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Rapport

Smart grid referansearkitektur og use cases

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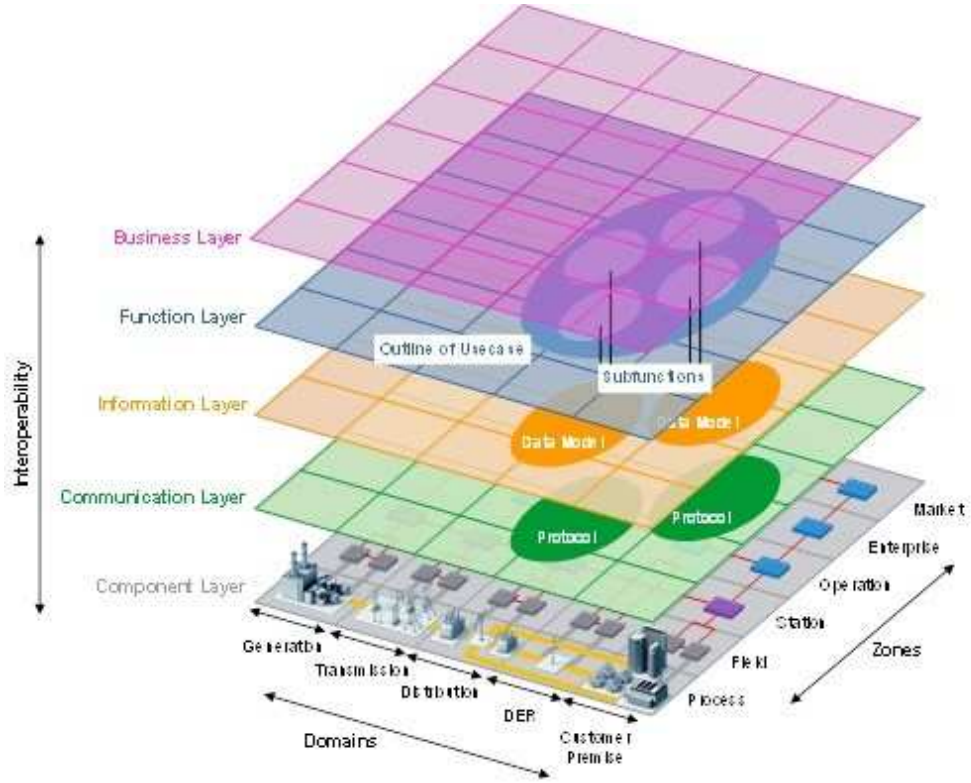

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Rapport

Smart grid referansearkitektur og use cases

EMNEORD:
Smart grid
Arkitektur
Interoperabilitet
Use Case
Template

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SAMMENDRAG
Denne rapporten er et resultat av WP1 i DeVID-prosjektet og har som formål å introdusere metoder for å beskrive og dekomponere Smart grids-domenet i mindre elementer slik at de enkelte elementer blir mer avgrenset og håndterbare for praktisk implementering.
Den metodikken som brukes mest i dag for å beskrive smart grid-funksjonalitet, er såkalte "use case". Et use case omfatter bl.a. en prosessbeskrivelse dvs. de ulike steg som er nødvendige for å realisere målet med use caset og informasjonsutvekslingen mellom aktørene som inngår i use caset. En aktør er enhver som utveksler informasjon: person, apparat, applikasjon, database, IT-system, organisasjon osv. Styrken til use case metodikken er at den gir en oversikt over det som kreves får å nå et gitt mål slik at personer fra ulike fagområder (f.eks. elkraft, tele, IT,...) kan samarbeide om å utvikle de ønskede løsninger.

I tillegg til use case, behandler rapporten smart grid-arkitektur som et hjelpemiddel til å strukturerer smart grid-området og som også er et godt hjelpemiddel til å oppnå interoperabilitet, dvs. effektivt samvirke mellom elementene/aktørene som inngår i ulike use case.

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Innholdsfortegnelse

1 Smart grids-begrepet

Smart grids-begrepet ble introdusert i slutten på 90-tallet, men for den betydningen som legges i begrepet i dag, var kanskje artikkelen "Toward A Smart Grid" [1] fra 2005 et viktig startpunkt. Sammen med EPRIs IntelliGrid-program som startet i 2003, ble det fokusert på å finne nye måter å gjøre kraftsystemet mer robust på – bl.a. trigget av omfattende avbrudd i kraftsystemet i Nord-Amerika. Visjonen var en mer adaptiv og automatisk respons på utfall og unormale situasjoner i kraftsystemet.

Samtidig fikk utslipp av klimagasser stadig større fokus, slik at det ble ønskelig å fase inn teknologier som i mindre grad forårsaket utslipp. Bl.a. ble det stigende fokus i mange land på å erstatte fossile energikilder med fornybare. Denne dimensjonen har etter hvert fått vel så stor fokus i Smart grids-konseptet. Dette har ført til at Smart grids blitt utvidet til å omfatte de fleste problemstillinger som inngår i planlegging, drift og vedlikehold av det elektriske energisystemet inklusive problemstillinger vedrørende samspillet med nettkundene (produksjon, last, Smart House).

Noen kjennetegn er:

- Aktive, energieffektive sluttbrukere
- Elektrifisering av transport
- Distribuert, fornybar energiproduksjon
- Aktive distribusjonsnett og transmisjonsnett

Viktige teknologier for realisering av Smart grid-konseptet vil være:

- AMS – Smart metering/Avanserte Måle- og Styringssystemer
- IKT – informasjons- og kommunikasjonsteknologier
- Nye sensor- og styreteknologier
- Observerbare og styrbare apparater, komponenter og anlegg (f.eks. inn-/utkobling/styring av belastninger, inn-/utkobling/styring av lokal produksjon, inn-/utkobling/styring av elbil-lading, styring av omformere/ FACTS, energilagringsanlegg...)

EU kommisjonens Smart Grids Task Force har definert følgende ønskemål til Smart grids :

- *Enabling the network to integrate users with new requirements*
- *Enhancing efficiency in day-to-day grid operation*
- *Ensuring network security, system control and quality of supply*
- *Enabling better planning of future network investment*
- *Improving market functioning and customer service*
- *Enabling and encouraging stronger and more direct involvement of consumers in their energy usage and management*

Implementering av Smart grid vil være forskjellig i ulike regioner og land ut fra de særtrekk de ulike (elektriske) energisystemene har og hvilke drivkrefter som driver utviklingen. Fokus vil være forskjellig i Nord-Amerika, Europa, Asia, osv. selv om det vil finnes mange likheter.

Ut fra at utviklingen finner sted parallelt finnes det også mange forskjellige definisjoner av selve begrepet Smart grids. IEC som er det globale standardiseringsorganet på elektroområdet har vedtatt følgende definisjon av Smart grids – IEC 60050 International Electrotechnical Vocalbulary – www.electropedia.org :

smart grid
intelligent grid
electric power system that utilizes information exchange and control technologies, distributed computing and associated sensors and actuators, for purposes such as:

– to integrate the behaviour and actions of the network users and other stakeholders,
– to efficiently deliver sustainable, economic and secure electricity supplies

Pr. dato er kanskje den viktigste Europeiske referansen for Smart grid-begrepet gitt i Mandat 490 ”Standardization Mandate to European Standardisation Organisations (ESOs) to support European Smart Grid deployment ” (mars 2011) [7]. I dette mandatet ber EU-kommisjonen de europeiske standardiseringsorganene (CEN/CENELEC/ETSI) om å utvikle et konsistent sett av standarder for Smart grids. I mandatet brukes følgende definisjon av Smart grid:

> *A Smart Grid is an electricity network that can cost efficiently integrate the behaviour and actions of all users connected to it – generators, consumers and those that do both – in order to ensure economically efficient, sustainable power system with low losses and high levels of quality and security of supply and safety.*

Denne definisjonen ble opprinnelig utviklet av de europeiske regulatorene [3] basert på en definisjon utviklet i ”The European Technology Platform on Smart Grids”.

Ser man nærmere på definisjonene, gir den liten mening i forhold til å påpeke hva som er nytt med Smart grids; nettet har alltid integrert nettkundene og de ”aksjoner” de har gjort, og målet har hele tiden vært økonomisk effektivitet, lave tap, høy leveringskvalitet og høy sikkerhet osv. Så det eneste elementet i definisjonene som innebærer noe delvis nytt er *sustainable* – bærekraftig.

IEC omtaler i [4] begrepet Smart grids slik:

“Smart Grid” is today used as marketing term, rather than a technical definition. For this reason there is no well defined and commonly accepted scope of what “smart” is and what it is not.
However smart technologies improve the observability and/or the controllability of the power system.
Thereby Smart Grid technologies help to convert the power grid from a static infrastructure to be operated as designed, to a flexible, “living” infrastructure operated proactively.
SG3 defines Smart Grids as the concept of modernizing the electric grid. The Smart Grid is integrating the electrical and information technologies in between any point of generation and any point of consumption.

Denne beskrivelsen er i tråd med definisjonen gitt av SINTEF Energi i [5]:

*Oppsummert kan **Smart grids** defineres som en merkelapp på fremtidens **kraftsystem** (2020/2050) hvor avanserte måle- og styresystemer (AMS, smarte målere) og kommunikasjon til ”alle” nettkunder og anlegg spiller en sentral rolle. **Smart grids** er nødvendig for å realisere mål og krav som stilles til fremtidens **energisystem** som bl.a. kjennetegnes av økt bruk av fornybare og intermitterende energikilder og økt grad av **elektrifisering** (transport, varmepumper, industriprosesser osv.).*

2 Smart grid-arkitektur

2.1 Generelt om arkitektur

Med det brede perspektivet Smart grids har, er det nødvendig å dele det opp i mindre elementer for å gjøre begrepet mer forståelig og implementerbart. Dette har mange erkjent og det er flere tilnærminger til dette problemet:

I. Top-down tilnærming – dvs at det tas utgangspunkt i de det generelle Smart grid-begrepet og så deles dette opp i underliggende elementer
II. Bottom-up tilnærming – dvs at ulike elementer som inngår i Smart grid-begrepet samles inn og struktureres.

Det finnes flere miljøer som jobber med dette og en av visjonene er at Smart grid-området skal beskrives ved hjelp av et sett av standardiserte use case koblet til en eller flere referansearkitekturer for Smart grids (IEC, NIST, EPRI osv).

Hva er så en referansearkitektur? Begrepet omtales slik i CEN/CENELEC/ETSI JWG report on standards for smart grids [6]:

> *In essence, the purpose of a Reference Architecture is to allow for a separation of a complex system (which a smart grid definitely is) into entities that can be isolated from each other according to some principles, thus making possible the description of the whole system in terms of the separate entities and their relationships.*

Inndelingen av Smart grids i ulike elementer kan skje etter flere prinsipper avhengig hvilke behov eller systemegenskaper som skal adresseres. I [6] er det påpekt flere muligheter:

- *Conceptual Architecture. A high-level presentation of the major stakeholders or the major (business) domains in the system and their interactions.*
- *Functional Architecture. An arrangement of functions and their sub-functions and interfaces (internal and external) that defines the execution sequencing, the conditions for control or data flow, and the performance requirements to satisfy the requirements baseline. (IEEE 1220)*
- *Communication Architecture. A specialization of the former focusing on connectivity.*
- *Information Security Architecture. A detailed description of all aspects of the system that relate to information security, along with a set of principles to guide the design. A security architecture describes how the system is put together to satisfy the security requirements.*
- *Information Architecture. An abstract but formal representation of entities including their properties, relationships and the operations that can be performed on them.*
- *Service-Oriented Architecture. An architecture that is technology-independent and organizes the discrete functions contained in internal or third-party applications & network elements into interoperable, standards-based services that can be combined and reused quickly to meet enterprise business needs.*

