

## Appendix 1 SGAM

The smart grid architecture model (SGAM) was created by CEN, CENELEC, ETSI and is defined in *CEN-CENELEC-ETSI Smart Grid Co-Ordination Group Smart Grid Reference Architecture* Bruinenberg et al (2012). The main purpose of SGAM is to model interactions between different components of a system, where mainly the exchange of information is characterised. The framework models these interactions in three dimensions: Domains, Zones and Layers.

The five layers represent the interoperability from different viewpoints on the system, allowing for the consideration of the business goals and involved stakeholders, a functional view of the system, the information exchange and related standards, communication protocols and finally, the hardware and software components used to implement the system.

On each layer of the model a plane composed of domains and zones is presented. The five domains, generation, transmission, distribution, DER and customer premises, are derived from the different domains of the electrical energy production and conversion chain. The six zones are based on the automation pyramid; process, field, station and operation, along with two additional zones for enterprise and market concerns. A visual representation of this three dimensional model is shown in Figure 1.

Employing the SGAM framework offers several advantages, as can be seen by the variety of already preexisting approaches which utilise it as were described in Uslar et al (2019). The structure of model allows for a holistic view on the system, which is useful for finding interoperability problems Messinis et al (2016), and ensures consistency by tracing the components through the SGAM layers, highlighting the places where a given architecture design may be insufficient.

