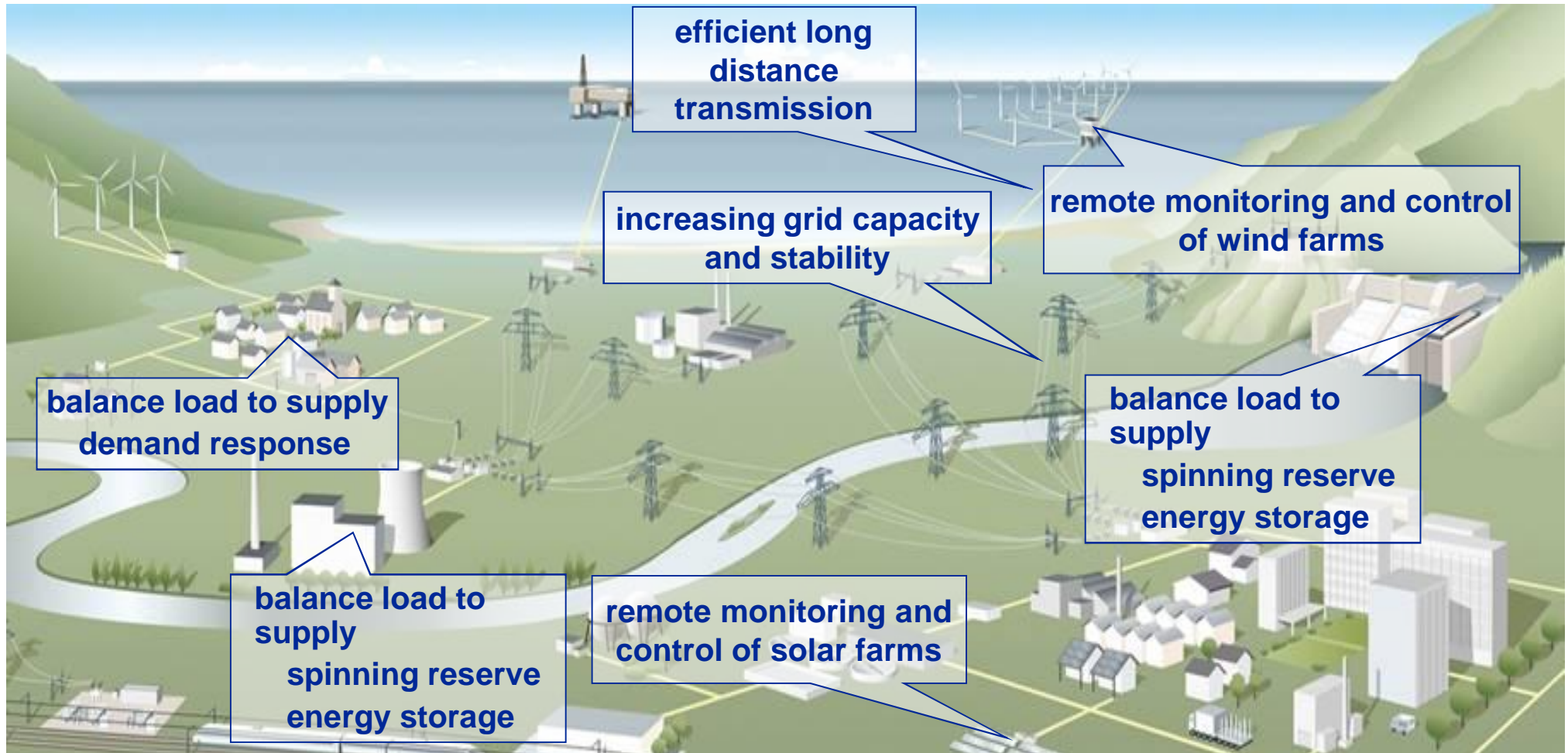
Linkki HELENIN Hima palvelun esittelyyn

[https://www.youtube.com/watch?v=bW0SS49i3\\_8&feature=youtu.be](https://www.youtube.com/watch?v=bW0SS49i3_8&feature=youtu.be)



# Smart Grid

## Integration of renewables



**A Smart Grid is an evolved grid system that manages electricity demand in a sustainable, reliable and economic manner, built on advanced infrastructure and tuned to facilitate the integration of all involved.**

**A Smart Grid utilizes bidirectional digital communications to balance power production and actual power consumption, thus enhancing the efficiency and reliability of the entire power supply.**

Power and productivity  
for a better world™