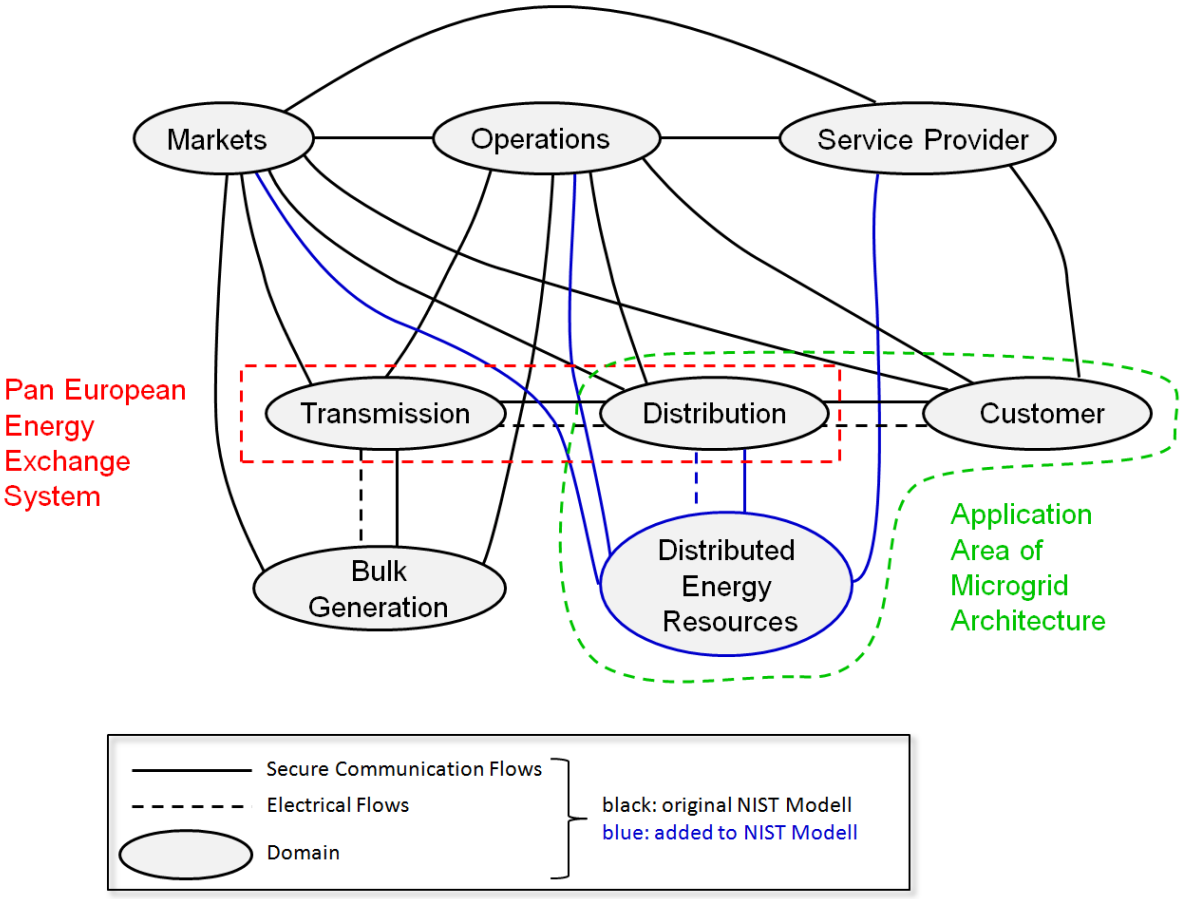
Under Mandat 490 er en av leveransene en referansearkitektur for Smart grids. En første versjon av en teknisk referansearkitektur ble publisert i [8]. Formålet med denne er å beskrive informasjonsflyten mellom domener og systemer/subsystemer.

De viktigste elementene som inngår i rapporten fra Mandat 490, er:

- En europeisk konseptuell modell for Smart grids
- En fem-lags Smart grid arkitekturmodell (The Smart Grids Architecture Model - SGAM)
- En kommunikasjonsarkitektur

Siden denne tilnærmingen er helt ny, forventes det at disse modellene utvikles videre, slik at oppdateringer av konsepter og arkitektur forventes å finne sted de nærmeste årene.

Figur 1 viser det europeiske Smart Grid-konseptet.



Figur 1 Det europeiske Smart grid-konseptet [8].

Som figuren viser, er konseptet basert på et konsept utviklet av The National Institute of Standards and Technology (NIST) i USA, men har noen tillegg og synliggjør også domenene i det pan-europeiske kraftsystemet og domenene i mikronett.

Konseptet deler Smart Grid inn i åtte domener:

- Storskala kraftproduksjon
- Transmisjon
- Distribusjon
- Nettkunde
- Distribuert produksjon/distribuerte energikilder (f.eks. energilagre)
- Marked
- Drift
- Entreprenørtjenester, serviceleveranser

Mellom domener flyter det informasjon og elektrisk energi. For at samspillet informasjonsmessig og energimessig skal fungere etter hensikten, må det være mulig å koble sammen (integrere) de ulike elementene – se avsnitt 2.2 om interoperabilitet.

I rapporten "Smart Grid projects in Europe: lessons learned and current developments" fra European Commission Joint Research Centre, [9] står det bl.a.:

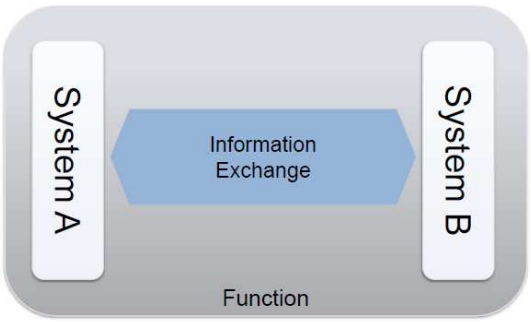
Most Smart Grid benefits are systemic in nature as they arise from the combination of technological, regulatory, economic and behavioural changes. The survey indicates that in almost all countries, a significant amount of investments has been devoted to projects, which address the integration of different Smart Grid technologies and applications. Most technologies are known, but the ***new challenge that these projects are now confronting is their integration***. (ikke uthevet i originalteksten).

2.2 Interoperablitet

Interoperabilitet er følgelig et helt sentralt tema inne Smart Grids og standarden IEC61850-2010 "Communication networks and systems in substations", [10], definerer interoperabilitet slik (oversatt):

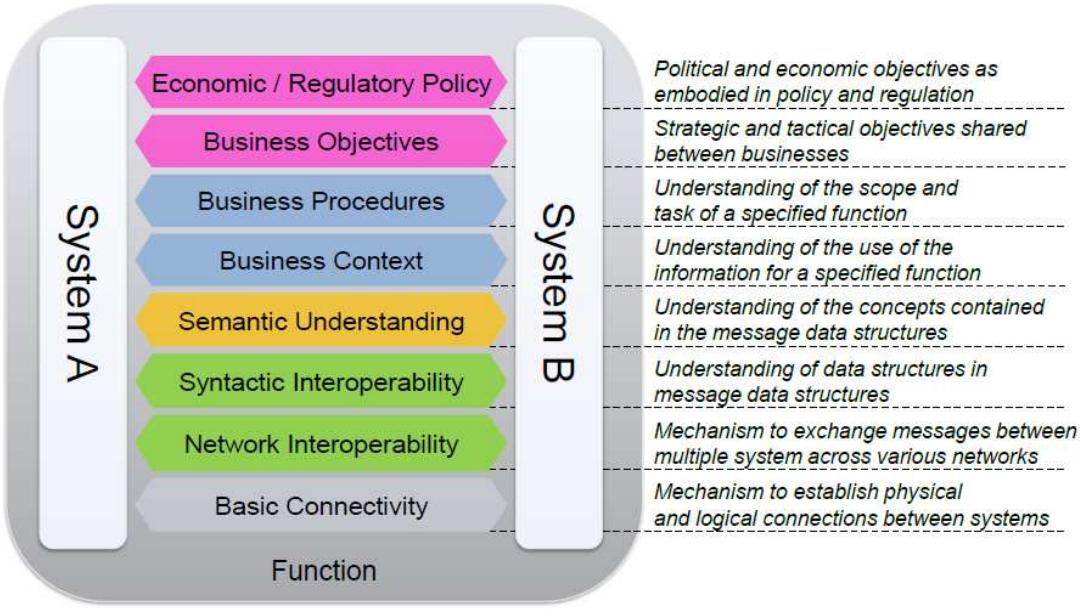
Interoperabilitet: Evnen som to eller flere innretninger fra samme eller ulike leverandører har til å utveksle informasjon og utnytte denne informasjonen til ønsket funksjon eller samvirke.

Begrepet *innretning* må i et Smartgrid-perspektiv gis en meget vid tolkning. Det omfatter apparater, anlegg, termostater, elbiler, datasystemer, databaser osv Figur 2 fra [8] illustrerer konseptet:



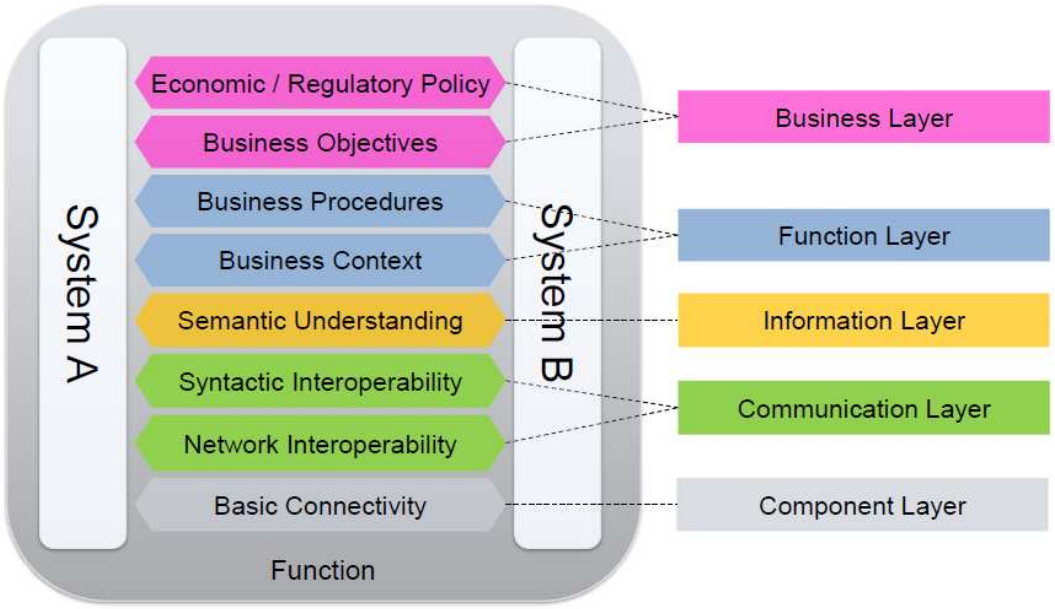
Figur 2 Interoperabilitet (fra [8]).

I dette interoperabilitetskonseptet er informasjonsutvekslingen detaljert gjennom en ytterligere inndeling i nivåer eller kategorier som vist i Figur 3 fra [11].



Figur 3 Kategorier (fra [11]).

Disse kategoriene er gruppert i fem klasser eller lag som vist i Figur 4.



Figur 4 Interoperabilitets nivå (fra [8]).

For at interoperabilitet skal sikres, må i prinsippet alle nivåene dekkes:

Component layer	:	Hardware, nettverk, osv
Communication layer	:	Protokoller, syntaks
Information layer	:	Semantisk tolkning
Function layer	:	Forretningsområder og forretningsprosesser
Business layer	:	Strategiske og taktiske mål for involverte aktører inklusive rammebetingelser (økonomiske, regulatoriske, forskrifter..)

De enkelte nivåene er kort beskrevet i det følgende:

Component layer: Dette nivået dekker mekanismer for fysisk og logisk kobling av systemer og inneholder hardware, nettverk, transmisjon, mottak og dekoding av karakterer, osv. Dette nivået omfatter det fysiske nivået og data link-nivået i OSIs syv-lags modell. Eksempel på interoperabilitets-standarder på dette nivået er:

- Ethernet-standarder
- WiFi
- EIA 232
- …

Communication layer: Dette nivået omfatter nettverksinteroperabilitet for å støtte utveksling av meldinger via ulike nettverk og syntaktisk interoperabilitet for å støtte tolkningen av data som utveksles. Eksempel på standarder for nettverksinteroperabilitet er:

- FTP
- TCP
- IP/IPv6
- …

Eksempel på standarder for syntaktisk interoperabilitet er:

- HTML
- XML
- SOAP
- …

Information layer: Dette nivået omfatter semantisk tolkning av innholdet i meldingene for å sjekke om informasjonsinnholdet i meldingene er meningsfull og hva innholdet er. Det er behov for dette laget fordi meldinger kan utveksles vellykket rent teknisk og likevel være helt meningsløse. F.eks. kunne en melding inneholde at "Primærspenningen til transformator T1 = 50 Ampere".
Eksempel på standarder for informasjonsmessig interoperabilitet er:

- CIM – Common Information Model IEC 61970
- Objektmodeller basert på IEC 61850 Communication networks and systems in substations
- ….

Function layer: Dette nivået omfatter samvirke mellom forretningsområder og forretningsprosesser. Dette er også et aspekt for å oppnå effektiv interoperabilitet, at involverte organisasjoner/ selskap/ aktører har kompatible prosesser og prosedyrer. Litt forenklet sikrer dette nivået at informasjon kommer inn i riktig prosess og til riktig aktør/rolle. For å fremme eHandel/eBusiness har det bl.a. vært jobbet med dette og tatt frem modeller innen FN-systemet (UN/CFACT, ebXML..).

Business layer: Dette nivået omfatter at strategiske og taktiske mål for involverte aktører inklusive rammebetingelser (økonomiske, regulatoriske, forskrifter..) er komplementære og kompatible. Et eksempel på

en slik beskrivelse er rolledelingen mellom aktørene (produsent, nettselskap, kunde, balanseansvarlig, osv) i kraftsystemet og de målsettinger som følger av disse rollene.

I DeVID-prosjektet forventes det i første omgang at det er viktigst å verifisere interoperabilitet på kommunikasjonsnivået og informasjonsnivået.

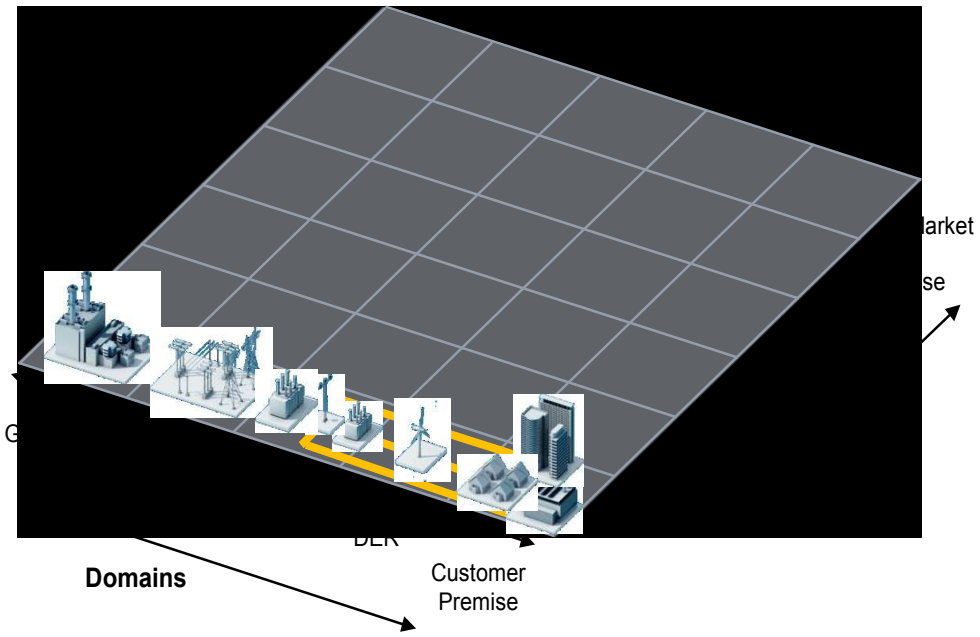
2.3 The Smart Grids Architecture Model – SGAM

Under Mandat 490 er det utviklet en referansearkitektur for Smart grids. Modellen tar utgangspunkt i domene som er vist i Figur 1 og den er delt inn i fem lag inspirert av interoperabilitetsnivåene fra Figur 4:

- Komponentlaget - Component layer
- Kommunikasjonslaget - Communication layer
- Informasjonslaget - Information layer
- Funksjonslaget - Function layer
- Forretningslaget - Business layer

Videre brukes et sonebegrep ("zones") til å representere ulike nivå av aggregering (hierarki). Dette konseptet er hentet fra standarder innen industriautomasjon (f.eks. IEC 62264 Enterprise control system integration).

Figur 5 viser arkitekturen på komponentnivå:



Figur 5 SGAM konseptet – komponentlaget.

Domenene følger logisk verdikjeden i det fysiske kraftsystemet:

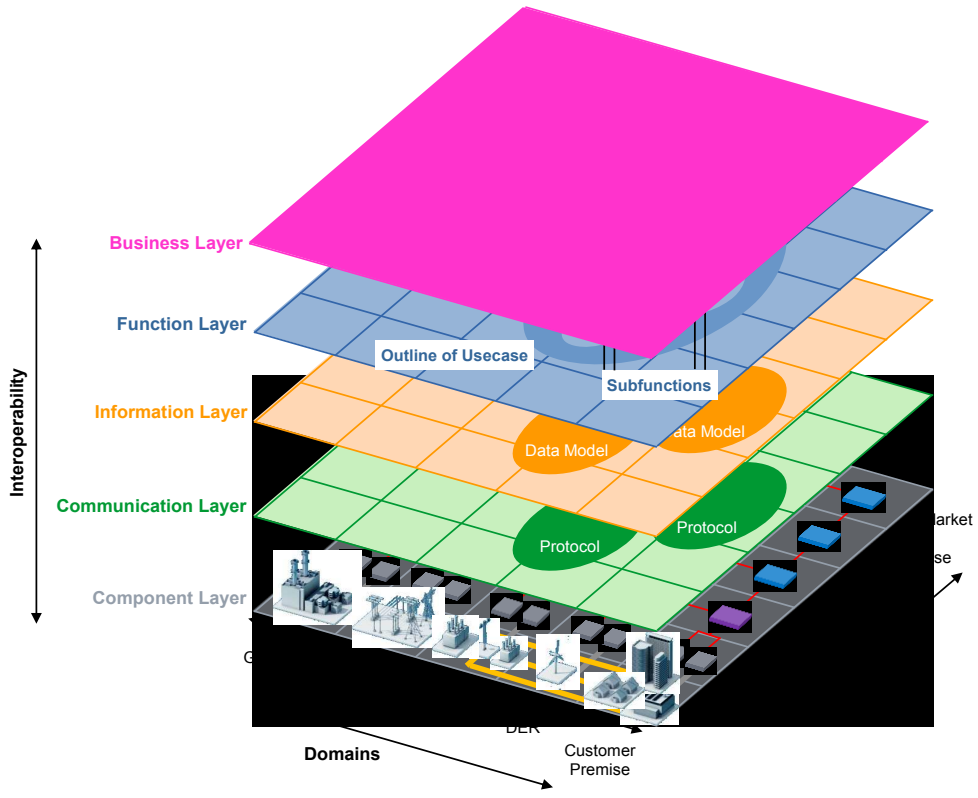
- Storskala produksjon (vannkraft, vindparker osv)
- Transmisjon (overføring/utveksling av elektrisk kraft i sentralnettet og regionalnett – typisk 400 kV – 66 kV i Norge)
- Distribusjon (distribusjon av elektrisk kraft i høy- og lavspennings distribusjonsnett typisk 22 og 11 kV samt 400 V og 230 V i Norge)
- Distribuert produksjon og energilagring (produksjon tilknyttet distribusjonsnettet. DER = distributed energy resources)
- Kunde – kundens installasjon (industri, husholdning, last/produksjon, elektriske biler osv)

Sonebegrepet representerer ulike hierarkiske nivå i håndteringen av kraftsystemet og er definert som følger:

- Prosess (process) – Primærkomponentene i kraftsystemet (generatorer, transformatorer, kabler, , brytere, elektriske laster, ...)
- Felt (field) – utstyr for å beskytte, styre og overvåke kraftsystemet (relevern, måletransformatorer, osv.)
- Stasjon (station) – aggregering av felt f.eks. datakonsentrator
- Drift (operation) – driftssystemer, driftsentral, ...
- Selskap/aktør (Enterprise) – nettselskap, kraftselger osv.
- Marked (market) – spotmarked, regulerkraftmarked, …

(Navngivingen av de ulike soner er ikke like intuitiv som navnene på domener – og er fortsatt under diskusjon.)

Figur 6 viser hele SGAM-konseptet:



Figur 6 SGAM-konseptet.

De ulike lagene forklares litt nærmere i det etterfølgende:

Forretningslaget (Business layer)
Forretningslaget representerer **utveksling av informasjon** i Smart grids sett fra forretningsperspektivet dvs. i forhold til forretningsprosesser, forretningsmodeller, målsettinger, produkter, tjenester. Rammevilkår og regulatoriske forhold inngår også. Eksempelvis kan kravet om teknisk-økonomisk rapportering til NVE fra nettselskap forankres til dette nivået.

Funksjonslaget (Function layer)
I funksjonslaget representeres use case, funksjoner osv. uavhengig av den fysiske realiseringen i systemer og komponenter. Et use case gir en oversikt over funksjoner og involverte aktører og informasjonsutvekslingen mellom disse. Use case-begrepet er nærmere diskutert i kapittel 3. Typisk vil et sett av funksjoner (use case) dekke et business case.

Informasjonslaget (Information layer)
I informasjonslaget beskrives datamodeller og informasjonsobjektene som inngår i use case slik at bl.a. informasjon kan tolkes riktig. CIM-standarden (Common information model) , [12] inneholder slike beskrivelser.

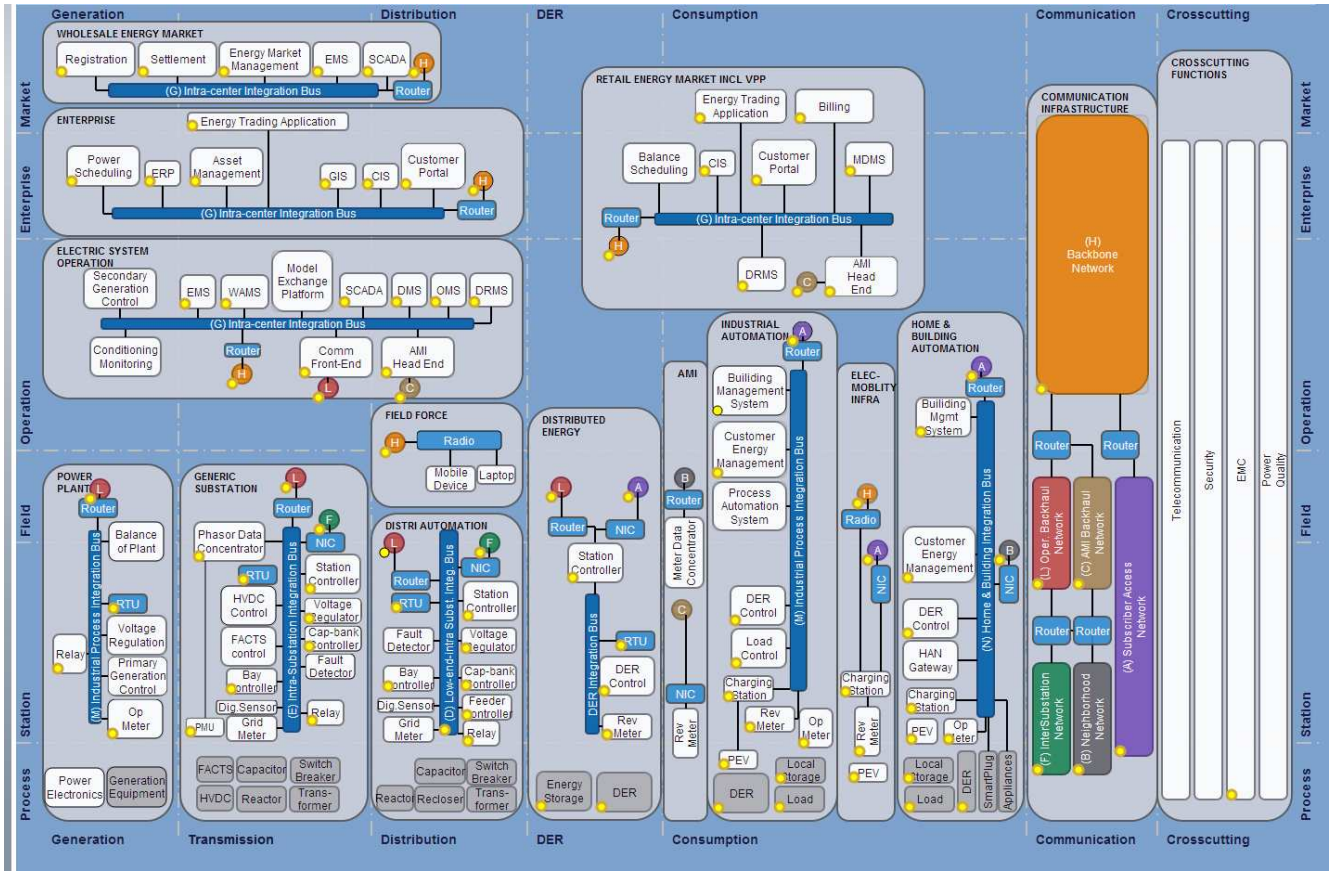
Kommunikasjonslaget (Communication layer)
I dette laget beskrives protokoller og mekanismer for utveksling av data.

Komponentlaget (Component layer)
Dette laget omfatter all fysisk infrastruktur (elektrisk utstyr, nettverk, trådløskommunikasjon, servere, rutere, PC-er osv.)

SGAM gir en felles forståelse av hva Smart Grid er, den bidrar til en felles terminologi og den kan brukes til å mappe use case, aktører, informasjonsflyt m.m. for bl.a. å kunne analysere interoperabilitet og om relevante standarder er tilgjengelige – se neste kapitel om IECs Smart Grid Standards Mapping Tool.

2.4 IEC Smart Grid Standards Mapping Tool

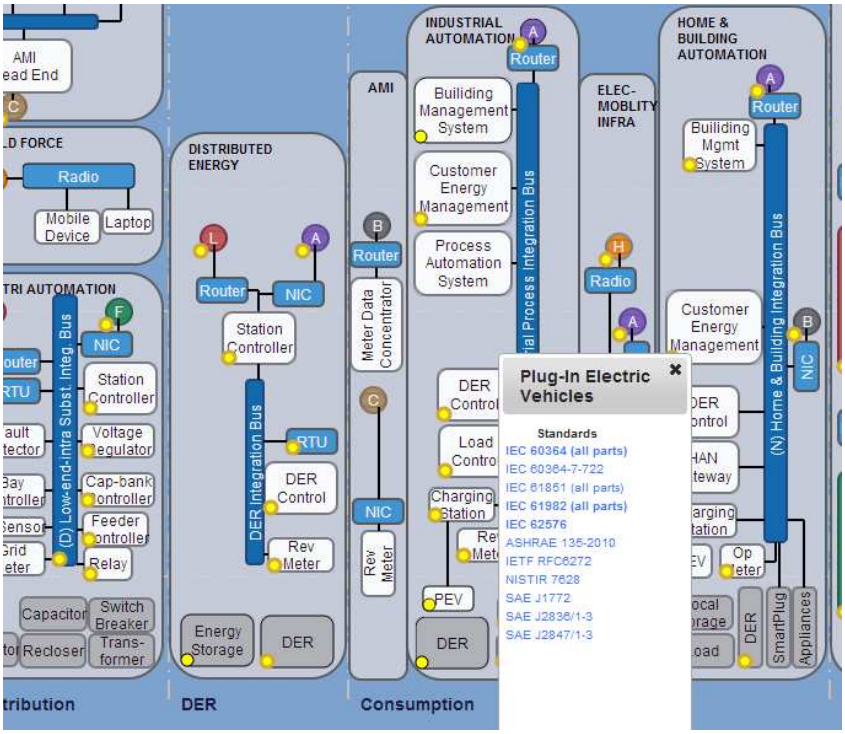
Den verdensomspennende standardiseringsorganisasjonen innen det elektrotekniske området IEC har utviklet interaktivt *Smart Grid Standards Mapping Tool* basert på SGAM-konseptet omtalt i forrige kapitel. Verktøyet er tilgjengelig online: smartgridstandardsmap.com. Figuren nedenfor viser brukerflaten (Architecture view – verktøyet har flere "views").



Figur 7 Smart Grid Standards Mapping Tool (http://smartgridstandardsmap.com/).

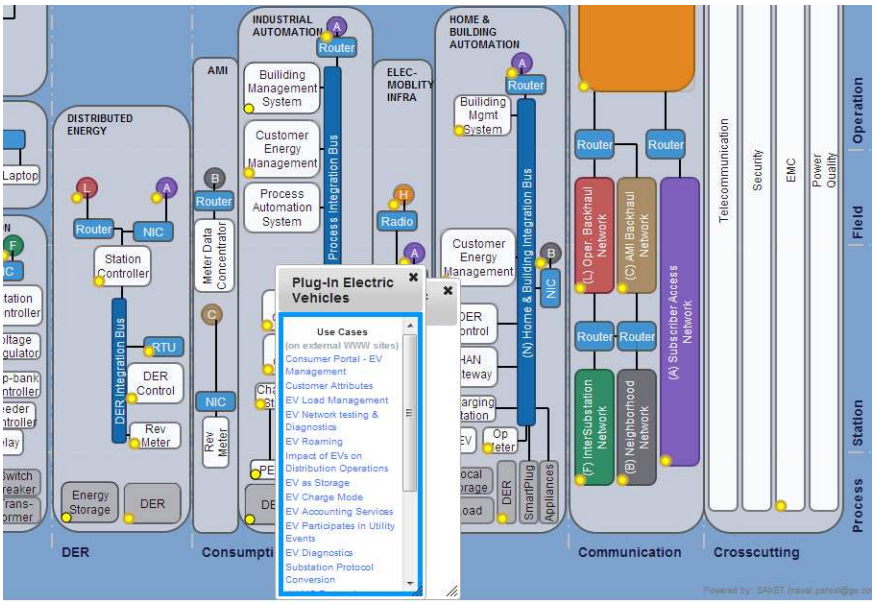
Horisontalt kjenner man igjen domenene fra SGAM-konseptet, mens sonene gjenfinnes vertikalt. I tillegg er figurene supplert med kommunikasjonsinfrastruktur og en del andre generelle funksjoner (crosscutting functions som f.eks. EMC, Security..). De ulike elementene i figuren er hovedsakelig *aktører.* En aktør er enhver som utveksler informasjon: person, apparat, applikasjon, database, IT-system, organisasjon osv. Mer om aktører i neste kapittel om use case.

Ved å klikke på elementene i figuren, kommer det opp en liste med aktuelle standarder, se eksemplet i Figur 8 hvor det er klikket på PEV (Plug in Electrical Vehicles):



Figur 8 Standarder relevante for PEV.

Ved å klikke på de gule prikkene får man listet use case hvor den aktuelle aktøren har en viktig rolle, se eksemplet i Figur 9.



Figur 9 Aktuelle use case hvor PEV inngår.

3 Use case

3.1 Generelt

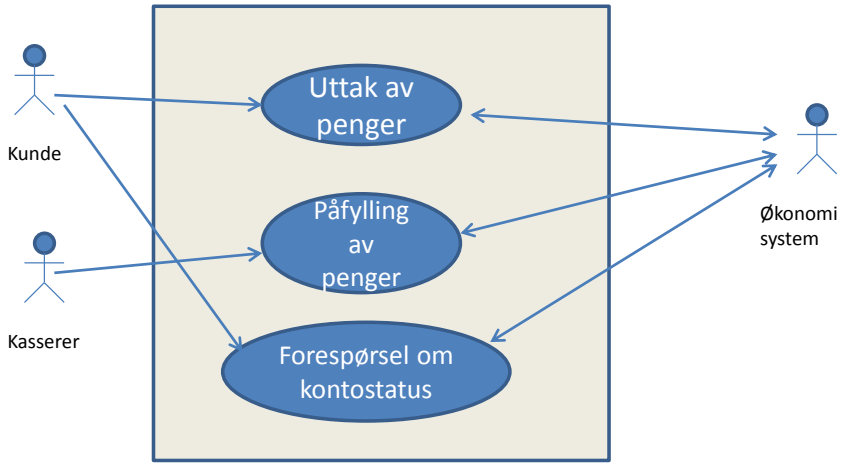
Use case-metodikken kommer fra programvareutvikling og er i den sammenheng et verktøy for å beskrive et IT-system sett fra kundens perspektiv. Det legges vekt på å beskrive hva et system skal gjøre slik at system-utviklere får et godt underlag for hva de skal lage og hvilke krav som må tilfredsstilles for at kunden skal være fornøyd. Denne metodikken har med visse tilpasninger fått sin anvendelse innen Smartgrids-området og brukes stadig mer. Det utvikles også standarder til støtte for bruk av metodikken i regi av IEC med bl.a. standardiserte maler for beskrivelse av use case og det finnes use case-databaser hvor man kan finne use case-beskrivelser og eventuelt tilpasse disse for egne prosjekter eller anskaffelser (se f.eks. http://smartgridstandardsmap.com/)

Et use case omfatter bl.a. en prosessbeskrivelse d.v.s. de ulike steg som er nødvendige for å realisere målet med use caset og informasjonsutvekslingen mellom aktørene som inngår i use caset. En aktør er enhver som utveksler informasjon: person, apparat, applikasjon, database, IT-system, organisasjon osv. Styrken til use case-metodikken er at den gir en oversikt over det som kreves for å nå et gitt mål slik at personer fra ulike fagområder (f.eks. elkraft, tele, IT,...) kan samarbeide om å utvikle de ønskede løsninger. En av de store utfordringene innen Smartgrids er å sikre interoperabilitet, d.v.s. sikre evnen som to eller flere innretninger fra samme eller ulike leverandører har til å utveksle informasjon og utnytte denne informasjonen til ønsket funksjon eller samvirke. Use case-metodikken er spesielt godt egnet til å støtte dette behovet.

I [13] er use case definert slik:

Use Case: *Description of the interaction between one or more actors, represented as a sequence of simple steps.*
NOTE 1: Actors are entities that exists outside the system ('black box') under study, and which take part in a sequence of activities in a dialogue with the system to achieve a specific goal. Actors may be end users, other systems, or hardware devices.
NOTE 2: Each Use Case is a complete series of events, described from the point of view of the actor.

Use case fokuserer altså på hva man ønsker å oppnå, og hvilke aktører som inngår i prosessen – framfor å beskrive hvordan det gjøres. Største delen av et use case er en tekstlig beskrivelse støttet av ulike UML-diagram. (UML står for Unified Modeling Language og er et modelleringsspråk til støtte for systemutvikling.) Det viktigste diagrammet er et såkalt use case-diagram som gir en oversikt over hva som inngår i use caset og hvilke aktører som er involvert. Figur 10 viser et enkelt eksempel på et use case-diagram for bruk av en minibank:



Figur 10 Eksempel på use case diagram – minibank.

I use caset inngår tre aktører:

- Kunde
- Kasserer
- Økonomisystem

[14] gir en god innføring i use case-metodikken og bruk av den innenfor Smart Grids.

Det finnes en standardisert mal for use case, publisert av IEC [15]. **En norsk versjon av malen er gitt i appendiks A, mens appendiks B viser et eksempel på bruk av malen.**

I use case-beskrivelser det viktig at aktørene er veldefinerte. I [13] er et sett av aktører definert basert på følgende hovedkilder:

- IEC 61968 Interface Reference Model
- ENTSO-E Role Model. Basert på ETSO, EFET, EbiX role model. Modellen forvaltes av ENTSO-E.
- SMCG : Smart Meter Coordination Group associated to M441 mandate

I appendiks C er aktørlisten gjengitt og supplert med forslag til norske aktørnavn.

Det anbefales at denne aktørlisten benyttes. Dersom det er aktører som mangler, må listen utvides.

Det foreligger en rekke use case-beskrivelser fra ulike Smart grid-prosjekt (demoprosjekt, fullskalaprosjekt osv.). Noen av disse er tilgjengelige i ulike databaser som f.eks. EPRIs use case repository (http://smartgrid.epri.com/Repository/Repository.aspx).

I DeVID-prosjektet er det laget en egen use case-samling med use case som er utviklet i prosjektet. Use case i DeVID publiseres i en web-browser som gjøres tilgjengelig for alle deltakerne: http://smartgrid.hiof.no/wiki/index.php/Main_Page

Alle use case som er produsert i prosjektet, er nå tilgjengelig her, og interesserte kan kontakte prosjektet for bruker- og påloggings-informasjon for å utforske denne. Det er også utviklet en konverterer som oversetter automatisk use case fra word-dokument til wiki-sider.

4 Referanser

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[12] Application integration at electric utilities - System interfaces for distribution management
IEC 61968-1

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[15] IEC 62559-2 Use case methodology –Part 2: Definition of the templates for use cases, actor list and requirements list, IEC 2014

Vedlegg A Use case mal fra IEC 62559-2 (Oversatt)

Use case methodology –Part 2: Definition of the templates for use cases, actor list and requirements list

1 Beskrivelse av Use Case

1.1 Navn på Use Case

Identifikasjon av use case		
ID	**Område/ Domene/Sone**	**Navn**

1.2 Versjonshåndtering

Versjonshåndtering				
Versjon	**Dato**	**Navn på forfatter(e)**	**Endringer**	**Status** Utkast, endelig versjon…

1.3 Use casets mål, hensikt, anvendelse

Beskrivelse av mål og hensikt med funksjonaliteten til use caset	
Hensikt	
Mål	
Relevante business case	

1.4 Use case beskrivelse

Use case beskrivelse
Kort beskrivelse – maks 3 setninger
Komplett beskrivelse

1.5 Nøkkelindikator - Key performance indicators (KPI)

Key performance indicators			
ID	**Navn**	**Beskrivelse**	**Referanse til use casets mål**

1.6 Use case forutsetninger og betingelser

Use case forutsetninger og betingelser
Forutsetninger
Betingelser

1.7 Ytterligere informasjon for klassifisering av use caset

Klassifiseringsinformasjon
Relasjon til andre use cases
Use casets detaljeringsgrad
Prioritering
Generisk, regionalt eller nasjonalt
Nature of the use case
Further keywords for classification

1.8 Generelle kommentarer

Eventuelle kommentarer

2 Diagram – skisser av Use Caset

Diagram – skisser av Use Caset det anbefales "contekst diagram" eller "sekvens diagram" i UML

3 Teknisk beskrivelse

3.1 Aktører: Mennesker, systemer, applikasjoner, databaser, anlegg, komponenter, utstyr og andre interessenter

Aktører			
Gruppe		Gruppebeskrivelse	
Aktørnavn Se egen liste	Aktørtype Se egen liste	Aktørbeskrivelse Se egen liste	Tilleggsinformasjon for dette spesifikke use caset

3.2 Referanser

Nr.	Referansetype	Referansen	Status	Betydning for use caset	Kilde	Link

4 Use caset steg for steg

4.1 Oversikt over scenarier

Scenario forutsetninger						
Nr.	Navn på scenariet	Scenario beskrivelse	Primær aktør	Initierende begivenhet	Startbetingelser	Sluttbetingelser

4.2 Steg for de ulike scenarier

		Scenario						
Scenario Navn :		Nr 1 -						
Steg Nr.	Hend-else	Navn på prosess/ Aktivitet	Beskrivelse av Prosess/ Aktivitet	Service	Informasjons-skaper (aktør)	Informasjons-mottaker (aktør)	Informasjon som utveksles	Krav-ID

5 Informasjon som utveksles

Informasjon som utveksles			
Informasjons-ID	Informasjonsnavn	Beskrivelse	Krav-ID

6 Krav (opsjon)

Krav		
Kategori-ID	Kategori-navn	Beskrivelse av kategori
Krav ID	Krav-navn	Beskrivelse av krav

7 Terminologi og definisjoner

Terminologi og definisjoner	
Term	Definisjon

8 Tilleggsinformasjon (opsjon)

Tilleggsinformasjon (opsjon)		
Nøkkel	Verdi	Referanse til seksjon i templaten

Vedlegg – Valgliste Domener

1 Transmisjonsnett, sentralnett,
2 Distribusjonsnett
3 Mikronett,
4 Smart automatisering/instrumentering i stasjoner
5 Distribuerte energikilder
6 Avanserte målesystemer – smart måling
7 Smarte hus, smart bygninger, smart industri – energistyring i bygg og prosesser
8 Elektrisk energilagring
9 Elektrisk transport,
10 Asset Management,
11 Storskala kraftproduksjon
12 Marked
13 Sikkerhet

SINTEF

Vedlegg B Eksempel på bruk av use case - (Fault location, isolation, system restauration)

1 Description of the use case

1.1 Name of use case

Use case identification		
ID	**Area /Domain(s)/ Zone(s)**	**Name of use case**
0100	Area: Energy System Domain: Distribution System, Zones; Operation, Station, Field	Locate and isolate fault and restore system (Fault location, isolation and system restoration (FLISR))

1.2 Version management

Version management				
Version No.	**Date**	**Name of author(s)**	**Changes**	**Approval status**
0.9	2011-11-24	Rolf Apel		WD Working Document
1.0	2012-05-15	Rolf Apel	Drawing added	WD Working Document
1.1	2013-10-08	Rolf Apel	Actor list updated, drawing updated, step-by-step description detailed	Example document

1.3 Scope and objectives of use case

Scope and objectives of use case	
Scope	FLISR automates the management of faults in the distribution grid.
Objective(s)	In order to improve performance indexes FLISR supports the localization of the fault, the isolation of the fault and the restoration of the energy delivery. During disturbances the automatic fault handling shortens outage time and offloads the operators in the distribution control center for more complicated situations. As FLISR is creating switching proposals to reconfigure the network, corresponding safety aspects need to be considered and implemented.
Related business case(s)	Therefore FLISR may help to improve performance indexes like SAIDI (System Average Interruption Duration Index) and SAIFI (System Average Interruption Frequency Index).

1.4 Narrative of use case

Narrative of use case
Short description
The FLISR use case is divided into four sequences: 1. Fault detection and clearance – The protection devices in the grid are detecting the fault and issuing suitable breaker tripping. 2. Fault localization – Identify the physical location of the fault by analysing the telemetered alarms received from protection devices in the grid. 3. Fault isolation – Determine switching actions which will isolate the faulty equipment(s) from the rest of the grid. 4. System restoration – Resupply those healthy parts of the grid, which are de-energized during the fault clearing. The execution within these sequences is typically highly automated, while the continuation with the next sequence typically requires a control room operator interaction.
Complete description
If a failure happens in the distribution grid the protection devices will detect this and initiate immediately breaker tripping to de-energize the fault. Due to the lower selectivity of the fault protection in distribution grids, typically a large part of the distribution grid becomes de-energized, e.g. a complete feeder. Together with the help of a communicating system, and fault passage indicators located on the power system, and communicating breakers located at the main substation, the FLISR application in the control center will be aware of a fault, identify the faulty section, remotely isolate the faulty section and remotely restore power to the healthy part, either under the control of the operator or in a kind of closed loop operation. The effects of the determined switching actions for isolation or restoration might be simulated and verified automatically or by the distribution operator prior to execution. Utilities that operate in such networks have a need for fast fault awareness, faulty section identification, rapid information gathering, and analysis of switching options to restore service when a part of the consumers, attached to the concerned feeder is lost. Without this capability, it can make several hours or more to restore power should an inner city substation be lost. This application runs at a control centre level, with tight connection with field devices acting either as sensors or actuators. Feeder can be of overhead or underground types or both. Implementing FLISR helps the utility to improve the performance based rates (PBR) and reduce the risk of penalties. The rules for Performance Based Rates (PBR) will vary from country to country, or even from state to state, however most include the performance measures of SAIDI (System Average Interruption Duration Index), SAIFI (System Average Interruption Frequency Index), and often system average interruptions per mile of line. Another business approach can be to measure the quantity of Non-Distributed-Energy due to un-availability of power at consumer side. The quicker is the restoration after a fault, the less is the quantity of non-distributed energy.

1.5 Key Performance Indicators

Key performance indicators			
ID	**Name**	**Description**	**Reference to mentioned use case objectives**
SAIDI	System Average Interruption Duration Index	Outage management: Measure reliability of power supply SAIDI = (sum of all customer interruption durations) / (total number of customers served)	improve performance indexes
CAIDI	Customer Average Interruption Duration Index	Outage management: Measure reliability of power supply CAIDI = (sum of all customer interuptions duration) / (tutal number of customer interuptions	improve performance indexes
ASUI	Average Service Unavailability Index	Outage management: Measure reliability of power supply ASUI = SAIDI / 8760	improve performance indexes

1.6 Use case conditions

Use case conditions
Assumption
• Safety conditions for automatic re-supply to be considered
Prerequisite
• The Distribution Protection Device is reacting in the presence of a fault
• Enough energy is stored and available for communicating
• The grid is continuously monitored
• Communication system between generic architectural component and control center where FLISR is hosted is operational
• The grid topology is known and reflects the real topology
• The grid energy path is known and reflects the real path (effective status).

1.7 Further information to the use case for classification / mapping

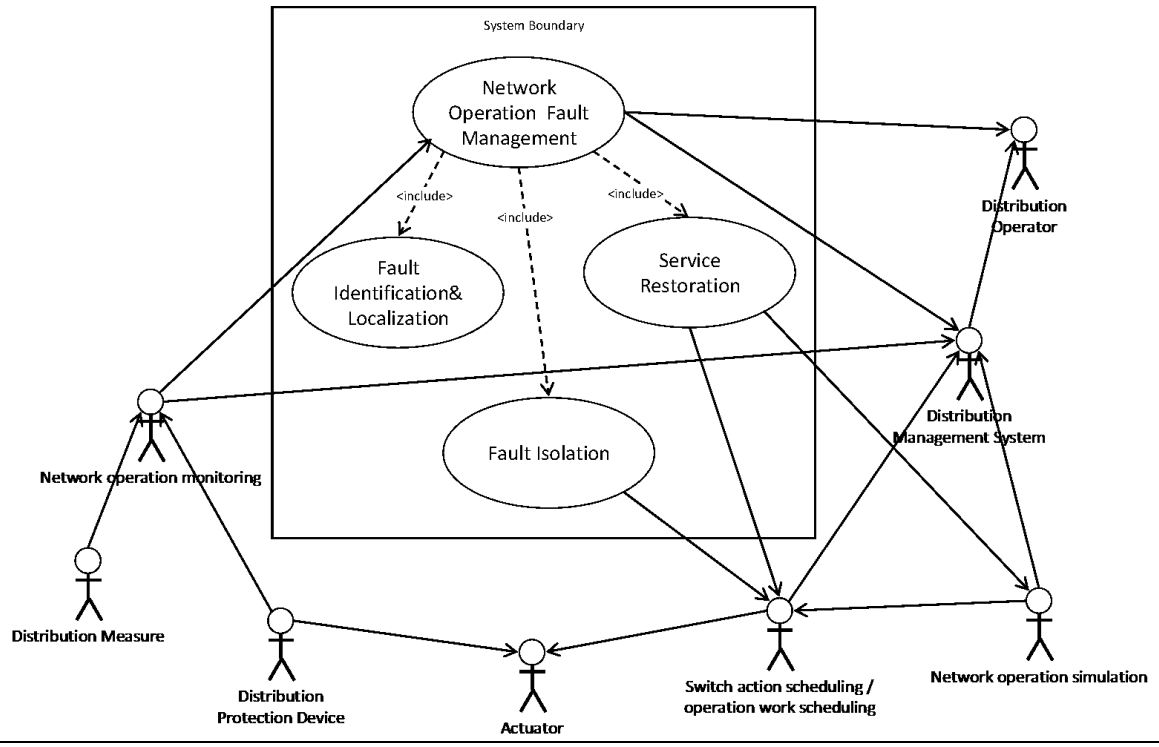
Classification information
Relation to other use cases
Distribution Management System, sub use cases for each scenario (e.g. Feeder Automation)
Level of depth
Detailed
Prioritisation
High
Generic, regional or national relation
Generic
Nature of the use case
System use case
Further keywords for classification
Fault detection, automatic restoration, automatic feeder configuration

1.8 General remarks

General remarks
Based on different grid topologies the use case may differ. This description fits the best to a weakly meshed network and a centralised execution of the FLISR application.

2 Diagrams of use case

Diagram(s) of use case



3 Technical details

3.1 Actors

Actors	
Grouping	**Group description**
Distribution Grid	Representing the infrastructure and organization which distributes electricity to customers (and more and more collects electricity from local decentralised generators like PV)

Actor name	Actor type	Actor description	Further information specific to this use case
Switch action scheduling / operation work scheduling	Application	Switch action scheduling provides supports for handling all aspects relevant to switch order formulation, drawing up operating guidelines, dispatching repair crews and informing customers affected. It assists in collecting the related data and delivering it in the various forms required.	IEC 61968-1
Network Operation Monitoring	Application	Network Operation Monitoring actors supervise network topology, connectivity and loading conditions, including breaker and switch states, and control equipment status. They locate customer telephone complaints and field crews.	Based on IEC 61968-1
Network Operations Simulation	Application	This set of functions allows facilities to define, prepare and optimise the sequence of operations required for carrying out maintenance work on the system (release/clearance orders) and operational planning.	IEC 61968-1
Distribution Management System (DMS)	Application	A system which provides applications to monitor and control a distribution grid from a centralized location, typically the control center. A DMS typically has interfaces to other systems, like an GIS or an OMS	SG-CG/M490/E
Distribution Operator	Person	Person operating the Distribution System	NIST
Network Operations Fault Management	Application	Fault Management actors enhance the speed at which faults are located, identified, and sectionalized so service can be restored. They provide information for customers, coordinate with workforce dispatch and compile information for statistics.	IEC 61968-1
Actuator	Device	An actuator is a transducer that accepts a signal and converts it to a physical action. In other words, an actuator causes an action to occur relating to the data that was sent to it. They are used to remotely operate devices such as switches and circuit-breakers.	SGIP Entity List
Distribution Measure	Application	Performed by actors that provide visibility into the flow of power and the condition of the systems in the field. In the future measurement might be found in built into meters, transformers, feeders, switches and other devices in the grid. An example would be the digital and analog measurements collected through the SCADA system from a remote terminal unit (RTU) and provide to a grid control center in the operations domain.	NIST Conceptual Model
Distribution Protection Device	Device	Actors that react rapidly to faults and other events in the system which might cause power outages, brownouts, or the destruction of equipment. Performed to maintain high levels of reliability and power quality. Examples include FACTs devices, switches, circuit interrupters, capacitors, reactors, fuses	SGIP Entity List

3.2 References

References						
No.	**References Type**	**Reference**	**Status**	**Impact on use case**	**Originator / organisation**	**Link**
	Standards	IEC 61850, IEC 60870-5-10x, IEC 61968-1			IEC TC 57	
	Use case	WGSP-0100 use case FLIR		Basic input (based on a TC 57 use case)	Smart Grid Coordination Group (Europe)	

4 Step by step analysis of use case

4.1 Overview of scenarios

Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-Condition**	**Post-Condition**
1	Fault occurs	Action taken by field devices during grid failure and information flow to control center	Distribution Protection Devices	Fault occurs	Distribution Protection Devices are operable and configured correctly	Part of the grid where the fault occurs is de-energized
2	Fault Location	Interaction of control center application to determine the location of the grid failure.	Network Operations Fault Management	Fault notification	Fault notification is transmitted via Network operation monitoring to the Network Operations Fault Management	Location of the fault is identified
3	Fault Isolation	Interaction of control center application to determine switching actions to isolate faulty grid part	Network Operations Fault Management	Fault localization ready	The fault location could be identified	The faulty equipment is isolated from the healthy part of the grid
4	System Restoration	Interaction of control center application to determine switching actions to resupply de-energized, but non faulty grid part	Network Operations Fault Management	Fault isolation ready	The faulty equipment could be isolated	Except of the faulty equipment all formerly de-energized parts of the grid are resupplied.

Scenario conditions						
No.	**Scenario name**	**Scenario description**	**Primary actor**	**Triggering event**	**Pre-Condition**	**Post-Condition**
5	No localisation possible	Information flow after fault localization algorithm fails to identify fault location	Network Operations Fault Management	Fault occurs	Distribution Protection Devices are operable and configured correctly	The location of the fault is not possible
6	No isolation possible	Information flow after fault isolation algortihm fails to determine isolation switching sequence	Network Operations Fault Management	Fault notification	Fault notification is transmitted via Network operation monitoring to the Network Operations Fault Management	There is no possibility for a closer isolation of the faulty equipment
7	Re-energizing failed	Information flow after fault isolation algortihm fails to determine resoration switching sequence	Network Operations Fault Management	Fault isolation ready	The faulty equipment could be isolated	Not all de-energized, but faultless parts of the grid could be restored

Scenarios

Scenario name:	No. 1 – Fault occurs							
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirements R-IDs**
1	Fault occurs in the grid	Tripping	Substation Protection Device detects a fault on the protected asset and trips to eliminate the current fault. It de facto de-energizes the protected asset e.g. the part of the radial operated network where the fault occurred	EXECUTE	Distribution Protection Device	Actuator (Breaker)	Trip command	QoS-1
2	Fault occurs in the grid	Fault notification	Substation Protection Device sends signal to the Network operation monitoring	CREATE	Distribution Protection Device	Network operation monitoring	Network Fault	IS-1
3	Breaker trip alarm	Information collection	Network Operations Monitoring collects all incoming information provided by the network operation monitoring which is related to the occurred fault	REPORT	Network operation monitoring	Network Operations Fault Management	Various fault and status informaion	IS-1
4	Fault data collection ready	Fault localisation	The Network Operations Fault Management application analyses the collected fault data and identifies the faulty equipment (see next scenario)	CREATE	Network Operations Fault Management	DMS	Faulty Equipment	QoS-2

Scenario name:	No. 2 – Fault location							
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information Exchanged (IDs)**	**Requirements R-IDs**
1	Fault location identified	Network analysis	The Network Operations Fault Management analyses the grid topology around the faulty equipment and identifies those switches which will isolate the faulty device when opened.	CREATE	Network Operations Fault Management	Switch action scheduling / operation work scheduling & Network operations simulation	InfEx-4	
2	Switching order ready	Simulation feeder configuation	The effects of the switching order are simulated and the simulation results are presented to the distribution operator	REPORT	Network Operations Simulation	Distribution operator	InfEx-11	

Scenario name:		No. 3 – Fault isolation						
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information exchanged (IDs)**	**Requirements , R-IDs**
1	Trigger switching sequence	Feeder re-configuration	The Switch action scheduling / operation work scheduling is triggered either automatically or by the DMS Operator to execute the isolation switching sequence	EXECUTE	Switch action scheduling / operation work scheduling	Actuators	InfEx-5	IS-1
2	Switching commands	Feeder feedback	The field operators or the Distribution Measure react according to the commands and report the success status of the execution	REPORT	Field Operators / Distribution Measure	Network operation monitoring	InfEx-6	IS-1, QoS-3
3	Successful execution of switching sequence	Confirmation of new network configuration	The Network Operations Monitoring verifies the success of the isolation and updates the data model	REPORT	Network Operations Monitoring	DMS	InfEx-11	

Scenario name:		No. 4 – System restoration						
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information *exchanged (IDs)***	**Requirements, R-IDs**
1	Successful isolation	Suggestion of feeder for restoration	The Network Operations Fault Management analyses the grid topology of the healthy, but de-energized equipment and determines switches which will restore energy to them	CREATE	Network Operations Fault Management	Switch action scheduling / operation work scheduling & Network Operations Simulation	InfEx-12	
2	Restoration proposal available	Analysis of feeder switching for restoration	The Network Operations Simulation simulated the effects of the proposed switching actions and verifies the operational safety	EXECUTE	Network Operations Simulation		(Only internal)	
3	Switching order ready	Display of simulation	The simulation results of the switching order are presented to the distribution operator	REPORT	Network Operations Simulation	Distribution Operator	InfEx-11	
4	Trigger switching sequence	Switching breakers for restoration	The Switch action scheduling / operation work scheduling is triggered either automatically or by the distribution operator to execute the restoration switching sequence	EXECUTE	Switch action scheduling / operation work scheduling	Field Actuators	InfEx-5 InfEx-6	IS-1
5	Successful execution of switching sequence	Feeder feedback after restoration	The Network Operations Monitoring verifies the success of the restoration and updates the data model	REPORT	Network Operations Monitoring	DMS	InfEx-7 InfEx-11	

Scenario name:		No. 5 – No localisation possible						
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information *exchanged (IDs)***	**Requirements, R-IDs**
1,2		See No.1						
3Err	Fault data collection ready	Localisation error	The Network Operations Fault Management application analyses the collected fault data but is not able to determine the fault location	CANCEL	Network Operations Fault Management	Distribution Operator	InfEx-8	

Scenario name:		No. 6 – No isolation possible						
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information *exchanged (IDs)***	**Requirements , R-IDs**
1	Fault location identified	Isolation error	The Network Operations Fault Management analyses the grid topology around the faulty equipment and identifies but can not find switches which will isolate the faulty device when opened.	CANCEL	Network Operations Fault Management	Distribution Operator	InfEx-9	

Scenario name:		No. 7 – Re-energizing failed						
Step No.	**Event**	**Name of process/ activity**	**Description of process/ activity**	**Service**	**Information producer (actor)**	**Information receiver (actor)**	**Information *exchanged (IDs)***	**Requirements, R-IDs**
1	Successful isolation	Restauration Error	The Network Operations Fault Management analyses the grid topology of the healthy, but de-energized equipment and tries to determine switches which will restore energy to them. A solution can not for be found for all de-energized parts	CANCEL	Network Operations Fault Management	Distribution operator	InfEx-10	
2ff			Similar to PS4, but only for the found solutions					

5 Information exchanged

Information exchanged			
Information exchanged ID	**Name of information**	**Description of information exchanged**	**Requirements IDs**
InfEx-1	Trip command	De-energizing the faulty equipment / area	SynInt -1
InfEx-2	Network Fault	Detected network fault, here generic	SynInt -1
InfEx-3	Fault Equipment	Identified fault equipment	SynInt -1
InfEx-4	Suggested feeder reconfiguration	Proposal how to reconfigure the grid topology to re-energize as mauch as possible customers	Saf-1
InfEx-5	feeder open / close commands	Signal to actuators in the field or to operator	SynInt -1
InfEx-6	Open / Close of feeders	Report of response to open close commands	SynInt -3
InfEx-7	Feedback of new feeder position	Visualization of new topology to DMS operator	SynInt -2
InfEx-8	Error Localization	Error message saying that the localization of the fault was not possible	SynInt -2
InfEx-9	Error Isolation	Error message saying that the faulty equipment can not be isolated closer.	SynInt -2
InfEx-10	Error Restauration	Error message saying that not all de-energized parts can be restored.	SynInt -2
InfEx-11	Grid state	Grid status visualization in operator displays (one-line-diagrams, tabulars,...)	SynInt -2
InfEx-12	Network element	Unique ID of a grid equipment used in the control center data model	SynInt -1

6 Requirements (optional)

Requirements (optional)		
Category ID	**Categories for requirements**	**Category description**
3.2	SynInt	Syntactic Interoperability
Requirement ID	**Requirement description**	
SynInt -1	The transmitted ID of an object has to be unique	
SynInt -2	The information has be presented in a usable and ergonomic way	
SynInt -3	Return code of application has to inform about success or failure	

Category ID	Categories for requirements	Category description
6.7	QoS	Quality of service requirement
Requirement ID	**Requirement description**	
QoS-1	Signal to be sent < 15 milliseconds	
QoS-2	Position or equipment to be identified precisely	
QoS-3	Signal to be sent < 30 seconds	

Category ID	Category name for requirements	Category description
7.1	IS	Information System and Communication Protection (Information security)
Requirement ID	**Requirement description**	
IS-1	Signals to be authentificated; integrity checked	

Category ID	Categories for requirements	Category description
7.4	Saf	Safety and Risk Assessment
Requirement ID	**Requirement description**	
Saf-1	Application results has to checked against safety requirements	

7 Common Terms and Definitions

Common Terms and Definitions	
Term	**Definition**
SAIDI	System Average Interruption Duration Index
SAIFI	System Average Interruption Frequency Index
ASUI	Average Service Unavailability Index
PBR	Performance Based Rates
FLISR	Fault Location, Isolation and System Restoration
GIS	Geographic Information System
OMS	Outage Management System
NIST / SGIP	National Institute of Standards and Technology / Smart Grid Interoperability Panel
SCADA	Supervisory Control and Data Acquisition
RTU	Remote Terminal Unit
FACTS	Flexible Alternating Current Transmission System

8 Custom Information (optional)

Custom Information (optional)		
Key	**Value**	**Refers to Section**

Vedlegg C Aktørliste

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
x	Network Operations (NO)	Drift, nettdrift	System	The Network Operation domain is a sub-domain within Operation providing the monitoring, control, and maintainance of the utilities network. Key applications include monitoring and control remote field equipment (eg: Phase Measurement Units (PMU), capacitor banks, sectionalizers)				61968-IRM
x	Records and asset management (AM)	Komponentarkiv, nettarkiv, asset management arkiv	System	The Records and Asset Management actors track and report on the substation and network equipment inventory, provide geospatial data and geographic displays, maintain records on non-electrical assets, and perform asset investment planning.				61968-IRM
x	Operational Planning (OP)	Driftsplanlegging	System	Operational Planning and Optimization actors perform simulation of network operations, schedule switching actions, dispatch repair crews, inform affected customers, and schedule the importing of power. They keep the cost of imported power low through peak generation, switching, load shedding or demand response.				61968-IRM
x	Network Extension Planning (NE)	Nettplanlegging	System	Network Extension planning actors develop long term plans for power system reliability, monitor the cost, performance and schedule of construction, and define projects to extend the network such as new lines, feeders or switchgear.				61968-IRM
x	Maintenance and Construction (MC)	Vedlikehold	System	Maintenance and Construction actors coordinate equipment inspection, cleaning and adjustment , organize construction and design, dispatch and schedule maintenance and construction work, capture records gathered by field personnel and permit them to view necessary information to perform their tasks.				61968-IRM
x	Utility Business Systems (UBS)	Forretningssystemer	System	Usually called back-office systems				
x	Customer Support (CS)	Kundestøtte	Application	Customer Support actors help customers to purchase, provision, schedule installation, troubleshoot power system services, and relay/record customer trouble reports.				61968-IRM
	Account Management	Regnskap	Application	Business function or service that manages supplier and customer business accounts.	UBS			61968-IRM

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	SCADA	SCADA, Driftssentral	Application	Supervisory Control And Data Acquisition	NO, NO-NMON, NO-CTL			DKE Repository
	Energy Manager	Energistyring	Application					DKE Repository
	Network operation monitoring (NO-NMON)	Driftsovervåking, nettbilde	Application	Part of Network Operation. Provides the means for supervising main substation topology (breaker and switch state) and control equipment status. It also provides the utilities for handling network connectivity and loading conditions. It also makes it possible to locate customer telephone complaints and supervise the location of field crews.	NO			61968-IRM
	Network Operations Analysis (NO-OFA)	Driftsstøttesystem	Application	Operation Feedback Analysis actors compare records taken from real-time operation related with information on network incidents, connectivity and loading to optimize operations and schedule periodic maintenance.	NO			61968-IRM
	Network Operations Calculations (NO-CLC)	Tilstandsestimering, sanntids nettberegninger	Application	Real-time Network Calculations actors provide system operators with the ability to assess the reliability and security of the power system.	NO			61968-IRM
	Network Operations Control (NO-CTL)	Nettstyring	Application	Centralized automated and manual control operations of the system to manage the flow of power and optimize reliability of the system. Network control is coordinated by actors in this domain, they may only supervise wide area, substation, and local automatic or manual control. An example would be the use of phase angle regulators within a substation to control power flow between two adjacent power systems	NO			61968-IRM
	Network Operations Reporting and Statistics (NO-OST)	Driftsstatistikk	Application	Operational Statistics and Reporting actors archive on-line data and to perform feedback analysis about system efficiency and reliability.	NO			61968-IRM
	Network Operations Fault Analysis (NO-FLT)	Driftsstøttesystem - feilhåndtering	Application	Fault Management actors enhance the speed at which faults are located, identified, and sectionalized so service can be restored. They provide information for customers, coordinate with workforce dispatch and compile information for statistics.	NO			61968-IRM

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Substation and network inventory (AM-EINV)	Nettarkiv	Application	The electrical substation and network assets that a utility owns, or for which has legal responsibility, and will maintain an accurate asset register developed around an asset hierarchy that supports advanced asset management functions.	AM			61968-IRM
	Geographical inventory (AM-GINV)	Geografisk nettdokumentasjon (GIS)	Application	Management of geospatial data, typically by utilizing computer graphics technology to enter, store, and update graphic and non-graphic information. Geographic depictions and related non-graphic data elements for each entity are typically stored in some form of a data store. The graphic representations are referenced using a coordinate system that relates to locations on the surface of the earth. Information in the data store can be queried and displayed based upon either the graphic or non-graphic attributes of the entities.	AM			61968-IRM
	Asset investment planning (AM-AIP)	Vedlikeholdssystem	Application	Asset investment planning involves strategy definition and prioritisation, maintenance strategy planning, risk management, programme management and decision-making. It drives the condition, configuration, performance, operating costs, and flexibility of the asset base, with the aim of maximising value.	AM			61968-IRM
	Network operation simulation (OP-SIM)	Driftsplanleggings-system	Application	This set of functions allows facilities to define, prepare and optimise the sequence of operations required for carrying out maintenance work on the system (release/clearance orders) and operational planning.	OP			61968-IRM
	Switch action scheduling / operation work scheduling (OP-SSC)	Drfitsstøttesystem	Application	Switch action scheduling provides supports for handling all aspects relevant to switch order formulation, drawing up operating guidelines, dispatching repair crews and informing customers affected. It assists in collecting the related data and delivering it in the various forms required.	OP			61968-IRM
	Power import scheduling and optimisation (OP-IMP)	Optimalisering av kraftimport (?)	Application	Power import scheduling and optimisation aims to minimise the cost of imported power by keeping the average imported power close to the contracted value, making use of peak plants, load switching or load shedding.	OP			61968-IRM
	Network calculations (NE-NCLC)	Nettberegninger	Application	Used to develop a long-term (generally one year and beyond) plan for the reliability (adequacy) of the interconnected electric transmission and distribution networks.	NE			61968-IRM

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Construction supervision (NE-CSP)	Prosjektstyringssystem (?)	Application	Monitoring and management of construction work to minimize negative variances from planned costs, performance, and schedule.	NE			61968-IRM
	Project definition (NE-PRJ)	Utbyggingsplanlegging	Application	Planned work activities to enhance or extend the network and/or other assets. Example include line extension for new housing development, a new substation, switchgear change at a substation. Capital development projects (i.e., not billed to a customer) are usually justified with an business case.	NE			61968-IRM
	Maintenance and inspection (MC-MAI)	Vedlikeholdsstyring	Application	Work involving inspection, cleaning, adjustment, or other service of equipment to enable it to perform better or to extend its service life. Examples of maintenance work are routine oil changes and painting. Examples of inspection work are pole inspections, vault inspections, and substation inspections.	MC			61968-IRM
	Construction (MC-CON)	Bygging	Application	Examples of construction work include service installations, line extensions, and system betterment projects.	MC			61968-IRM
	Design (MC-DGN)	Prosjektering	Application	A design is created by an engineer or work planner. Designs can be made up of individual line items or by a set of “compatible units” or CUs. Line items and compatible units are associated with a Design Location which is associated with a design location.	MC			61968-IRM
	Work scheduling and dispatching (MC-SCHD)	Ressurstyring	Application	Work scheduling and dispatching makes it possible, for a defined scope of work, to assign the required resources and keep track of work progress.	MC			61968-IRM
	Field recording (MC-FRD)	Dokumentasjon i felt (innhentig av tilstandsdata etc)	Application	Field recording is often accomplished through hand held devices which allow field personnel to view and enter information relevant to the work they are performing in the field. For example, line crews and servicemen can access their respective district maps, do searches by pole number, substation, transformer number, switch numbers, and feeder names.	MC			61968-IRM
	Customer service (CS-CSRV)	Kundesenter	Application	This function set covers the different aspects related to customer interfaces required for operation and commercial purposes.	CS			61968-IRM
	Trouble call management (CS-TCM)	Kundesenter-feilmelding	Application	Customer troubles related to blackouts are transmitted and compared with network data in order to provide accurate information on the incident.	CS			61968-IRM

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Point of sale (CS-POS)	Strømkjøp-forhåndbetaling	Application	A point of sale system is used for the management of prepayment meters, where a customer either purchases a token or makes a prepayment for service.	CS			61968-IRM
	Supply Chain Logistics	Logistikk (?)	Application	Business function or service that manages supplier and customer business accounts.	UBS			61968-IRM
	Stakeholder Planning and Reporting	Myndighets-rapportering m.m.	Application	These actors perform track and manage the needs and concerns of various utility stakeholders by monitoring customer input, regulators, service standards, and legal proceedings.	UBS			61968-IRM
	Premises	Eiendoms- og rettighetsforvaltning	Application	Information regarding the location of a service. This set of functions includes: Address management; Right of ways, easements, grants; and Real estate management.	UBS			61968-IRM
	Financial	Finans	Application	Financial actors measure performance across the whole organization, including the evaluation of investments in capital projects, maintenance, or operations. They track risk, benefits, costs and impact on levels of service.	UBS			61968-IRM
	Business Planning and Reporting	Forretningsplanlegging og rapportering	Application	These actors perform strategic business modeling, manpower planning, reporting, account management, and both assess and report on risk, performance and business impact.	UBS			61968-IRM
	Human Resources	Personalforvatning	Application	Human Resources (HR) actors manage personnel information and activities including safety, training, benefits, performance, review, compensation, recruiting, sceduling, training/employee job-ratings and expenses. HR also determines overtime scheduling and job qualifications for specifc tasks.	UBS			61968-IRM
x	AMI operator	AMS operatør	generic role	General operator of the AMI system	AMI Operator			
	HES operator (A)	Operatør av måler-innsamlingssystem	generic role	External actor interacting with the system functions and components via the HES Head End System (Metering)	AMI operator		MDC, MO, MDA, MDMS	SMCG
	Meter User (B)	Ektern bruker av AMS-måler	generic role	External actor interacting directly with the smart meter (Metering End Device).	AMI operator		Consumer, MO	SMCG
	Display User (C)	Bruker av AMS display	generic role	External actor interacting directly with the simple external consumer display.	AMI operator		Consumer	SMCG
	Home Automation Operator (D)	Smarthusoperatør	generic role	External actor interacting directly with the home automation end device.			Consumer, ESP, Supplier	SMCG

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	AMI service engineer [E]	AMS servicemontør	generic role	External actor responsible for the installation, operation, maintenance and de-installation of the system components. It may access, if properly identified and authorized, those components either directly, via local operation and maintenance interfaces, or from a system component from a higher hierarchical level (e.g. meters may be accessed for maintenance purposes via NNAPs or the HES).	AMI Operator		MO, DNO	SMCG
	GIS Operator	GIS ansvarlig	Person	Operator of the Geographical Information System				
	DMS Operator	NIS-bruker (Distribusjon)	Person	Operator of the Distribution Management System				
	System Administrator	Systemadministrator	Person					
	Field crew	Montører - entreprenører	Person	actor on the field				
	Call Taker	Kundemottak	Person	actor generally using a Trouble call management system				
	Dispatcher	Driftssentralperson	Person	actor in charge of dispatching Electricity (usually at the transmission level				
x	Consumer	Kunde	Role	End user of electricity, gas, water or heat. NOTE: As the consumer can also generate energy using a Distributed Energy Resource, he is sometimes called the "Prosumer".				ENTSO-E role model updated by SMCG
x	Energy Service Provider, ESP	Energitjenesteleverandør	Role	Organisation offering energy services to the consumer.			supplier	SMCG
x	Supplier	Kraftleverandør	Role	Entity that offers contracts for supply of energy to a consumer (the supply contract). Within this role he will initiate DSM activities NOTE: In some countries referred to as Retailer				ENTSO-E role model
x	Distribution Network Operator, DNO	Nettselskap - distribusjon	Role	Organization responsible for managing the electricity, gas, heat and/or water network supplying consumer premises. Also refered to as DSO.	grid operator			SMCG

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
x	Balance Responsible Party	Balanseansvarlig	Role	A party that has a contract proving financial security and identifying balance responsibility with the imbalance settlement responsible of the market balance area entitling the party to operate in the market. This is the only role allowing a party to buy or sell energy on a wholesale level. Additional information: The meaning of the word "balance" in this context signifies that the quantity contracted to provide or to consume must be equal to the quantity really provided or consumed. Such a party is often owned by a number of market players. Equivalent to "Program responsible party" in the Netherlands. Equivalent to "Balance responsible group" in Germany. Equivalent to "market agent" in Spain.				ENTSO-E role model
x	Balance Supplier	Leverandør av balansetjenester	Role	A party that markets the difference between actual metered energy consumption and the energy bought with firm energy contracts by the party connected to the grid. In addition the balance supplier markets any difference with the firm energy contract (of the party connected to the grid) and the metered production. Additional information: There is only one balance supplier for each metering point.				ENTSO-E role model
x	Consumer	Kunde	Role	A party that consumes electricity. Additional information: This is a Type of Party Connected to the Grid		to SMCG		ENTSO-E role model
x	Grid Operator	Kraftnettoperatør	Role	A party that operates one or more grids.				ENTSO-E role model
x	Market Operator	Markedsoperatør	Role	The unique power exchange of trades for the actual delivery of energy that receives the bids from the Balance Responsible Parties that have a contract to bid. The market operator determines the market energy price for the market balance area after applying technical constraints from the system operator. It may also establish the price for the reconciliation within a metering grid area.		double		ENTSO-E role model
x	Party Connected to the Grid	Nettkunde	Role	A party that contracts for the right to consume or produce electricity at a metering point.				ENTSO-E role model

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
x	Producer	Kraftprodusent	Role	A party that produces electricity Additional information: This is a type of Party Connected to the Grid	Party Connected to the Grid			ENTSO-E role model
x	System Operator	Systemoperatør	Role	A party that is responsible for a stable power system operation (including the organisation of physical balance) through a transmission grid in a geographical area. The SO will also determine and be responsible for cross border capacity and exchanges. If necessary he may reduce allocated capacity to ensure operational stability. Transmission as mentioned above means "the transport of electricity on the extra high or high voltage network with a view to its delivery to final customers or to distributors. Operation of transmission includes as well the tasks of system operation concerning its management of energy flows, reliability of the system and availability of all necessary system services." (definition taken from the UCTE Operation handbook Glossary). Note: additional obligations may be imposed through local market rules.				ENTSO-E role model
x	Transmission System Operator (TSO)	Sentralnettsoperatør	Role	According to the Article 2.4 of the Electricity Directive 2009/72/EC (Directive): "a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the transmission system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the transmission of electricity". Moreover, the TSO is responsible for connection of all grid users at the transmission level and connection of the DSOs within the TSO control area.	system operator, grid operator			EG3
x	Distribution System Operator (DSO)	Distribusjonsnettoperatør	Role	According to the Article 2.6 of the Directive: "a natural or legal person responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity". Moreover, the DSO is responsible for regional grid access and grid stability, integration of renewables at the distribution level and regional load balancing.	grid operator			EG3

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
x	Generator	Generator	Role	Generating electricity, contributing actively to voltage and reactive power control, required to provide the relevant data (information on outages, forecast, actual production) to the energy marketplace (see also the Articles 2.1 and 2.2 of the Directive).				EG3
x	Electricity Installer / Contractor	Installatør	Role	Electrical contractors design, install and maintain intelligent systems for all kinds of industrial, commercial and domestic purposes. Alongside the power and lighting applications, they equally install ICT and telecommunications, public street lighting, high medium and low voltage lines, control and energy management systems, access, fire and security control equipment, lightning protection systems, advertising and identification signs, emergency power generating systems and renewable energy systems.				EG3
x	Retailer	Kraftselger/ Kraftomsetter	Role	Entity selling electrical energy to consumers - could also be a grid user who has a grid connection and access contract with the TSO or DSO. In addition, multiple combinations of different grid user groups (e.g. those grid users that do both consume and produce electricity) exist. In the remainder of this document, the terms customer/consumer and grid user are used interchangeably where appropriate.				EG3
x	Ancillary Services providers	Leverandør av systemtjenester	Role					EG3
x	Aggregator	Aggregator	Role	Aggregator offers services to aggregate energy production from different sources (generators) and acts towards the grid as one entity, including local aggregation of demand (Demand Response management) and supply (generation management). In cases where the aggregator is not a supplier, it maintains a contract with the supplier.				EG3
	Meter Data Collector, MDC	Måledatainnsamlings-anvarlig	Role	A party responsible for meter reading and quality control of the reading.				ENTSO-E role model
	Meter Operator, MO	Måleroperatør	Role	A party responsible for installing, maintaining, testing, certifying and decommissioning physical meters				ENTSO-E role model

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Metered Data Aggregator, MDA	Måledata-aggregator	Role	A party responsible for the establishment and qualification of metered data from the Metered data responsible. This data is aggregated according to a defined set of market rules.				ENTSO-E role model
	AccountingPoint responsible	Regnskapsansvarlig	Role	Responsible for the maintenance and mapping between the logical registers and the accounting points in compliance with local market rules				ENTSO-E role model
	Billing Agent	Faktureringsansvalig	Role	The party responsible for invoicing a concerned party. Note: This role has been introduced into the role model in order to underline the fact that the Imbalance settlement responsible has not the responsibility to invoice. However this role is not specific to the settlement process and may be used in other processes as required.				ENTSO-E role model
	Block energy supplier	Kraftselger	Role	A party that is selling energy on a firm basis (a fixed volume per market time period)				ENTSO-E role model
	Capacity Trader	Aggregator regulerkraftporteføljer	Role	A party that has a contract to participate in the capacity market to acquire capacity through a Transmission Capacity Allocator. Note: The capacity may be acquired on behalf of an Interconnection Trade Responsible or for sale on secondary capacity markets.				ENTSO-E role model
	Consumption Responsible Party	Balanseansvarlig	Role	A party who can be brought to rights, legally and financially, for any imbalance between energy bought and consumed for all associated metering points. Additional information: This is a type of Balance Responsible Party	Balance Responsibl e Party			ENTSO-E role model
	Control Area Operator	Kontrollområde-ansvarlig	Role	Responsible for: 1. The coordination of exchange programs between its related market balance areas and for the exchanges between its associated control areas. 2. The load frequency control for its own area. 3. The coordination of the correction of time deviations.				ENTSO-E role model

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Control Block Operator	ikke aktuelt	Role	Responsible for: 1. The coordination of exchanges between its associated control blocks and the organisation of the coordination of exchange programs between its related control areas. 2. The load frequency control within its own block and ensuring that its control areas respect their obligations in respect to load frequency control and time deviation. 3. The organisation of the settlement and/or compensation between its control areas.				ENTSO-E role model
	Coordination Center Operator	ikke aktuelt	Role	Responsible for: 1. The coordination of exchange programs between its related control blocks and for the exchanges between its associated coordination center zones. 2. Ensuring that its control blocks respect their obligations in respect to load frequency control. 3. Calculating the time deviation in cooperation with the associated coordination centers. 4. Carrying out the settlement and/or compensation between its control blocks and against the other coordination center zones				ENTSO-E role model
	Grid Access Provider	Tilknytningsansvarlig	Role	A party responsible for providing access to the grid through a local metering point and its use for energy consumption or production to the party connected to the grid.				ENTSO-E role model
	Imbalance Settlement Responsible	Ansvarlig for ubalanseavregning	Role	A party that is responsible for settlement of the difference between the contracted quantities and the realised quantities of energy products for the balance responsible parties in a market balance area.				ENTSO-E role model
	Interconnection Trade Responsible	Balanseansvarlig - tilknytning(?)	Role	Is a Balance Responsible Party or depends on one. He is recognised by the Nomination Validator for the nomination of already allocated capacity. Additional information: This is a type of Balance Responsible Party				ENTSO-E role model

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Market Information Aggregator	Aggregator av markedsinformasjon	Role	Market Information Aggregator, A party that provides market related information that has been compiled from the figures supplied by different actors in the market. This information may also be published or distributed for general use. Note: The Market Information Aggregator may receive information from any market participant that is relevant for publication or distribution.				ENTSO-E role model
	MOL Responsible	Regulerkraftmarkeds-operatør	Role	Responsible for the management of the available tenders for all Acquiring System Operators to establish the order of the reserve capacity that can be activated.				ENTSO-E role model
	Nomination Validator	?	Role	Has the responsibility of ensuring that all capacity nominated is within the allowed limits and confirming all valid nominations to all involved parties. He informs the Interconnection Trade Responsible of the maximum nominated capacity allowed. Depending on market rules for a given interconnection the corresponding System Operators may appoint one Nomination Validator.				ENTSO-E role model
	Production Responsible Party	Produksjonsgruppe-ansvarlig	Role	A party who can be brought to rights, legally and financially, for any imbalance between energy sold and produced for all associated metering points. Additional information: This is a type of Balance Responsible Party.				ENTSO-E role model
	Reconciliation Accountable	Avregningsansvarlig - ubalanseoppgjør	Role	A party that is financially accountable for the reconciled volume of energy products for a profiled Local metering point.				ENTSO-E role model
	Reconciliation Responsible	Balanseavregnings-ansvarlig	Role	A party that is responsible for reconciling, within a Metering grid area, the volumes used in the imbalance settlement process for profiled metering points and the actual metered quantities.				ENTSO-E role model
	Reserve Allocator	Regulerkraftallokering landsentral	Role	Informs the market of reserve requirements, receives tenders against the requirements and in compliance with the prequalification criteria, determines what tenders meet requirements and assigns tenders.				ENTSO-E role model
	Resource Provider	Regulerkrafttilbyder	Role	A role that manages a resource object and provides the schedules for it				ENTSO-E role model

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Scheduling Coordinator	Produksjonsplanlegger	Role	A party that is responsible for the schedule information and its exchange on behalf of a balance responsible party. For example in the Polish market a Scheduling Coordinator is responsible for information interchange for scheduling and settlement.				ENTSO-E role model
	Trade Responsible Party	Balanseansvarlig (kun finansielt) (?)	Role	A party who can be brought to rights, legally and financially, for any imbalance between energy bought and consumed for all associated metering points. Note: A power exchange without any privileged responsibilities acts as a Trade Responsible Party Additional information: This is a type of Balance Responsible Party.				ENTSO-E role model
	Transmission Capacity Allocator	ansvarlig for tilgjengelig overføringskapasitet	Role	Manages the allocation of transmission capacity for an allocated capacity area. For explicit auctions: The Transmission Capacity Allocator manages, on behalf of the System Operators, the allocation of available transmission capacity for an Allocated capacity area. He offers the available transmission capacity to the market, allocates the available transmission capacity to individual Capacity Traders and calculates the billing amount of already allocated capacities to the Capacity Traders.				ENTSO-E role model
	Industrial consumer	Industrikunde	Role	A large consumer of electricity in an industrial / manufacturing industry. May be involved in contract based Demand/Response.	Consumer			EG3
	Transportation consumer	Eltransportkunde	Role	A consumer of electricity providing transport systems. May be involved in contract based Demand/Response.	Consumer			EG3
	Building operator	Bygningsoperatør	Role	A consumer of electricity which is a private or business building, may also be involved in contract-based Demand/Response.	Consumer			near to EG3
	Home customer	Husholdning	Role	A residential consumer of electricity (including also agriculture users) may also be involved in contract-based Demand/Response.	Consumer			EG3

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Grid communications network providers	Kommunikasjons-leverandør	Role	Plan, build and maintain the communications systems that enable the data communication required to maintain grid stability, load balancing and fault protection systems by a TSO or DSO. This function is mostly executed by the TSO or the DSO, or may be performed by an independent actor but the overall responsibility and ownership of information remains with TSO and DSO.4 Grid communications network provider ensures compliance with the agreed service levels (Service Level Agreements including quality of service, data security and privacy) and compliance with any national and/or international regulations as necessary;				EG3
	Meter Data Management System, MDMS	Meter Data Management System, MDMS, Måleverdidatabase	System	System for validating, storing, processing and analyzing large quantities of meter data.				ENTSO-E role model
	Timer	Timer/tidsur	System	An initiator that triggers of time based/scheduled use cases	AMI System			SMCG
	Head End System (HES)	Måleverdiinnsamlings-system	System	Central Data System collecting data via the AMI of various meters in its service area. It communicates via a WAN directly to the meters and/or to the NNAP of LNAP.	AMI System			SMCG
	NNAP	Tilknytningspunkt for nettverk med flere kunder	System	The Neighbourhood Network Access Point is a functional entity that provides access to one or more LNAP's, metering end devices, displays and home automation end devices connected to the neighbourhood network (NN). It may allow data exchange between different functional entities connected to the same NN.	AMI System			SMCG
	LNAP	Tilknytningspunkt nettverk lokalt hos kunde	System	The Local Network Access Point is a functional entity that provides access to one or more metering end devices, displays and home automation end devices connected to the local network (LN). It may allow data exchange between different functional entities connected to the same LN.	AMI System			SMCG
	Smart Meter (SM)	AMS måler	System	Meter with additional functionalities one of which is data communication.	AMI System			SMCG
	Simple external consumer display	AMS Display	System	Display providing accurate information on consumption, tariffs and so on in order to increase consumer awareness.	AMI System			SMCG

High Level Actors	Actor Name	Navn på aktør	Actor Type	Actor Description	Parent	Equivalent to	Possible Roles/ Func-tions	Source
	Home automation end device	Energistyringsapparat	System	Device providing additional functionalities enabling consumers to interact with their own environment.				SMCG
	Energy Management Gateway	Energistyrings Gateway	System					DKE Repository
	Energy Management LAN	Energistyrings LAN	System					DKE Repository
	Object device	Apparat	System	Combination of load and generation object devices				DKE Repository
	Appliances	Apparat	System	Object devices	Customer			DKE Repository
	El. Vehicle (EV/PHV)	Elektrisk kjøretøy (EV/PHEV)	System		Transpor-tation			DKE Repository

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